REPORT

Tonkin+Taylor

Herne Bay Tunnel – Construction Noise and Vibration Management Plan

Construction Noise and Vibration Management Plan

Prepared for
Watercare Services Ltd
Prepared by
Tonkin & Taylor Ltd
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Distribution:

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1 Introduction

Tonkin & Taylor Ltd (T+T) has been engaged by Watercare Services Ltd to provide a draft Construction Noise and Vibration Management Plan (CNVMP) for works associated with the construction of the Herne Bay Trunk Sewer Line (the Project) to support the resource consent application. The Project will connect to the proposed Central Interceptor (CI) wastewater conveyance and storage tunnel that is planning to be extended from Tawariki Street in Grey Lynn to a new drop shaft in Point Erin Park.

This draft CNVMP identifies the likely construction noise and vibration levels for the project and sets out the best practicable options (BPO) for noise and vibration management that will be implemented to mitigate and minimise any adverse noise and vibration effects. It also outlines community engagement with surrounding affected residents in relation to the noise and vibration aspects of the project.

This draft CNVMP relies on information around the construction methodology provided by the Contractor, Brian Perry Civil Ltd[1]. It will be finalised prior to works commencing.

The final CNVMP will be implemented throughout the construction period. It will be considered a 'living document' that should be amended and updated as appropriate and is intended to be the primary tool to manage the project's construction noise and vibration effects.

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[1] Construction methodology Updated 13 March 2023, Memorandum, From Tony Sage (Brian Perry Civil Ltd)

2 Roles and responsibilities

2.1 Environmental roles and responsibilities

Each person involved in the Project has equal responsibility to avoid, remedy or mitigate adverse environmental effects. There are three key groups with responsibility for environmental management of the Project:

- Watercare as the Project owner and holder of the resource consents;
- Brian Perry Civil Ltd undertaking the works; and
- Auckland Council to audit the works and monitor compliance with designation and resource consent conditions, the Construction Management Plan (CMP) and sub-plans.

2.2 Project contacts

The Project Manager has the overall responsibility for complying with the requirement of this CNVMP. The Site Manager is responsible for community engagement.

Table 2.1 sets out the contact details for key project personnel relevant to the implementation of this CNVMP.

Table 2.1: Contact details

Role	Name	Organisation	Phone	Email
Project & Site Manager (Contractor)	Tony Sage	Brain Perry Civil Ltd	022 0479 490	tonysa@fcc.co.nz
Site Manager	TBC	TBC	xx	xx
Community Liaison Manager	TBC	TBC	xx	xx
Acoustic Consultant	Sharon Yung	Tonkin + Taylor Ltd	xx	xx
Compliance Officer	TBC	TBC	xx	xx

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3 Project overview

3.1 Timeframe

The indicative construction methodology indicated construction activities are expected to be undertaken within two years of commencement. Commencement date TBC.

3.2 Hours of operation

Noise generating activities and truck movements will typically occur during standard construction hours, which are as follows:

- Monday to Friday: 6:30 am to 7:00 pm (noise generating activities to occur from 7 am);
- Saturdays: 8:00 am to 6:30 pm;
- Sundays or public holidays: no works;
- Tunnelling activities will occur during standard construction hours only.

3.3 Description of works

Watercare is working jointly with Auckland Council in delivering a programme of infrastructure improvement works to reduce wastewater overflows and improve water quality at local beaches. The programme of works is known as the Western Isthmus Water Quality Improvement Programme (WIWQIP).

To build a resilient wastewater system and ensure reliability of service and reduced overflows, Watercare is proposing to construct a new wastewater trunk sewer for the Herne Bay catchment, to connect into the proposed Central Interceptor (CI) tunnel extension to Point Erin Park.

The scope of the works involves:

- Installation of approximately 1.5 km of 2.1 m internal diameter trunk sewer line, constructed via a tunnel-boring machine (TBM);
- Installation of approximately 150 m of 600 mm diameter trunk sewer within Marine Parade, constructed via open-cut trenching;
- Construction of 8x primary tunnel shafts, ranging in diameter from 3.5 m to 11 m, along with 4 x 3.5m diameter intercepting shafts;
- Installation of 4 x interception pipes and 11 x connections to existing engineered overflow points ('EOP's);
- Establishment of two construction support areas (CSAs) in public reserves; and,
- Relocation and reinstatement of utilities as required;

Figure 3.1 below shows the proposed alignment and key features of the Project.

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Figure 3.1: Project alignment

The pipeline is constructed via a series of shafts from which a tunnel boring machine (TBM) is launched (thrust shafts) and retrieved (receiving shafts). As the TBM progresses along the alignment, sections of pipe are placed in the thrust shaft and then jacked in behind the TBM as it progresses.

The tunnel will progress from Point Erin Park along the alignment to Marine Parade. Shafts are required at the changes in direction to provide entry for the TBM (thrust shafts) and to retrieve the TBM (receiving shafts) and will be constructed as the project progresses ensuring there is a receiving shaft as the TBM commences a drive towards it.

Following completion of the main drive, the interception shafts can be constructed adjacent to the main tunnel and the connections to the EOP's either drilled with trenchless technology or laid in open trenches as feasible. As works are completed in each area, the local site will be disestablished and returned to public use as soon as practicable.

Preliminary geological investigations have indicated that rock is not expected to be encountered at open-cut trench depths and no surface rock breaking will be required.

Other noise generating activities that are not specifically identified as part of this draft CNVMP will be addressed as they are identified. Site vehicle movements have been considered within this draft CNVMP, however haulage to and from the site is not specifically addressed in this draft CNVMP. Haulage is unlikely to significantly alter the existing traffic noise environment in and around the site.

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3.4 Construction method and staging

Table 3.1 provides the preferred method, depth and location of each connection. The construction staging and activities are summaries in

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Table 3.2.

Table 3.1: Indicative construction method for interception lines and EOP connections

Shaft Name	Location	Methodology	Distance	Depth to Invert	End Depth
SE01	59 Hamilton Road	Steel Casing			17.8 m
EP202	69 Hamilton Road	Horizontal Drill	85 m	1.1 m	11.5 m
EP195	59 Hamilton Road	Open trench Excavation	6.4 m	2.0 m	2.3 m
SE02	80 Sarsfield Street	Steel Casing			13.4 m
EOP200	28 Sentinel Road	Open trench Excavation	184 m	4.0 m	4.7 m
SE03	91 Sarsfield Street	Steel Casing			9 m
EOP201	91 Sarsfield Street	Open trench Excavation	4.3 m	4.1 m	4.5 m
Shaft 2		Secant Pile			14 m
EOP1019	11 Cremorne Street	Open trench Excavation	55 m	2 m	5 m
EOP1019 WWMH01	12 Stack Street	Horizontal Drill	85 m	7.3 m	8.7 m
EOP1019 WWMH02	1 Wairangi Street	Horizontal Drill	80 m	5 m	7.3 m
SE04	45 Argyle Street	Steel Casing			7m
EOP740A	45 Argyle Street	Open trench Excavation	7 m	4.1 m	5 m
Shaft 4		Secant Pile			17 m
EOP197	1 Marine Parade	Horizontal Drill	65 m	3.6 m	14.5 m
Shaft 7		Trench box			6 m
EOP198	22 Marine Parade	Open trench Excavation	3.5 m	4.7 m	4.9 m
Shaft 8		Trench box			2.5 m
EOP199A	Bella Vista Road x Marine Parade	Open trench Excavation	26.5 m	1.8 m	2.3 m

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Table 3.2: Construction and staging activities

Construction Elements	Activities
Establishment	Main site established – (At Salisbury Reserve and 94a/94b Shelly Beach Road) • Central construction support compound set up. • Worker welfare facilities established. • Temporary traffic management set out.
Enabling	Enabling works at each shaft location: • Pothole services throughout the route. • Service diversions.
Satellite site establishment	• Traffic and fencing management. • Environmental controls. • Hardfill. • Plant delivery.
Shaft piling	• Piling shaft construction. • Temporary excavation support – either casing shaft or secant piling. • Removal of spoil.
Shaft construction	• Concrete breaking back. • Excavation. • De-water shafts. • Concrete construction.
Interception shafts construction	• Construct drilling platform. • Drill 3.5 m diameter casing. • Cut into main sewer.
Tunnelling	• Tunnelling using a TBM. • Set up tunnelling rig/equipment – supporting crane and excavator. • Spoil removal. • Install pipes.
Manhole construction	• Install manholes within shafts. • Progress backfilling of shaft around manhole. • Removal of sheet piling or casing shaft as required. • Break down concrete of secant shaft 1 m below ground. • Reinstatement of surrounding roadway.
Directional drilling	Directional drill • Excavate drill pits with trench shields. • Drill bore. • Pull through drainage line.
Open trenching	Open trench construction (limited section as needed) • Temporary excavation support – trench shields. • Removal of spoil – to be loaded onto truck and removed from site. • Install bedding and then new pipe, manhole backfill. • Reinstatement works. • Activities will be undertaken during daytime hours.

