Sensitivity: General

REPORT

Tonkin+Taylor

Healthy Waters - Te Ararata Flood Resilience Works -Walmsley Road Bridge Replacement

Construction Noise and Vibration Technical Assessment

Prepared for

Auckland Council

Prepared by

Tonkin & Taylor Ltd

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1 Introduction

Tonkin & Taylor Ltd (T+T) has been engaged by Auckland Council's Healthy Waters department (Healthy Waters) to undertake an assessment of the noise and vibration effects associated with the proposed Te Ararata Walmsley Road bridge replacement works (the Project). The Project is flood resilience works, with this assessment prepared to support a resource consent application under the Severe Weather Emergency Recovery (Auckland Flood Resilience Works) Order 2024.

This report provides an assessment associated with the construction of the Project based on an indicative construction methodology and concept design developed to support the resource consent application. In particular, this report:

- Establishes the relevant noise and vibration limits for the site set out in the Auckland Unitary Plan (AUP).
- Identifies the construction activities that will generate noise and vibration.
- Identifies nearby receivers.
- Predicts construction noise and vibration levels at identified receivers and determines compliance with relevant noise and vibration limits.
- Discusses potential noise and vibration effects.
- Provides recommendations to avoid, remedy or mitigate these effects.

A glossary of terms is included at the end of this report (Appendix A).

This report has been prepared in accordance with the Te Ararata Stage 2 Design agreement dated 4 June 2024 and Variation Order dated 30 August 2024.

2 Project description

2.1 Project background

The January 2023 floods, followed closely by Cyclone Gabrielle, marked a period of unprecedented weather challenges for Auckland. The floods, and the subsequent cyclone caused significant infrastructural damage, with an estimated 8,000 homes destroyed or damaged and thousands of residents' lives affected. The events underscored the city's vulnerability to extreme weather, prompting Auckland Council to endorse the "Making Space for Water Programme" developed by Healthy Waters. This initiative aims to mitigate flood risks through a series of blue-green networks, addressing critical flood-prone areas with sustainable stormwater solutions.

As part of the overall Programme, Healthy Waters identified a combination of interventions within the Te Ararata catchment (overall referred to as the Te Ararata Project) to collectively address the flood resilience issues further outlined in the Assessment of Effects on the Environment (AEE).

2.2 Project overview

The first package of works within the overall Te Ararata Project is for the Walmsley Road bridge replacement works (i.e. the Project) and is the subject of this assessment. The Project seeks to achieve greater flow capacity and reduce blockage risk beneath Walmsley Road and within Te Ararata Creek.

A detailed description of the proposed work and indicative methodology is provided in the AEE prepared for the application. The Project is located within the existing Walmsley Road bridge, Te Ararata Creek, Black Bridge Reserve and Walmsley Road Reserve (refer to Figure 2.1). Overall construction of the Project is anticipated to take approximately 10 – 12 months, with closure of the existing Walmsley Road bridge required for approximately 7 months during this period.

In summary, the Project includes the following key elements:

- Demolition and removal of the existing Walmsley Road twin culvert.
- Construction of a new replacement Walmsley Road bridge over Te Ararata Creek.
- Works to tie in the new replacement bridge with the existing road network.
- Recontouring of the stream banks under the bridge to achieve a wider stream channel.
- Relocation of the existing Watercare watermain pipe bridge foundations to achieve a wider clearance beneath the structure.
- Existing service relocation and/or realignment.
- Vegetation clearance, including within riparian margins and the removal of trees.
- Earthworks associated with temporary and permanent works, including within the riparian margins.
- Other temporary works and activities to facilitate the construction of the permanent Project including:
  - The formation and operation of laydown areas and a site compound predominantly within Black Bridge Reserve.
  - Works within and around the Te Ararata Creek including temporary stream diversion.
  - Temporary traffic management measures including a temporary bailey bridge to facilitate pedestrian and active mode diversions between Coronation Road and Walmsley Road. Vehicular traffic will be diverted to the wider existing road network.