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Construction Elements	Activities
Reinstatement	• Road reconstruction. • Concrete break out and excavation. • Kerbing. • Traffic Islands and footpaths. • Asphalt. • Line marking.

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4 Performance standards

4.1 Consent conditions

Resource consent BUNxxxxx provides the following consent condition(s) in relation to construction noise:

XXX TBC upon receipt of consent XXX

4.2 Project thresholds

Where works are within the road reserve there are no noise limits applicable, and the vibration limits are solely those set out in DIN 4150-3: 1999 provided this CNVMP is submitted to Council no less than five days prior to works commencing.

The removal of noise limits for works in the road reserve allows for potentially disruptive works to be completed efficiently to minimise road closures and subsequent disruption. As stated, this does not remove the requirement to manage noise levels.

The project's noise and vibration thresholds are detailed in Table 4.1.

Table 4.1: Project thresholds

Time period	Noise dB – 1 m from occupied building		Vibration mm/s PPV
	$L_{AEQ\ (15min)}$	L_{AMAX}	
Standard construction hours 7:00 am to 6 pm, Monday to Saturday	70	85	DIN 4150-3
06:30 am to 07:30 am, Monday to Friday	55	75	DIN 4150-3
06:00 pm to 08:00 pm, Monday to Friday	65	80	DIN 4150-3
All other times	45	75	DIN 4150-3

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5 Construction equipment

5.1 Noise sources

Table 5.1 provides indicative construction noise levels for proposed activities 1 m from building façade without noise barriers and approximate activity sound power levels in Table 5.2. These tables will be used by the Project Manager (or nominated person) prior to construction to inform what equipment will require mitigation and/or management and when specific engagement is required with affected properties. At the request of the Project Manager, it shall be kept up to date by the Acoustic Consultant when new information becomes apparent through noise monitoring or other means.

Table 5.1: Equipment list – Source data and indicative construction noise levels at different distances (without mitigation)

Source	Sound Power Level (dB L_{WA})	Noise Level (dB L_{Aeq}) at set back distances				Set back distance to achieve 70dB (m)
		10 m	20 m	30 m	50 m	
Auger pile rig (Secant pile)	111	86	80	76	71	52
Vibro pile rig (casing)	110	85	79	75	70	48
23 t Excavator with breaker attachment	112	87	81	77	72	58
15 t Excavator	96	71	65	61	56	11
300 t Crane	104	79	73	69	64	28
100 t Mobile crane	101	76	70	66	61	20
Hiab	98	73	67	63	58	14
Concrete pump	103	78	72	68	63	25
Concrete saw	114	89	83	79	74	69
Road miller (mini)	96	71	65	61	56	11
Road paver	104	79	73	69	64	28
8 t Roller	103	78	72	68	63	25
500 kg compactor (4 t)	105	80	74	70	65	30
Hydrovac	111	86	80	76	71	52
3 axle- Trucks	105	80	74	70	65	30
Dewatering pump	98	73	67	63	58	14
Generator	101	76	70	66	61	20
Slurry treatment plant	107	82	76	72	67	36
Horizontal Directional Drill (HDD)	106	81	75	71	66	33
6-wheeler trucks	107	82	76	72	67	36

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Table 5.2: Activity sound power levels and compliance distance without mitigation

Activity	Activity sound power level (dB L_{WA})	Setback distance to achieve 70 dB without mitigation (m)
Enabling works	111	54
Secant piling for shaft	112	58
Shaft construction	112	58
Manhole construction	113	61
Open trenching	114	68
Road reinstatement	112	60
Tunnelling support	110	47
Directional drilling	106	33
Support area (stock piling, refuelling, steel cage construction)	104	28

5.2 Vibration sources

Vibration predictions have been carried out using the empirical relations contained in BS 5228-2[2]. These relations are known to be conservative as they tend to over-predict compared to validation trials. Set back distances have been calculated for the main items of equipment and presented in Table 5.3 below.

Table 5.3: Indicative vibration levels at distances

Distance from activity	Excavator with breaker – percussive breaking of concrete hard surfaces (PPV)	Compactor /Vibro casing (PPV)	Auger bore piles (PPV)	20T Excavator (PPV)
5 m	3 – 5 mm/s	3 - 4 mm/s	1.5 - 2 mm/s	2 – 3 mm/s
10 m	2 – 4 mm/s	2 - 3 mm/s	1 – 1.5 mm/s	1 – 2 mm/s
15 m	2 – 3 mm/s	2 - 3 mm/s	< 1 mm/s	1 – 2 mm/s
20 m	1 – 2 mm/s	1 - 2 mm/s	< 1 mm/s	1 mm/s

[2] BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Vibration.

6 Noise and vibration levels

6.1 Receivers

Residential receivers are situated around all construction work areas of the Project. The majority of receivers are two storey high buildings, with a number of apartment blocks and three storey high buildings. A map of nearby properties that may potentially be affected by noise and/or vibration from the construction works have been identified in **Appendix B.**

The Project's tunnel alignment follows along the road reserve of Sarsfield Street, Wallace Street, Argyle Street, Herne Bay Road, Upton Street and part of Marina Parade. The TBM will operate at a depth between 3 m and 17 m below ground surface level with the shallowest depths between shaft 6 and 7. Potential receivers have been identified in **Appendix C**.

AUP zoned Herne Bay Road 'Historic Heritage Area' is located on both the western and eastern frontages of Herne Bay Road and includes the road reserve as shown in Figure 6.1 and Figure 6.2. Two receivers are listed historic heritage buildings[3] at 58 Wallace Street and 85 Sarsfield Street as shown in Figure 6.2. These properties are considered sensitive to vibration for this Project and are subjected to DIN 4150-3 limit of 3 mm/s.

Figure 6.1: Herne Bay Road Heritage Area (purple hatching)

[3] As listed on Heritage New Zealand Pouhere Taonga

Figure 6.2: Two scheduled receivers (purple hatching)

6.2 Predicted noise levels

Appendix D summarises the predicted worst-case noise levels for receivers without screening for the construction activities. Noise levels are shaded to identify low (green), medium (orange) and high (red) risk ratings with the same shading as the hierarchy of mitigation Table 7.1.

The table identifies receivers located within 80 m radius of each shaft location[4] and their associated distance from the nearest surface construction area to be used in conjunction with Table 5.1.

For the stockpiling at Salisbury Reserve CSA the predicted noise levels and distances from site boundary at most receivers directly adjacent to the compound are identified in Table 6.1 below.

[4] No predicted exceedances of the AUP construction noise limits beyond 80m from any construction works.

Table 6.1: Predicted noise level at nearest receivers from CSAs site

Address	Distance from compound site boundary (m)	Predicted noise level at first floor level (L_{Aeq}, dB)
		Stock piling activities
14 Argyle Street	5	**75**
4/40 Wallace Street	7	**72**
6 Argyle Street	7	**72**
32D Wallace Street	10	69
5/26 Wallace Street	10	69
6/26 Wallace Street	10	69
42A Wallace Street	11	68
4/36 Wallace Street	14	66
26 Argyle Street	16	65
16 Argyle Street	26	61
Point Erin Swimming pool	90	47
121C Shelly Beach Road	180	40

The CSA at 94a/94b Shelley Beach Road is located over 90 m from the nearest receiver (Point Erin Swimming Pool) and over 180m from the nearest residential receiver. The distance alone effectively mitigates noise associated with activities at this site.

6.3 Predicted vibration levels

Properties predicted to potentially exceed the DIN 4150-3 limits are presented in Table 6.2. A full list of receivers with their predicted vibration levels from works other than tunnelling is provided in **Appendix D.**

Table 6.2: Properties predicted to exceed Project vibration limit

Address	Building Classification	Predicted vibration level, PPV
1 Marine Parade	Residential	**> 10 mm/s**
8 Wairangi Street	Residential	**5 - 6 mm/s**
6 River Terrace	Residential	**4 - 5 mm/s**
33 Marine Parade	Residential	**4 - 5 mm/s**
34 Herne Bay Road	Historical / Sensitive	**4 - 5 mm/s**
72 Argyle Street	Historical / Sensitive	**3 - 4 mm/s**

A full list of receivers with their predicted vibration levels from tunnelling is provided in **Appendix E**.

Consultation as per Section 9 will be undertaken with all adjacent landowners affected by the exceedance identified in **Appendix D** and **Appendix E.** Consultation communications and specific mitigation will be documented and appended to this report (**Appendix F**).

7 Procedures for managing risk

7.1.1 General requirements

Works within the road reserve are going to be less than 30 m from the nearest receivers and likelihood of exceedances are likely to be medium and high risk. Works shall adopt BPO to ensure that noise and vibration levels do not exceed a reasonable level for prolonged durations.

A hierarchy of mitigation measures is set out in Table 7.1. Mitigation measures are outlined in detail in Section 8.

Table 7.1: Hierarchy of mitigation

Risk	Hierarchy of mitigation
Low (< 70 dB L_{Aeq})	General measures: • Staff training and awareness. • Stakeholder/community engagement. • General equipment measures.
Medium (70 – 75dB L_{Aeq})	Mitigation measures: • Stakeholder engagement and confirmation of occupancy and times of greatest sensitivity to noise exposure (both residential and commercial). • Where practicable utilise acoustic screens/barriers for works at ground level. • Use of low vibration equipment or alternative construction methodology.
High (> 75 dB L_{Aeq})	Enhanced mitigation measures: • Where practicable place additional acoustic screens including at the source of the noise, i.e., if percussive breaking or concrete cutting is required. • Further engagement with affected parties for works to be arranged around times when properties will be unoccupied, or occupants agree to high noise / vibration levels. • Methodology to be changed e.g., to crushing/grinding or hand breaking if practicable.

7.2 Specific requirements

7.2.1 Surface construction works within road reserve

7.2.1.1 Noise

- 1.8 m acoustic screens should be erected around the perimeter of the active construction site to mitigate noise levels at ground level, if practicable.
- Additional localised screening should be included, if practicable. For example, when percussive breaking is undertaken for extended periods of time (> 1 hour) and within ~ 30 m of occupied receivers.
- Care should be taken when creating high noise near to where the public may be present (adjacent to pedestrian walkways), such as during surface breaking and saw cuts.
- Advanced notice and communication should be given to the most affected receivers within 50 m around each work site at least 3 weeks prior to work commencing.
- If practicable, the alternative method of HDD should be used where exceedances over 85 dB L_{Aeq} are predicted due to open cut trenching activities for interception pipelines.

7.2.1.2 Cumulative effects with CI

If noisy activities potentially overlap with CI, efforts to mitigate noise levels should be undertaken with CI's coordination via communication and scheduling. This scheduling will be documented appended to this CNVMP.

When sheet piling for CI is occurring along the southern-west corner of Point Erin Park, no noisy works around shaft 1 shall be undertaken concurrently.

7.2.1.3 Vibration

Properties predicted to experience DIN4150-3 limits of 5 mm/s for residential and 3 mm/s for sensitive/heritage buildings will require a building condition survey as per Section 8.9.1 prior to works commencing within 10 m commencing. Vibration monitoring as per Section 10 will be required throughout works within 10 m of the properties to ensure vibration levels do not exceed predicted levels where possible.

The following properties will require a building condition survey and advance consultant:

Table 7.2: Properties requiring building condition surveys

Address	Closest works area	Building Type / DIN4150-3 limit
1 Marine Parade	HDD	Residential / 5mm/s
8 Wairangi Street	Open Trench	Residential / 5mm/s
72 Argyle Street	Shaft 4	Heritage / 3mm/s
34 Herne Bay Road	Shaft 5	Heritage / 3mm/s

Heritage area / listed buildings of 58 Wallace Street, 85 Sarsfield Street and 29 Herne Bay Road will require monitoring as per Section 10 when works are within 15 m of receivers.

7.2.2 Construction support area mitigation

- 1.8 – 2 m high hoarding is recommended around the parameter of the CSA at Salisbury Reserve and stock piling activities to be undertaken at 94a/94b Shelley Beach Road CSA only. See Figure 7.1.
- Construction of pile cages must use localised screening on a minimum of three sides and use a low noise generating cutter such as a hydraulic bar cutter at Salisbury Reserve.

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Figure 7.1: Barrier location plan – CSA Salisbury Reserve

7.2.3 Tunnelling works

Tunnelling works are not expected to operate at night for this Project.

If emergency night time works are required, consultation should be undertaken for receivers within 18 m of the approaching TBM location where emergency night time works may be anticipated (refer to Appendix C). Consultation should include information of potential regenerated noise and vibration effects for the building occupants. Temporary relocation may be considered on a case-by-case basis.

7.2.4 Works outside of standard hours

Activities outside of standard work hours such as site meetings, setup, pack-ups, large plant delivery and CCTV should be limited as far as practicable.

This CNVMP shall be updated with an activity specific section if these activities are required to identify management and mitigation measures (i.e., adopting the best practicable option (BPO) to minimise potential adverse effects) such as communication with surrounding properties, the use of acoustic barriers and other practicable controls.

8 Noise management and mitigation

8.1 Training

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

- Construction noise and vibration thresholds;
- Activities with the potential to generate high levels of noise or vibration;
- Noise mitigation and management procedures; and
- The sensitivity of receivers and any operational requirements and constraints identified through communication and consultation.

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

8.2 Equipment selection

When selecting construction equipment, where practicable:

- Prioritise quieter construction methodologies;
- Prioritise electric motors over diesel engines;
- Prioritise rubber tracked equipment over steel tracked equipment;
- Equipment should be suitably sized for the proposed task;
- Equipment should be maintained and fitted with exhaust silencers and engine covers; and
- Avoid tonal reversing or warning alarms (suitable alternatives may include flashing lights, broadband audible alarms or reversing cameras inside vehicles).

8.3 General measures

Complaints can arise whether or not noise levels comply with the thresholds. To avoid complaints, 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;
- Mitigate track squeal from tracked equipment, such as excavators (may include tensioning and watering or lubricating the tracks regularly);
- Minimise construction duration near sensitive receivers;
- Stationary equipment should be located away from noise sensitive receivers and site buildings and material stores used to screen them;
- Orient mobile machinery to maximise the distance between the engine exhaust and the nearest sensitive building façade (e.g. excavators);
- Utilise noise barriers where appropriate;
- Implement specialised mitigation measures for concrete cutting and percussive breaking.
- Ensure additional communication with affected building occupants is completed prior to commencing activities that are predicted to exceed the noise performance standards; and
- Undertake noise and vibration monitoring as appropriate.

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8.4 Noise barriers

Acoustic panels must be abutted or overlapped to provide a continuous screen without gaps at the bottom or sides of the panels.

Examples of temporary noise barriers include the following proprietary 'noise curtains':

- Echo Barrier Temporary Acoustic Noise Barrier (http://www.supplyforce.co.nz/);
- Duraflex 'Noise Control Barrier - Performance Series' (www.duraflex.co.nz);
- Soundex 'Acoustic Curtain - Performance Series' (www.ultimate-solutions.co.nz);
- Flexshield 'Sonic Curtain with 4 kg/m^2 mass loaded vinyl backing' (www.flexshield.co.nz).

8.5 Percussive breaking

If percussive breaking is required to break hard surfaces, then where practicable:

- Use acoustic screens where extended percussive breaking in proximity to receivers is required;
- Use the correct chisel / tip shape for the type of material being broken;
- If within 10 m of any building, deploy vibration monitoring; and
- Schedule percussive breaking to occur between less noise sensitive times, e.g., 9 am – 5 pm, or through consultation with neighbours.

8.6 Piling and compaction

Noise and vibration mitigation methods and measures for piling and compaction activities shall include, where practicable:

- Minimising cable slap and chain clink;
- Providing mufflers and engine covers/screens on plant where appropriate;
- Removing obstructions which may exacerbate vibration transmission where appropriate, prior to piling operations;
- Minimise alternating rotation of the bored piling auger to loosen spoil into the muck bin; Shaking the 'kelly bit' connection creates very loud banging that can result in noise complaints.