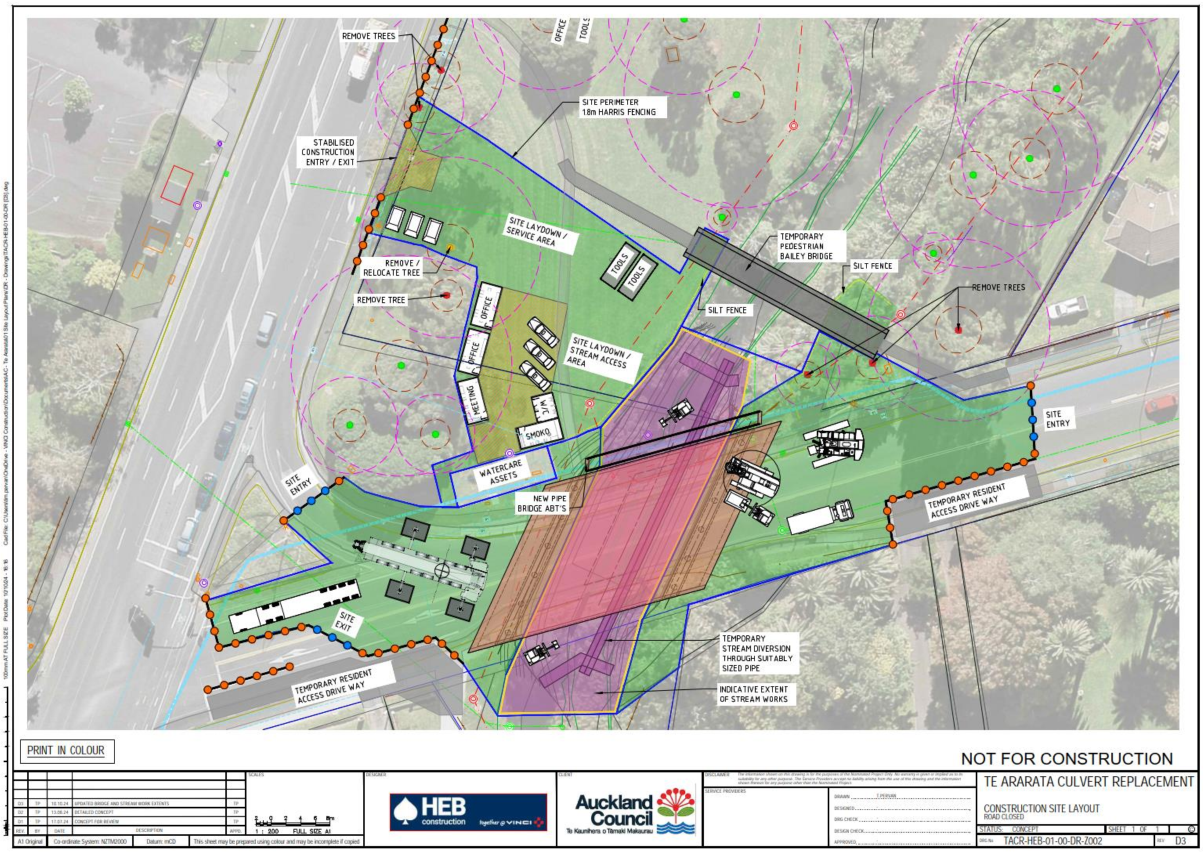

Figure 2.1: Full Road closure site plan.

2.3 Indicative construction methodology

The construction activities and duration of work are outlined below.

This assessment has been based on an indicative construction methodology and details of the duration for the construction activities as provided by the contractor. Whilst the construction methodology has not been finalised, a reasonable worst case has been assumed within this assessment to account for potential changes to the activities and programme. As such, minor changes to the final construction methodology and programme are unlikely to change the overall envelope of effects as presented in this report.

2.3.1 Duration of works

Construction work is likely to occur over a period of approximately 10 - 12 months. Piling works at each end of the bridge will take approximately 3 – 4 weeks.

2.3.2 Construction hours of operation

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

- Monday to Friday: 7.00 am to 7.00 pm (site mobilisation and pack down works are proposed to occur for 30 mins at the start and end of this period).
- Saturdays: 8.30 am- 7:00 pm.
- Sundays or public holidays: no works planned.

Due to the nature of construction and the Project's timeline, it is likely that some activities will be undertaken outside these usual hours, for example, site meetings, setup, pack up, large plant delivery early in the morning or later in the evening to avoid peak traffic volumes. These activities undertaken outside work hours have been assessed as low risk, are likely to be within permitted noise levels and will be carried out to meet AUP requirements.

Early morning works (starting from 4.00 am) for concrete pours may be required for the temporary road and bridge construction. It is anticipated 3 - 4 early morning concrete pours may be required for the Project. Road tie-ins may be required for an anticipated 4 – 5 nights at each end of the bridge.

Work outside of standard hours will be limited as far as is practicable to reduce disruption as outlined above. The works outside of standard construction hours will be detailed in the Project's Construction Noise and Vibration Management Plan (CNVMP).