8.7 Scheduling

Scheduling of construction activities can be a key tool for managing construction noise and vibration effects. The time of day and the duration of the construction activities will be adjusted after consultation, where possible, to avoid particularly sensitive times for affected receivers.

The following should be considered:

- Identify any particularly sensitive times for high-risk receivers and where practicable avoid nearby noisy works during those times;
- Night time disturbance to nearby residential receivers will be reduced by carrying out noisy activities during the day;
- Provide respite periods by limiting the number of consecutive nights worked near residences;
- Where practicable, avoid conflicts with community events.

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Where there are no practicable alternative options to complete works prior to 7 pm and noise level exceedances are anticipated, it will be necessary to implement enhanced noise and vibration management measures. For example:

- Increase the frequency of communications with stakeholders;
- Carry out regular noise and vibration monitoring to confirm noise and vibration levels; or
- Offer temporary relocation to affected residents if unreasonable noise and/or vibration levels cannot be avoided.

8.8 Vibration mitigation

A hierarchy of vibration mitigation measures should be adopted through the draft CNVMP as follows:

- Managing times of activities to avoid night works and other sensitive times where practicable (communicated through community liaison);
- Liaising and consultation with neighbours prior to commencing works for vibration generating activities;
- Selecting equipment and methodologies to minimise vibration;
- Monitoring of vibration during activities predicted to exceed the 2 mm/s amenity limit and at the two heritage buildings;
- Where vibration levels are predicted to exceed the applicable DIN 4150-3 limit (5 mm/s for residential, 3 mm/s for heritage) then a building condition survey shall be undertaken in general accordance with the parameters set out in Section 8.8.1.

Mitigation will therefore focus on effective communication with neighbours, and selection of appropriate equipment and methods.

8.8.1 Building condition surveys

A pre-construction building condition survey will be undertaken at all of the identified buildings detailed in Table 6.2 before the main works construction begins. The Construction Manager will request in writing the approval of the property owner to undertake a building condition survey at the following times:

- Where vibration is predicted to exceed the cosmetic building damage limits (Table 6.2);
- Where vibration is measured to exceed the cosmetic building damage limits in (**Appendix D**) and/or in response to a reasonable claim of damage from construction vibration;
- A post condition survey will be undertaken after construction works has been completed, unless the landowner agrees otherwise, or if monitoring determines the post condition survey is unnecessary (ie below the DIN4150-3 threshold).

The building condition surveys will generally be undertaken as follows:

- The building surveys will be undertaken by a suitably qualified and experienced practitioner;
- Seek permission from the owner of a building, structure or service for a suitably qualified and experienced practitioner to prepare a report that describes:
  - any information about the type of foundations;
  - the existing levels of damage (cosmetic, superficial, affecting levels of serviceability);
  - any observed damage is associated with structural damage;

  - identifies the potential for further damage to occur and describes actions that will be taken to avoid further damage; and
  - photographic evidence;
- The Project team will provide the building condition survey report to the property owner.

Where further surveys identify damage has been encountered relevant suitably qualified specialists will be engaged to investigate the cause. This may include the vibration specialist, building inspector and building condition author. The outcome of the investigation will be shared with the complainant/affected receiver. If it is determined that the Project is responsible for the damage, a plan will be made to rectify it at Watercare's cost.

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9 Communication and complaints

This section details the communication procedures relating to noise and vibration for the Herne Bay Project as well as the complaints process. The CMP and Communications Plan contain a more detailed discussion of communication activities for the Project.

9.1 Communication

Written communication (e.g., newsletter, emails, letter drops) shall be provided to occupiers of buildings within 100 m of the shaft sites at least 5 days prior to the Project works commencing. It will acknowledge that some activities are predicted to generate high noise and/or vibration levels that may result in disturbance for short periods. It will include details of the overall works, its timing, duration and contact details for where complaints and enquiries should be directed.

Written communication during the works will include:

- Public site signage to include contact details for the Project's communication liaison officer;
- Regular project updates will include details of impending activities that may result in disturbance, including secant piling, open-cut trenching, hydro excavation and road breaking. It will include scheduled timing and duration of these activities and contact details where complaints and enquiries should be directed; and
- Occupants of buildings within 100 m of night works will be advised at least 5 days prior to the works commencing.

9.2 Complaints

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

- Acknowledge receipt of the concern or complaint and record:
  - Time and date the complaint was received and who received it;
  - Time and date of the activity subject to the complaint (estimated where not known);
  - The name, address and contact details of the complainant (unless they elect not to provide);
  - The complainant's description of the activity and its resulting effects; and
  - 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;
- If a reasonable complaint relates to building damage, inform the on-duty site manager as soon as practicable and cease associated works pending an investigation;
- Review the activity noise and/or vibration levels (Section 6) to determine if the activity is predicted to comply with the relevant performance standards (Section 4) at the complainant's building;
- Consider attended monitoring to verify the underlying reference level assumptions;
- If the activity is measured to be non-compliant with the noise and/or vibration limits (Section 40) the following shall be undertaken;
  - Implement mitigation measures (Sections 7 and 8) and undertake additional monitoring to determine compliance;

- If compliance cannot be achieved, halt works and prepare an addendum to this draft CNVMP (if not already done);
- Report the findings and recommendations to the Construction Manager, implement changes and update this draft CNVMP as appropriate; and
- 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.

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10 Noise and vibration monitoring

Construction noise and vibration levels will be monitored:

- At the start of high noise and vibration activities (as highlighted red in and Table 5.3);
- As required by this CNVMP;
- In response to a reasonable noise or vibration complaint;
  - For noise – at 1 m from the most affected building façade, or proxy position and adjusted for distance and façade reflections where appropriate;
  - For vibration – at the foundation of the building or in accordance with DIN 4150-3:1999;
- By a suitably qualified and experienced practitioner (e.g., Member of the Acoustical Society of New Zealand);
- For a representative duration, reported with the measured level (e.g., 70 dB $L_{Aeq\ (15\ min)}$); and
- The results should be used to update the noise and vibration source data used in the calculations if appropriate.

Noise and vibration monitoring will be undertaken in accordance with the requirements of NZS6803 and DIN 4150-3 respectively.

A monitoring flowchart is presented as Figure 10.1 below.