2.3.2.1 Construction activities

The works involves the temporary full road closure of Walmsley Road bridge for approximately 7 months within the overall 10 – 12 month construction period. Temporary traffic diversion will occur using the surrounding existing road network (refer to the AEE and Integrated Transport Assessment (ITA)). A temporary Bailey bridge for active modes only, will be established to the north of the works, within Black Bridge Reserve.

Construction will be carried out in stages and generally in a continuous manner as outlined in Table 2.1. Key noise / vibration generating activities or items of equipment have been highlighted in bold. An indicative sequence of work is proposed as follows across the stages:

- Site Establishment.
- Existing Culvert Removal and Temporary Stream Works.
- Bridge Substructure Construction.
- Watercare Pipe Strengthening and foundation relocation.
- Permanent Stream Works.
- Bridge superstructure installation.
- Civil tie-in Road works.

Table 2.1: Construction and staging activities

Stage of works	Key anticipated construction activities
Site establishment and temporary bailey bridge construction	• Establish environmental controls, site fencing, working areas, laydown areas, crane platforms and site offices. **Vegetation and tree removal** and pruning will also be undertaken, and tree protection measures installed as necessary. • **Delivery** of construction equipment (e.g. cranes, excavators, piling rig, vibro and impact hammers) and materials (e.g. H piles and temporary bridge beams). Some of these deliveries may need to occur at night due to the size of equipment and materials. • **Construction of the temporary bailey bridge abutments** either side of the stream. This is expected to comprise shallow pad concrete abutments with some localised clearing and minor earthworks using typical civil equipment such as excavators. Installation of temporary micro piles may be required to provide additional slope stability measures using a mini piling rig.

Stage of works	Key anticipated construction activities
	• Delivery and installation of the temporary bailey bridge into place with a **mobile or crawler crane**. • Construction of the footpaths approaching on either side of the bailey bridge using conventional civil works plant and equipment (e.g. **trucks, graders, excavators and rollers**).
Existing Culvert Removal and Temporary Stream Works	• Establish environmental controls in and around the stream. This includes temporary stream diversion through a pipe and creating a temporary dry instream working area. Construction access for installing the temporary stream diversion will be via temporary access tracks cut down from both upstream and downstream ends of the existing culvert. • Identify and protect and/or divert existing services within works area (as required). • **Excavate, demolish and remove existing twin culvert.** The eastern and western side walls of the existing culvert will be progressively excavated and exposed down to the base slab of the culvert. The culvert side walls will then be cut and lifted out in sections. **Where basalt is encountered, this will be broken out**. • Temporary retaining walls will be installed as required to provide temporary ground retention during excavation and exposure of the culvert side walls.

Permanent bridge substructure construction	• Identify and protect and/or divert existing services within works area (as required).
	• **Install piles** required for each permanent bridge abutment, starting on one side of the stream and then moving to the other side.
	  – For the western abutment, **a drill rig** will be used to drill/core an oversized hole **through the upper basalt layer** (approximately 2 – 3 m thick close to ground surface) as required.
	  – On both abutments, closed end tube piles will be driven into the ground using a **vibro hammer**. A **hydraulic impact hammer** will be used to drive the pile to its design founding depth. Piles will then be concreted.
	• **Form abutment caps, wingwalls and settlement slabs** for the permanent bridge, place reinforcing and pour using **boom pumps**. These activities will occur on both sides of the existing bridge (eastern and western). Piles will also be cut down to the underside of the abutment beam.

Watercare pipe strengthening and foundation relocation	• Construct new shallow foundations on either side of the existing pipe and install micro piles if required for additional support using a mini **piling rig and excavator.** • Install new steel girder beams and then transfer the weight of the pipe from the existing foundations to the new girder beam supports. • The existing foundations will then be demolished using typical civil works plant and equipment.
Permanent stream works	• **Cut back stream banks** to achieve final stream profile. Will include construction of retaining walls and installation of rip rap. Excavators will work from behind both abutments to service smaller excavators positioned on working platforms within the dry instream working area.
Permanent bridge superstructure construction	• Establish **mobile crane** behind the western abutment of the permanent bridge. Bridge beams to be delivered, lifted from the truck and placed into position using the crane.