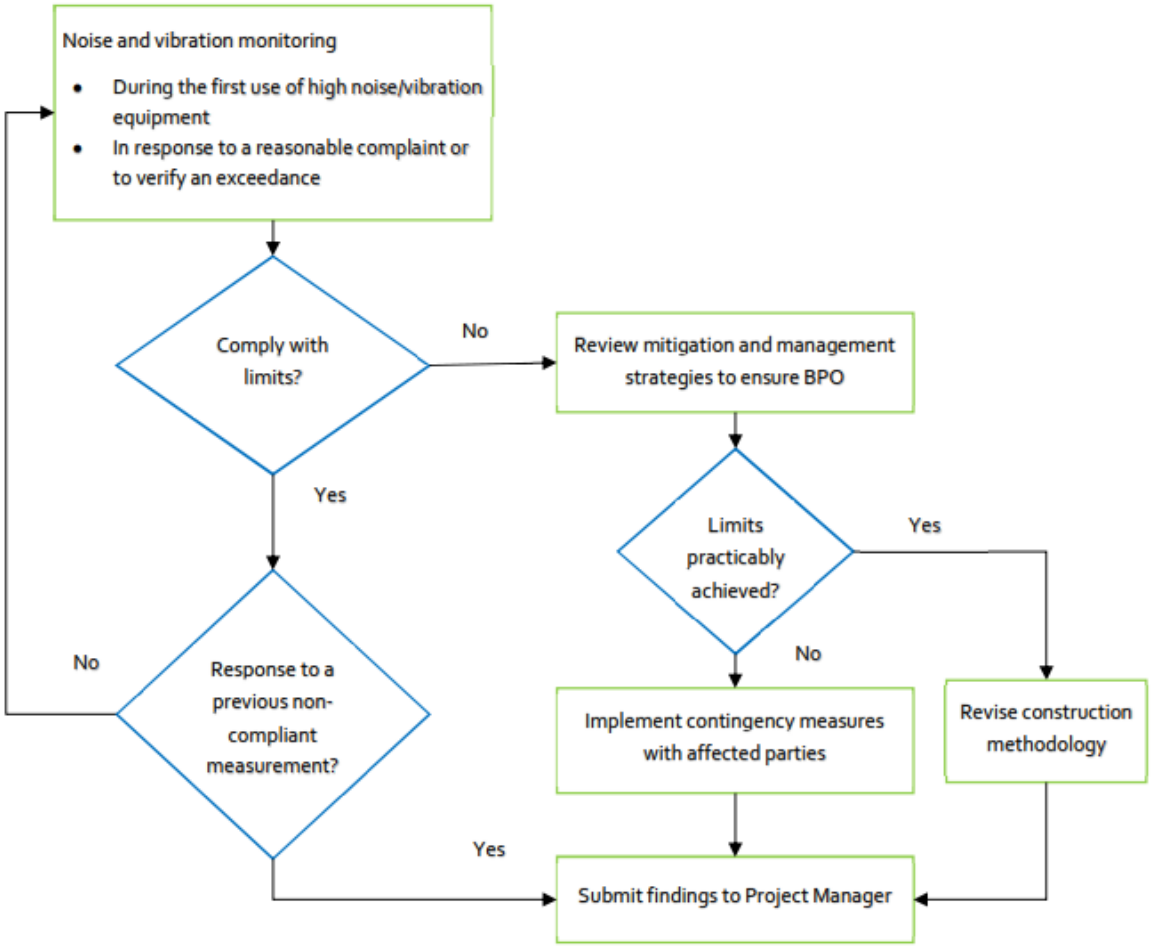

Figure 10.1: Noise monitoring flowchart

Measurements will be taken if any high-risk construction activities source levels need validating. These source measurements will be performed by the project's Acoustic Consultant. The results of these source measurements will be used to update the noise source data in this draft CNVMP.

If noise monitoring indicates that project criteria are being exceeded, and that was not anticipated in the draft CNVMP for the activity/location, then the management plan will be immediately reviewed. A construction noise management schedule will be prepared if one does not already exist. The schedule will provide an activity specific assessment together with management controls.

10.1 Documentation

All electronic files relating to construction noise and vibration will be kept by the Project Manager. This will include:

- Section 1: Construction noise and vibration management plans:
  - This draft CNVMP and any revisions; and,
  - Construction noise induction sheets.
- Section 2: Consultation and complaints registers;
- Section 3: Noise and vibration monitoring:
  - Site survey sheets and associated aerial photographs;
  - Site survey summary sheet;
  - Survey reports;
  - Survey and equipment operating procedures;
  - Current and past equipment kit details and calibration summary; and,
  - Copies of calibration certificates.

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11 Applicability

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

We understand and agree that our client will submit this report as part of an application for resource consent and that Auckland Council as the consenting authority will use this report for the purpose of assessing that application.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
.....	.....
Sharon Yung Senior Acoustic Consultant	Shannon Richardson Project Director

SHYU
\\ttgroup.local\corporate\auckland\projects\1090120\1090120.3000\workingmaterial\report\cnvmp\cnvmp final draft v1.1 - s92 repsonse.docx

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Appendix A Project induction form

There are residential neighbours in close proximity to the works, where noise and vibration criteria apply. To ensure criteria are achieved, all staff are responsible for good noise and vibration management.

1 When arriving at work, please drive slowly on site and keep revs to a minimum. Keep stereos off and do not slam doors.

2 No shouting or swearing on site. Either walk over and talk to somebody or use a radio/phone.

3 Be careful with tools and equipment. Place them down and do not drop them.

4 Do not drag materials on the ground. Place them down when you arrive at the work area.

5 Equipment and vehicles should not be left running when not in use.

6 When loading trucks try not to drop material from a height.

7 Stationary equipment such as pumps and generators should be located away from neighbours.

8 All equipment is to be well maintained.

9 No work that could cause noise and/or vibration disturbance shall be conducted outside the hours of 0700 h to 1800 h Monday to Saturday unless by arrangement with the Project Manager / Construction Site Management.

10 If you see anything/anyone making unnecessary noise, then stop it/them.

11 It is essential that good relationships are maintained with neighbours. Any queries from members of the public should be responded to politely and referred to the site manager. Staff shall assist the public to make contact with this person. Staff shall not enter into debate or argue with members of the public.

NAME	COMPANY	SIGNED	DATE

Appendix B Noise sensitive receiver

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LOCATION PLAN: Auckla

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APPROVED	DATE	

CLIENT WATERCARE SERVICES LIMITED
PROJECT HERNE BAY SEWER BRANCH 5
TITLE SENSITIVE RECEIVERS

SCALE (A3) 1:2,000 FIG No. APPENDIX B FIGURE 1.1 REV 0

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TITLE SENSITIVE RECEIVERS
SCALE (A3) 1:2,000 FIG No. APPENDIX B FIGURE 1.2 REV 0

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SCALE (A3) 1:2,000 FIG No. APPENDIX B FIGURE 1.3 REV 0

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TITLE SENSITIVE RECEIVERS
SCALE (A3) 1:1,500 FIG No. APPENDIX B FIGURE 1.4 REV 0

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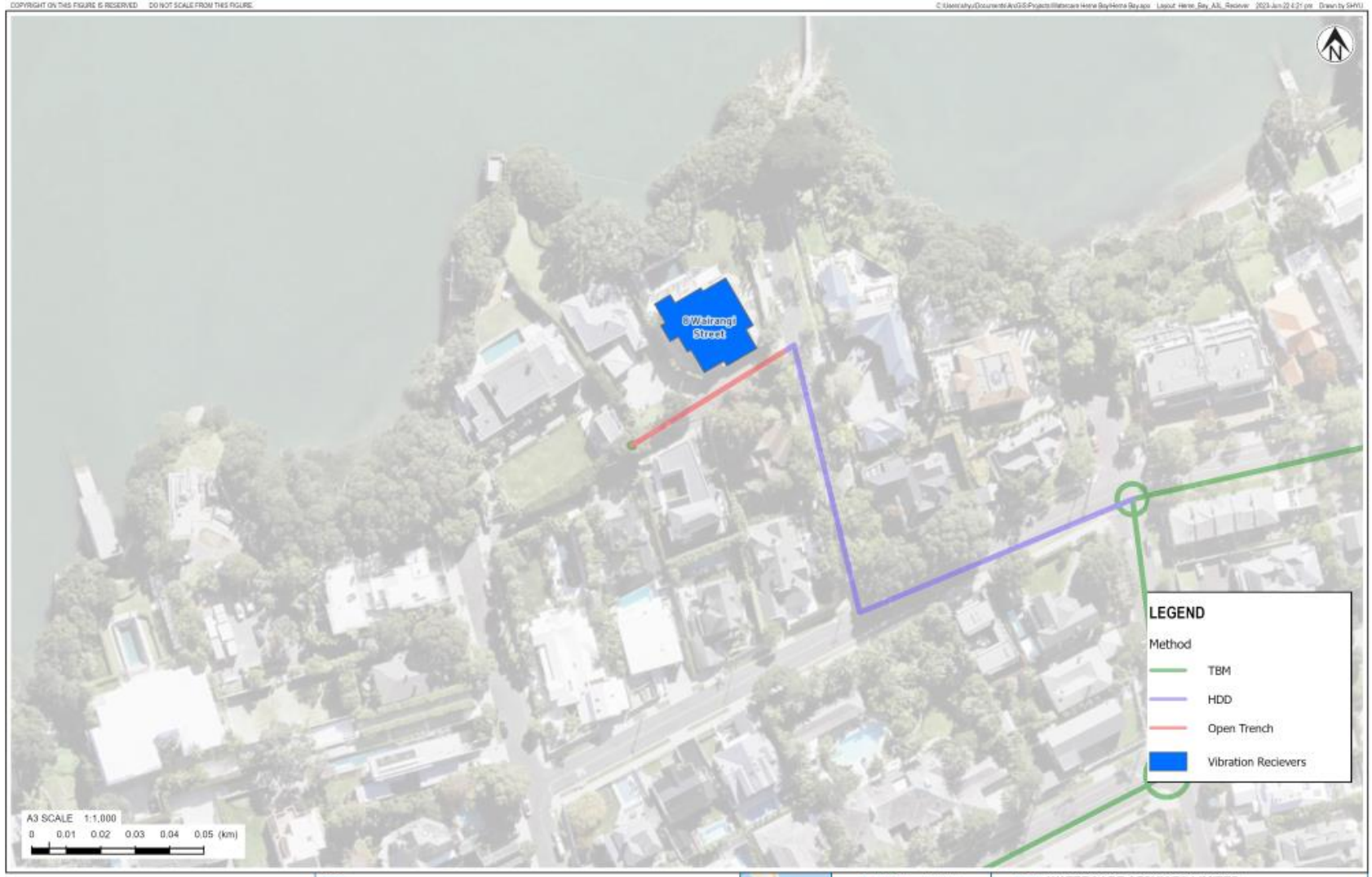

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PROJECT **HERNE BAY SEWER BRANCH 5**
TITLE VIBRATION SENSITIVE RECEIVERS
SCALE (A3) 1:1,000 FIG No. APPENDIX B FIGURE 2.1 REV 0

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PROJECT HERNE BAY SEWER BRANCH 5
TITLE VIBRATION SENSITIVE RECEIVERS

SCALE (A3) 1:1,000 FIG No. APPENDIX B FIGURE 2.2 REV 0

Appendix C Vibration receivers – Tunnelling setback distances

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CLIENT WATERCARE SERVICES LIMITED
PROJECT HERNE BAY SEWER BRANCH 5
TITLE TUNNELING - NOISE AND VIBRATION
SCALE (A3) 1:1,000 FIG No. APPENDIX E FIGURE 1.1 REV 0

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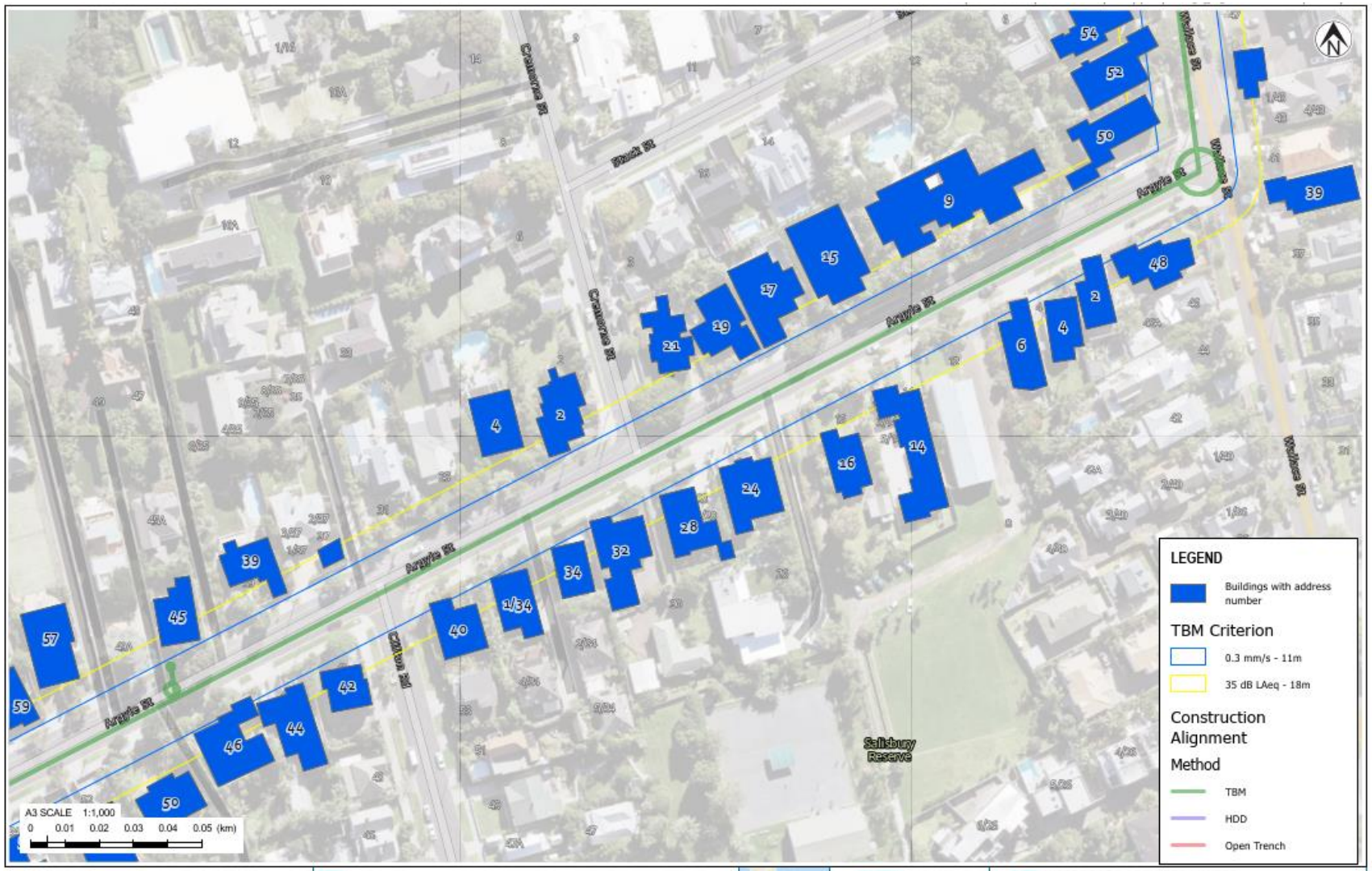
PROJECT HERNE BAY SEWER BRANCH 5
TITLE TUNNELING - NOISE AND VIBRATION
SCALE (A3) 1:1,000 FIG No. APPENDIX E FIGURE 1.2 REV 0



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TITLE TUNNELING - NOISE AND VIBRATION
SCALE (A3) 1:1,000 FIG No. APPENDIX E FIGURE 1.3 REV 0

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TITLE TUNNELING - NOISE AND VIBRATION
SCALE (A3) 1:1,000 FIG No. APPENDIX E FIGURE 1.4 REV 0

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TITLE TUNNELING - NOISE AND VIBRATION
SCALE (A3) 1:1,000 FIG No. APPENDIX G FIGURE 1.5 REV 0

Appendix D Predicted noise and vibration levels – surface construction

Receiver ID	Address	Nearest work location	Distance from works (m)	Open Trenching (L_{Aeq}, dB)	Shaft Construction (L_{Aeq}, dB)	Intercept Shaft construction (L_{Aeq}, dB)	HDD (L_{Aeq}, dB)	Vibration levels (PPV)
1	1 Marine Parade	HDD	1	-	65	-	71	> 10 mm/s
2	8 Wairangi Street	Open Trench	5	92	46	-	66	5 - 6 mm/s
3	34 Herne Bay Road*	Shaft 5	6	-	82	-	59	4 - 5 mm/s
4	33 Marine Parade	Shaft 6	7	69	-	-	-	4 - 5 mm/s
5	6 River Terrace	Open Trench	7	88	55	-	58	4 - 5 mm/s
6	67 Hamilton Road	HDD	8	-	-	-	69	3 - 4 mm/s
7	22 Marine Parade	Open Trench	8	87	69	-	-	3 - 4 mm/s
8	72 Argyle Street*	Shaft 4	8	-	-	-	-	3 - 4 mm/s
10	54 Sarsfield Street	SE01	9	-	-	78	72	3 - 4 mm/s
11	49 Marine Parade	Open Trench	10	84	57	-	-	3 - 4 mm/s
12	91 Sarsfield Street	SE03	10	65	65	81	-	3 - 4 mm/s
13	32 Sentinel Road	Open Trench	10	85	46	-	-	3 - 4 mm/s
14	34 Sentinel Road	Open Trench	10	84	42	-	-	3 - 4 mm/s
15	53 Marine Parade	Open Trench	11	79	45	-	-	3 - 4 mm/s
16	36 Sentinel Road	Open Trench	11	83	44	-	-	3 - 4 mm/s
17	40 Sentinel Road	Open Trench	11	81	43	-	-	3 - 4 mm/s
18	45 Argyle Street	SE04	11	-	57	81	-	3 - 4 mm/s
19	45 Marine Parade	Open Trench	12	83	61	-	-	3 - 4 mm/s
20	53 Sentinel Road	Open Trench	12	83	-	-	-	3 - 4 mm/s
21	45 Sentinel Road	Open Trench	12	83	-	-	-	3 - 4 mm/s
22	3 Wairangi Street	Open Trench	12	83	56	-	67	3 - 4 mm/s
23	50 Wallace Street	Shaft 3	12	56	79	-	59	3 - 4 mm/s
24	36 Herne Bay Road	Shaft 5	12	47	80	-	68	3 - 4 mm/s
25	48 Wallace Street*	Shaft 3	13	63	79	-	56	3 - 4 mm/s
26	44 Sentinel Road	Open Trench	13	82	52	66	-	3 - 4 mm/s
27	5 Stack Street	HDD	13	74	65	-	72	3 - 4 mm/s