Stage of works	Key anticipated construction activities
	• Undertake superstructure works including **deck pours, edge barrier placements, wingwall construction and service installation / relocation.** • Undertake **civil tie in** works at each permanent bridge abutment to tie the existing road into the new bridge. This will involve standard plant equipment such **as excavators, rollers and graders.**
Demobilisation	• Once the new bridge has re-opened to traffic, the temporary work site and activities can be demobilised: – Temporary pathways and hardstand areas will be stripped off and any temporary concrete abutments will be demolished using typical civil works plant and equipment. – A crane will be mobilised to the existing site compound to lift out any temporary structures and remove them offsite. – Any temporary piling will be extracted with a crane and piling rig. – Environmental controls, tree protection measures, office and security fencing will be removed.

The contractor has commented that the ground conditions are a major factor in determining the piling method. The current ground conditions consist of an upper basalt layer (western abutment) and weak soils that extend to a significant depth, with the underlying rock layer being very deep. This is not conducive to the installation of bored piles due to economical or practical reasons. They are instead targeting founding the piles within a shallower competent soil layer by driving closed end steel tubes. A drill rig will be used to drill / core an oversized hole through the upper basalt layer, closed end tube casing will be installed using a vibro hammer and at the point of reaching refusal, hydraulic impact hammer will be used to drive the design to depth.

The contractor further notes that driven piles were also used as foundations for the Walmsley Road pedestrian overbridge (running over SH16) constructed as part of the Manukau Harbour Crossing project (due to the same ground conditions).

2.3.3 Construction support areas

The main construction compound will be located within Black Bridge Reserve with work areas established on the eastern and western sides of the existing Walmsley Road bridge (as shown on Figure 2.1). The main construction compound will be used for the following purposes:

- Bulk delivery and removal of materials.
- Storage of materials (equipment and tools).
- Worker welfare facilities.
- Main site office.

3 Performance Standards

3.1 AUP requirements

3.1.1 Construction noise

Rule E25.6.1(3) of the AUP states that "*The noise from any construction activity must be measured and assessed in accordance with the requirements of New Zealand Standard NZS6803:1999 Acoustics – Construction noise*".

Rules E25.6.27(1) and E25.6.27(2) respectively contain construction noise limits for activities sensitive to noise (residential receivers) and for any other activity (commercial receivers).

In accordance with E25.6.27(4), projects with a construction duration of more than 20 weeks are to include a 5 dB reduction to the noise limits in E25.6.27(1). The applicable construction noise limits with the required 5 dB reduction applied (in accordance with NZS6803:1999) are detailed in Table 3.1 for residential receivers and Table 3.2 for non-residential receivers. The limits apply at 1 m from the façade of any building that contains an activity sensitive to noise that is occupied during the works.

Table 3.1: Construction noise levels - Applies to buildings containing noise sensitive activities AUP Table 25.6.27.1)

Time of week	Time period	Noise limit dB	
		L_{Aeq}	L_{Amax}
Weekdays	6:30 am – 7:30 am	55	70
	7:30 am – 6:00 pm	70	85
	6:00 pm – 8:00 pm	65	80
	8:00 pm – 6:30 am	45	75
Saturdays	6:30 am – 7:30 am	45	75
	7:30 am – 6:00 pm	70	85
	6:00 pm – 8:00 pm	45	75
	8:00 pm – 6:30 am	45	75

Table 3.2: Construction noise limits for noise affecting any other activity (non-residential) (AUP Table E25.6.27.2)

Time period	Noise limit dB L_{Aeq}
7:30 am – 6:00 pm	70
6:00 pm – 7:30 am	75

3.1.2 Works in the road reserve

Part of the works are within the road reserve. Planned works within the road reserve between 7 am and 10 pm are not required to comply with the construction noise limits of Table 3.1and Table 3.2 where a CNVMP is provided to the Council no less than five days prior to the works commencing

(Standard E25.6.29(3)(d)). The requirements for the CNVMP are listed in Standard E25.6.29(5) and include:

- Details of the community consultation to be undertaken to advise the occupiers of properties located within 100 m of the proposed works of relevant details of the works.
- A description of the works and duration, anticipated equipment to be used, the processes to be undertaken and the predicted noise and vibration levels.
- Identification of the best practicable options that will be undertaken to mitigate and minimise any noise and vibration being produced that is likely to exceed the relevant construction noise and vibration limits.

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.

3.1.2.1 Night works

Noise levels within the road between 10 pm and 7 am do not apply if the number of nights where night generated by the works exceeds at one receiver is 3 nights or less and cannot be practicably carried out during the day.