Receiver ID	Address	Nearest work location	Distance from works (m)	Open Trenching (L_{Aeq}, dB)	Shaft Construction (L_{Aeq}, dB)	Intercept Shaft construction (L_{Aeq}, dB)	HDD (L_{Aeq}, dB)	Vibration levels (PPV)
28	28 Sentinel Road	Open Trench	13	81	42	-	-	3 - 4 mm/s
29	39 Wallace Street	Shaft 3	13	67	80	-	56	3 - 4 mm/s
30	26 Marine Parade	Open Trench	13	82	62	-	-	3 - 4 mm/s
31	46 Argyle Street	SE04	13	-	-	84	-	3 - 4 mm/s
32	38 Bella Vista Road	Open Trench	14	79	-	-	-	2 - 3 mm/s
33	10 Wairangi Street	Open Trench	14	80	56	-	64	2 - 3 mm/s
34	48 Sentinel Road	Open Trench	14	81	57	69	-	2 - 3 mm/s
35	64 Hamilton Road	SE01	15	-	-	76	69	2 - 3 mm/s
36	66 Hamilton Road	HDD	15	-	-	70	63	2 - 3 mm/s
37	69 Hamilton Road	HDD	15	-	-	-	65	2 - 3 mm/s
38	50 Sentinel Road	Open Trench	15	81	47	72	-	2 - 3 mm/s
39	54 Sentinel Road	Open Trench	16	81	52	75	-	2 - 3 mm/s
40	2/49 Sentinel Road	Open Trench	16	80	-	-	-	2 - 3 mm/s
41	56 Sentinel Road	Open Trench	16	81	57	79	-	2 - 3 mm/s
42	24 Marine Parade	Open Trench	16	81	58	-	-	2 - 3 mm/s
43	28 Marine Parade	Open Trench	16	80	61	-	-	2 - 3 mm/s
44	96 Sarsfield Street	Shaft 2	16	81	83	-	74	2 - 3 mm/s
45	98 Sarsfield Street	Shaft 2	16	81	83	-	74	2 - 3 mm/s
46	30 Sarsfield Street	Shaft 1	17	-	78	-	-	2 - 3 mm/s
47	11 Cremorne Street	Open Trench	17	79	45	-	42	2 - 3 mm/s
48	57 Sentinel Road	Open Trench	17	80	-	68	-	2 - 3 mm/s
49	2/49 Sentinel Road	Open Trench	17	80	-	-	-	2 - 3 mm/s
50	42 Sentinel Road	Open Trench	17	79	48	-	-	2 - 3 mm/s
51	56 Sarsfield Street	SE01	17	-	-	73	67	2 - 3 mm/s
52	28 Sarsfield Street	Shaft 1	18	-	76	-	-	2 - 3 mm/s
53	57 Marine Parade	Open Trench	18	79	-	-	-	2 - 3 mm/s

Receiver ID	Address	Nearest work location	Distance from works (m)	Open Trenching (L_{Aeq}, dB)	Shaft Construction (L_{Aeq}, dB)	Intercept Shaft construction (L_{Aeq}, dB)	HDD (L_{Aeq}, dB)	Vibration levels (PPV)
54	39 Marine Parade	Shaft 7	18	79	66	-	-	2 - 3 mm/s
55	41 Wallace Street	Shaft 3	18	67	77	-	47	2 - 3 mm/s
56	31 Herne Bay Road	Shaft 5	18	-	76	-	68	2 - 3 mm/s
57	35 Sentinel Road	Open Trench	19	77	-	-	-	2 - 3 mm/s
58	12 Stack Street	HDD	19	64	62	-	68	2 - 3 mm/s
59	47 Marine Parade	Open Trench	19	79	54	-	-	2 - 3 mm/s
60	2/59 Sentinel Road	Open Trench	19	80	-	71	-	2 - 3 mm/s
61	31 Marine Parade	Shaft 6	19	63	76	-	-	2 - 3 mm/s
62	80 Sarsfield Street	Open Trench	19	80	-	77	-	2 - 3 mm/s
63	43 Wallace Street	Shaft 3	19	66	78	53	59	2 - 3 mm/s
64	49A Argyle Street	SE04	19	-	46	78	-	2 - 3 mm/s
65	29 Herne Bay Road*	Shaft 5	19	-	76	-	63	2 - 3 mm/s
66	37A Sentinel Road	Open Trench	20	78	-	-	-	2 - 3 mm/s
67	58 Heritage Wallace Street	Shaft 2	20	67	74	-	67	2 - 3 mm/s
68	32 Marine Parade	Open Trench	20	78	57	-	-	2 - 3 mm/s
69	79 Argyle Street	Shaft 4	20	-	76	-	69	2 - 3 mm/s
70	103 Sarsfield Street	Shaft 2	21	74	74	53	66	2 - 3 mm/s
71	41 Sentinel Road	Open Trench	21	78	-	-	-	2 - 3 mm/s
72	88 Sarsfield Street	SE03	21	63	64	77	-	2 - 3 mm/s
73	30 Marine Parade	Open Trench	21	78	58	-	-	2 - 3 mm/s
74	32 Herne Bay Road	Shaft 5	21	-	76	-	57	2 - 3 mm/s
75	26 Sentinel Road	Open Trench	21	76	40	-	-	2 - 3 mm/s
76	42 Herne Bay Road	Shaft 4	21	39	75	-	67	2 - 3 mm/s
77	3 River Terrace	Open Trench	22	80	44	-	45	2 - 3 mm/s
79	50 Argyle Street	SE04	22	-	57	79	-	2 - 3 mm/s
80	70 Argyle Street	Shaft 4	22	-	75	-	67	2 - 3 mm/s

Receiver ID	Address	Nearest work location	Distance from works (m)	Open Trenching (L_{Aeq}, dB)	Shaft Construction (L_{Aeq}, dB)	Intercept Shaft construction (L_{Aeq}, dB)	HDD (L_{Aeq}, dB)	Vibration levels (PPV)
81	99 Sarsfield Street	SE03	22	68	68	75	59	2 - 3 mm/s
82	38 Bella Vista Road	Open Trench	23	77	46	-	-	2 - 3 mm/s
83	35 Marine Parade	Shaft 7	23	74	74	-	-	2 - 3 mm/s
84	44 Argyle Street	SE04	23	-	-	75	-	2 - 3 mm/s
85	15 Cremorne Street	Open Trench	24	75	44	-	49	2 - 3 mm/s
86	46 Wallace Street	Shaft 3	24	62	75	-	53	2 - 3 mm/s
87	52 Wallace Street	Shaft 3	24	55	75	-	65	2 - 3 mm/s
88	70 Curran Street	Shaft 1	25	-	72	-	-	2 - 3 mm/s
89	65 Hamilton Road	HDD	25	-	-	57	54	2 - 3 mm/s
90	57 Argyle Street	SE04	25	-	49	76	-	2 - 3 mm/s
91	26 Sarsfield Street	Shaft 1	26	-	72	-	-	2 - 3 mm/s
92	83 Sarsfield Street	SE02	26	73	48	74	-	2 - 3 mm/s
93	89 Sarsfield Street	SE03	26	66	63	77	-	2 - 3 mm/s
94	86 Sarsfield Street	SE03	26	61	63	77	-	2 - 3 mm/s
95	46 Sentinel Road	Open Trench	26	76	57	56	-	2 - 3 mm/s
96	6 Stack Street	HDD	26	66	69	-	67	2 - 3 mm/s
97	43 Marine Parade	Open Trench	26	76	62	-	-	2 - 3 mm/s
98	79 Sarsfield Street	SE02	26	74	-	75	-	2 - 3 mm/s
99	27 Herne Bay Road	Shaft 5	26	-	75	-	58	2 - 3 mm/s
100	33 Sentinel Road	Open Trench	26	75	-	-	-	2 - 3 mm/s
101	52 Sentinel Road	Open Trench	27	77	50	69	-	2 - 3 mm/s
102	61 Sarsfield Street	SE01	27	-	-	79	68	2 - 3 mm/s
103	1 Stack Street	HDD	27	72	67	-	68	2 - 3 mm/s
104	60 Hamilton Road	SE01	28	-	-	72	64	1 - 2 mm/s
105	54 Wallace Street	Shaft 2	28	60	76	-	69	1 - 2 mm/s
106	94 Sarsfield Street	Shaft 2	28	72	72	-	65	1 - 2 mm/s