3.1.3 Construction vibration

AUP Standard E25.6.29(4A) notes that the vibration levels specified in Standard E25.6.29(1A)(b) (vibration limits in buildings) do not apply where (a) for planned works, a copy of the works access permit issued by Auckland Transport or approval from the New Zealand Transport Agency is provided to the Council five days prior to work commencing, and (b) a CNVMP is provided to the Council no less than five days prior to the works commencing. The requirements for the CNVMP are provided in Standard E25.6.29(5). Standard E25.6.29(1A)(a) applies to all works in the road (limits contained in DIN4150-3:1999), and hence are applicable to this Project.

The AUP contains rules relating to construction vibration that cover both building damage and amenity limits[1]. Rule E25.6.30 states that construction activities must be controlled to ensure any resulting vibration does not exceed:

- The limits set out in *German Industrial Standard DIN 4150-3:2016 (1999): Structural vibration – Part 3 Effects of vibration on structures*[2], when measured in accordance with that Standard on any structure not on the same site.
- The limits set out in Table E25.6.30.1 (see Table 3.5) in buildings in any axis when measured in the corner of the floor of the storey of interest for multi-storey buildings, or within 500 mm of ground level at the foundation of a single storey building.

Standard E25.6.29(1A) states that vibration from any construction, maintenance and demolition activities in the road must comply with the relevant vibration levels in E25.6.30(1)(a) and Table E25.6.30.1.

3.2 NZS 6803:1999 Construction noise standard

NZS 6803:1999 *Acoustics – Construction noise* sets out procedures for the measurement and assessment of noise from existing and proposed construction work, including maintenance and demolitions. The Standard is referenced in the AUP and recommends noise limits for construction noise with which the AUP construction noise limits align (see Table 3.1 and Table 3.2) and provides

[1] There are no sources of potential vibration post-construction.
[2] Superseded by latest version DIN 4150-3:1999:2016

guidance on methods of predicting and managing construction noise. These noise limits are specified in terms of the time of day and the duration of work, recognising that residential receivers will be more sensitive to noise at night, and that lower limits are appropriate for longer duration works.

For typical daytime working hours, construction noise limits are less restrictive than the typical operational noise limits, on the basis that the effects of construction activities are of limited duration.

The Standard's noise limits apply at 1 m from external façades of occupied buildings, hence noise limits are not applicable if a building is unoccupied. Noise is typically assessed over a representative 15 minute period of construction activity, recognising that construction noise sources will vary with the types and numbers of equipment operating for the activities being undertaken.

3.3 DIN 4150-3:2016 Vibration standard

The German Industrial Standard DIN 4150:3-12 *Vibration in buildings – Part 3: Effects of vibration on structures* (DIN 4150-3:2016) is an internationally recognised standard used to assess the effects of vibration on structures. The AUP references the previous version (1999) of this Standard. The Standard is commonly used across New Zealand as there are no vibration standards specific to New Zealand. The DIN 4150-3:2016 criteria to evaluate the effects of short-term vibration on structures are shown in Table 3.3 and summarised in Figure 3.1. Short-term vibration is vibration that does not occur often enough to cause structural fatigue, and which does not induce resonance in a building structure.

The table and figure show the recommended vibration limits in terms of PPV as this is directly related to strain, and hence potential for damage to structures. They are lowest in the frequency range of 1-10 Hz, which is the normal range of natural frequency of most structures. The limits increase at higher frequencies where the potential harmonic effects are reduced. The guideline values for PPV are at the foundation and in the plane of the highest floor of various types of building.

Table 3.3: DIN 4150-3:2016 guidelines for evaluating the effects of short-term vibration on structures

Line	Type of structure	Vibration at the foundation at a frequency of			Vibration at horizontal plane of the highest floor	Floor slabs, vertical direction
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequencies	
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20 mm/s	20 to 40 mm/s	40 to 50 mm/s	40 mm/s	20 mm/s
2	Dwellings and buildings of similar design and/or occupancy	5 mm/s	5 to 15 mm/s	15 to 20 mm/s	15 mm/s	20 mm/s
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value	3 mm/s	3 to 8 mm/s	8 to 10 mm/s	8 mm/s	20 mm/s

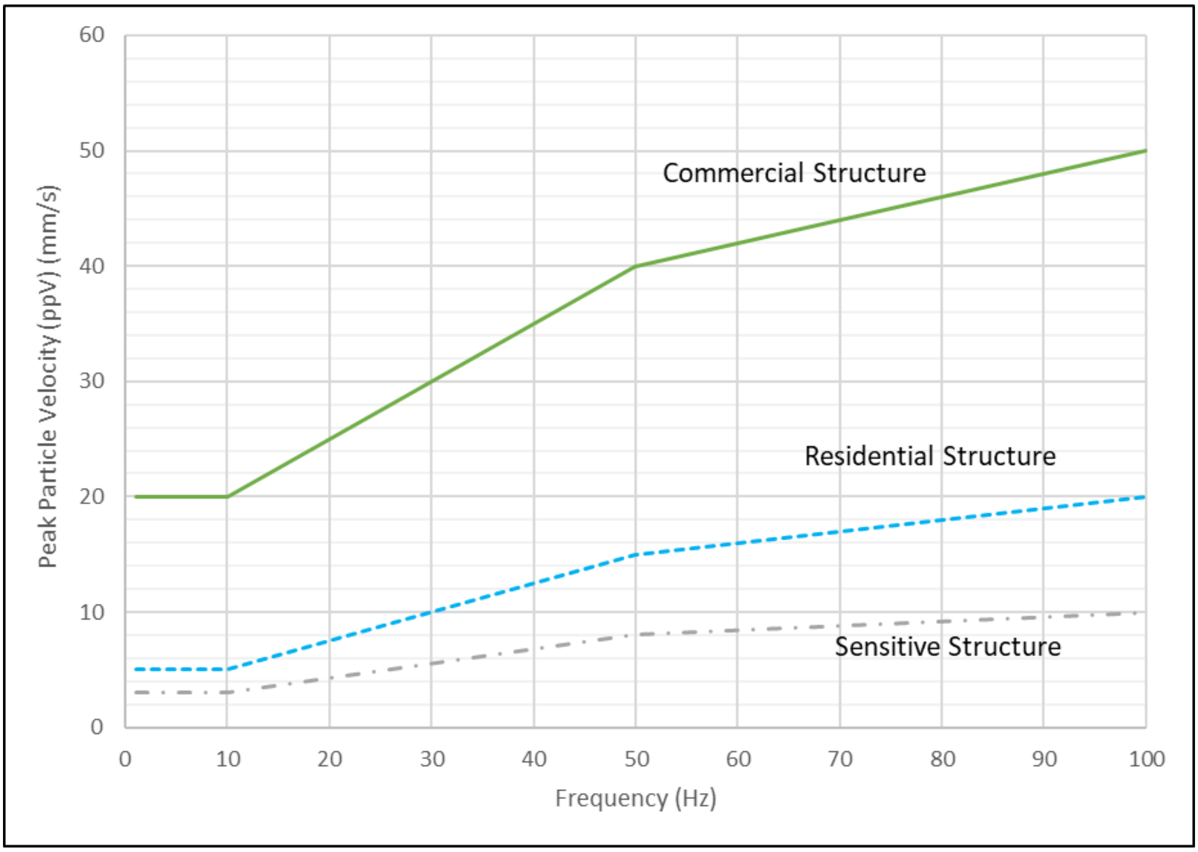

Figure 3.1: DIN 4150-3: 2016 Short-term standard baseline curves.

DIN 4150-3:2016 gives further context to the guideline values:

> *"Experience has shown that if these values are complied with, damage that reduces the serviceability of the building will not occur. If damage nevertheless occurs, it is to be assumed that other causes are responsible. Exceeding the values in table 1 does not necessarily lead to damage; should they be significantly exceeded; however, further investigations are necessary."*

For the structures listed in lines 2 and 3 of Table 3.3, the serviceability is considered to have been reduced if:

- Cracks form in plastered surfaces of walls.
- Existing cracks in the building are enlarged.
- Partitions become detached from loadbearing walls or floors.

These effects are deemed 'minor damage'.

The limits recommended in DIN 4150-3:2016 provides a low probability of cosmetic damage. In reality, structural damage is unlikely to occur in both residential and commercial structures at less than 50 mm/s, and for in-ground structures and infrastructure services at less than 100 mm/s.

3.3.1 Human vibration response

Human perception and response to vibration varies depending upon the sensitivity of the individual, the tasks being performed, the magnitude, frequency and duration of the vibration, whether the vibration is expected, and whether there is concern that structural damage may occur.

Low levels of vibration can cause fixtures and fittings, such as doors and windows, to rattle and the noise that is sometimes generated by the 'rattling' can draw an individual's attention to the original source of the vibration. Humans perceive vibration at much lower magnitudes than the levels of vibration that are likely to cause building damage and as such homeowners are likely to complain about vibration significantly below the levels likely to result in cosmetic damage of buildings.

Within New Zealand there are no national vibration standards for the effects on human exposure within buildings, however, it is accepted practice to apply the guidance from British Standard BS 5228-2:2009 *Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration* (BS 5228-2)[3].