Receiver ID	Address	Nearest work location	Distance from works (m)	Open Trenching (L_{Aeq}, dB)	Shaft Construction (L_{Aeq}, dB)	Intercept Shaft construction (L_{Aeq}, dB)	HDD (L_{Aeq}, dB)	Vibration levels (PPV)
107	37 Wallace Street	Shaft 3	29	61	72	-	38	1 - 2 mm/s
108	16 Upton Street	Shaft 6	29	72	73	-	-	1 - 2 mm/s
109	84 Sarsfield Street	SE03	30	68	64	77	-	1 - 2 mm/s
110	3 Wairangi Street	Open Trench	30	76	56	-	64	1 - 2 mm/s
111	2 Argyle Street	Shaft 3	31	63	74	-	42	1 - 2 mm/s
112	47 Wallace Street	Shaft 2	31	71	72	62	60	1 - 2 mm/s
113	37 Marine Parade	Shaft 7	31	75	64	-	-	1 - 2 mm/s
114	53B Sentinel Road	Open Trench	31	75	-	46	-	1 - 2 mm/s
115	90 Sarsfield Street	SE03	31	61	60	74	49	1 - 2 mm/s
116	63 Hamilton Road	HDD	31	-	-	75	66	1 - 2 mm/s
117	49A Argyle Street	SE04	31	-	43	73	-	1 - 2 mm/s
118	7 Stack Street	HDD	32	72	61	-	66	1 - 2 mm/s
119	85 Heritage Sarsfield Street	SE02	33	73	59	74	-	1 - 2 mm/s
120	58 Wallace Street	Shaft 2	33	58	74	-	64	1 - 2 mm/s
121	41 Marine Parade	Open Trench	33	75	57	-	-	1 - 2 mm/s
122	39 Argyle Street	SE04	33	-	-	75	-	1 - 2 mm/s
123	2/49 Sentinel Road	Open Trench	34	71	-	-	-	1 - 2 mm/s
124	87 Sarsfield Street	SE03	34	68	61	73	-	1 - 2 mm/s
125	45A Argyle Street	SE04	34	-	47	74	-	1 - 2 mm/s
126	59 Hamilton Road	SE01	35	-	39	76	66	1 - 2 mm/s
127	2/59 Sentinel Road	Open Trench	35	75	-	66	-	1 - 2 mm/s
128	2 Upton Street	Shaft 5	35	46	71	-	57	1 - 2 mm/s
129	52 Argyle Street	SE04	35	-	59	75	-	1 - 2 mm/s
130	39 Marine Parade	Shaft 7	36	73	59	-	-	1 - 2 mm/s
131	101 Sarsfield Street	SE03	37	69	70	71	62	1 - 2 mm/s
132	60 Wallace Street	Shaft 2	37	69	68	-	61	1 - 2 mm/s

Receiver ID	Address	Nearest work location	Distance from works (m)	Open Trenching (L_{Aeq}, dB)	Shaft Construction (L_{Aeq}, dB)	Intercept Shaft construction (L_{Aeq}, dB)	HDD (L_{Aeq}, dB)	Vibration levels (PPV)
133	31 Sentinel Road	Open Trench	37	71	-	-	-	1 - 2 mm/s
134	9 Argyle Street	Shaft 3	38	63	70	-	64	1 - 2 mm/s
135	25 Herne Bay Road	Shaft 5	38	-	71	-	58	1 - 2 mm/s
136	59 Argyle Street	SE04	38	-	58	74	52	1 - 2 mm/s
137	92 Sarsfield Street	Shaft 2	38	70	70	73	63	1 - 2 mm/s
138	52 Wallace Street	Shaft 3	39	62	53	-	63	1 - 2 mm/s
139	34 Bella Vista Road	Open Trench	39	72	48	-	-	1 - 2 mm/s
140	78 Sarsfield Street	Open Trench	39	73	-	72	33	1 - 2 mm/s
141	11 Cremorne Street	Open Trench	39	71	46	-	57	1 - 2 mm/s
142	40 Marine Parade	Open Trench	40	71	-	-	-	1 - 2 mm/s
143	88 Sarsfield Street	SE03	40	57	56	72	-	1 - 2 mm/s
144	59 Marine Parade	Open Trench	41	72	-	-	-	1 - 2 mm/s
145	14 Stack Street	HDD	41	65	61	-	65	1 - 2 mm/s
146	11 Bella Vista Road	Open Trench	42	72	59	-	-	1 - 2 mm/s
147	30 Masons Avenue	Shaft 5	42	-	70	-	59	1 - 2 mm/s
148	42 Argyle Street	SE04	42	-	-	72	-	1 - 2 mm/s
149	37B Sentinel Road	Open Trench	44	71	-	-	-	1 - 2 mm/s
150	61 Marine Parade	Open Trench	46	71	-	-	-	1 - 2 mm/s
151	9/57 Sarsfield Street	HDD	46	73	-	64	48	1 - 2 mm/s
152	5 Upton Street	Shaft 5	46	53	71	-	37	1 - 2 mm/s
153	72 Sarsfield Street	Open Trench	47	72	-	65	39	1 - 2 mm/s
154	95 Sarsfield Street	SE03	49	57	51	73	37	1 - 2 mm/s
155	9 Cremorne Street	Open Trench	49	71	59	-	58	1 - 2 mm/s
156	57 Hamilton Road	SE01	51	-	48	72	61	1 - 2 mm/s
157	39 Lawrence Street	Open Trench	52	71	43	-	-	1 - 2 mm/s
158	42 Marine Parade	Open Trench	52	70	-	-	-	1 - 2 mm/s

Receiver ID	Address	Nearest work location	Distance from works (m)	Open Trenching (L_{Aeq}, dB)	Shaft Construction (L_{Aeq}, dB)	Intercept Shaft construction (L_{Aeq}, dB)	HDD (L_{Aeq}, dB)	Vibration levels (PPV)
160	61 Sarsfield Street	SE01	54	-	-	62	44	1 - 2 mm/s
161	72 Sarsfield Street	Open Trench	54	70	-	44	37	1 - 2 mm/s
162	31 Lawrence Street	Open Trench	60	67	39	-	-	1 - 2 mm/s
163	67 Sarsfield Street	SE01	60	-	-	52	51	1 - 2 mm/s
164	49 Lawrence Street	SE03	62	65	60	70	-	1 - 2 mm/s
165	11 Galatea Terrace	Shaft 5	62	53	60	-	45	1 - 2 mm/s

Appendix E Predicted vibration levels – Tunnelling

Address	Approx horizontal distance to Tunnel alignment (m)	Predicted vibration level (mm/s PPV)
98 Sarsfield Street	3.9	1.3
96 Sarsfield Street	4.1	1.2
94 Sarsfield Street	4.4	1.1
12 Galatea Terrace	4.6	1
70 Curran Street	4.7	1
2 Argyle Street	5.7	0.8
61 Sarsfield Street	5.9	0.7
52 Wallace Street	6	0.7
92 Sarsfield Street	6.1	0.7
56 Sentinel Road	6.2	0.7
61 Sarsfield Street	6.4	0.6
39 Sarsfield Street	6.8	0.6
5 Upton Street	6.8	0.6
6 Argyle Street	7.2	0.5
49 Sarsfield Street	7.2	0.5
53 Sarsfield Street	7.6	0.5
45 Sarsfield Street	7.7	0.5
20 Marine Parade	7.7	0.5
43 Sarsfield Street	7.8	0.5
41 Sarsfield Street	7.8	0.5
46 Argyle Street	7.9	0.5
40 Argyle Street	8	0.5
32 Argyle Street	8.1	0.5
64 Argyle Street	8.2	0.4
72 Argyle Street*	8.2	0.4
50 Wallace Street	8.2	0.4
48 Wallace Street*	8.5	0.4
5 Upton Street	9.4	0.4
71 Sarsfield Street	9.5	0.4
1/34 Argyle Street	9.5	0.4
22 Marine Parade	9.6	0.4

* Heritage / sensitive building

Appendix F Consultation communications

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