3.3.1.1 BS 5228-2:2009

BS 5228-2:2009[4] discusses vibration levels at which adverse comment is likely from building occupants. The guidance values of Table B.1 of BS 5228-2:2009 are provided in Table 3.4.

Table 3.4: Guidance on effects of vibration levels - BS 5228-2:2009

Vibration level (PPV)	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction[5]. At lower frequencies, people are less sensitive to vibration.
0.3 mm/s	Vibration might be just perceptible in residential environments.
1.0 mm/s	It is likely that vibration of this level in residential environments will cause complaint but can be tolerated if prior warning and explanation has been given to residents.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level in most building environments.

3.3.1.2 AUP amenity vibration limits

Whilst AUP rule E25.6.29 (4A) notes that the vibration levels specified in Standard E25.6.29(1A)(b) (vibration limits in buildings) do not apply for this Project, the AUP amenity limits are set out in Table 3.5 below for reference and applicable for works outside the road reserve (such as stream enhancement works).

Table 3.5: AUP Table E25.6.30.1 Vibration limits in buildings (amenity values)

Receiver	Period	Peak Particle Velocity (PPV) mm/s
Occupied activity sensitive to noise	Night-time 10 pm to 7 am	0.3
	Daytime 7 am to 10 pm	2.0
Other occupied buildings	At all times	2.0

AUP Rule E25.6.30 includes an allowance for up to 5 mm/s PPV being received between 7 am and 6 pm for no more than three days (for the project duration) provided that building occupants within 50 m are advised at least three days prior to works commencing.

[3] The previous version of this standard is referenced extensively throughout NZS 6803 as a method for predicting the noise levels from specific construction activities. The current version is considered appropriate.
[4] BS 5228-2:2009+A1:2014, Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration
[5] Below 50Hz

3.4 Project criteria

A summary of the most stringent noise and vibration standards for the core proposed hours of construction (Monday to Friday 7:30 am to 6 pm with potential weekends works) is provided in Table 3.6. For construction works at other times of day, the noise limits in Table 3.1 and Table 3.2 apply.

Table 3.6: Project criteria for construction noise and vibration

Day of week	Time of work	Noise dB		Vibration mm/s PPV		
		L_{Aeq}	L_{Amax}	Amenity	Effects on sensitive structures	Effects on residential structures
Monday to Saturday	7.30 am to 6 pm	70	85	2^	3*	5*

* Guideline value increases with high frequency (3 mm/s PPV for sensitive/heritage properties, 5 mm/s PPV for residential properties 1-10 Hz), see DIN 4150-3:2016.

^ Applicable for works outside road reserve.

4 Existing environment

4.1 Overview

The Project works are predominantly within the road reserve with stream widening being undertaken both within and outside the road reserve.

The proposed construction site is located on the corner junction of Walmsley Road, Coronation Road, Miller Road and McKenzie Road at Black Bridge Reserve. The site is bound by busy arterial roads with Coronation Road serving as the off junction for State Highway 20 (SH20) located to the east. Ambient noise monitoring has not been undertaken for this assessment, but site visit observations indicated the soundscape is dominated by road traffic noise from both the arterial roads and SH20.

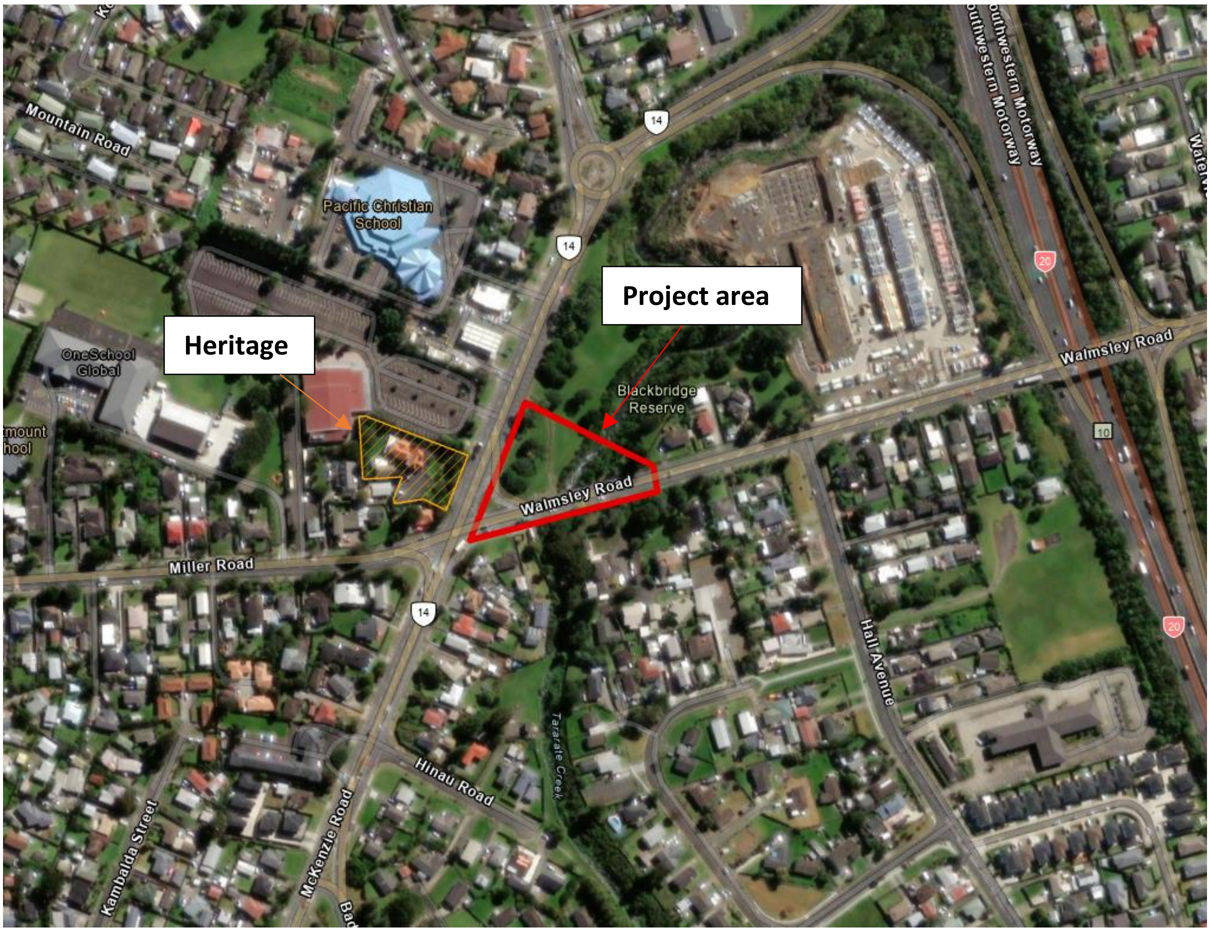

Figure 4.1: Location of project area (Walmsley Road Bridge) within the context of Māngare (map source: ESRI world imagery).

4.2 Receivers

The works are surrounded by residential areas of mixed housing suburban zone to the east and west, with mixed housing urban zone to the south and open space to the north as shown in Figure 4.2.

Noise sensitive receivers are any occupied building that contains noise sensitive activities, e.g. dwellings. Sheds and garages are not considered noise sensitive dwellings. Other occupied buildings such as commercial or industrial properties are not noise sensitive but are considered receivers for construction noise and fall under Table 3.2 “all other activities” criteria.

One residential building at 164 Coronation Road (located west of the site) is identified as listed category B historic heritage buildings under the AUP and are subjected to the heritage DIN 4150-3 limits (Line 3 of Table 3.3). This property is located over 45 m from the nearest construction boundary and over 80 m from the nearest piling works.

Figure 4.2: AUP zoning (source: Auckland Council Geomaps accessed 22 July 2024).

Table 4.1 below lists the receivers and nearest distance to works applicable for construction noise, i.e. from the façades of these receivers to the nearest location of construction works within 90 m (Figure 4.3 shows receivers in relation to the project area and main noise generating locations). Noise levels at receivers will be well below the construction noise limits at distances greater than 90 m and have not been considered (with the exception of the Heritage buildings). Residential receivers identified are a mixture of two storey and single storey buildings.

Other receivers identified within the area include a school (148 Coronation Road) and Plymouth Brethren Christian Church (156 Coronation Road) to the north-west and a new housing development at 81 Walmsley Road to the east, all of which are more than 100 m from the works and have not been considered further. It is understood that the Brethren Christian Church is not currently in use.

Figure 4.3: Location of receivers identified for assessment (less than 100 m from the construction activities and including heritage site).

Table 4.1: Receivers identified less than 100 m from the construction activities and including heritage site (ordered by nearest distance to piling)

Address	Receiver Type	Nearest distance to piling (m)	Nearest distance to rock breaking (m)
4 Walmsley Road	Residential	24	20
8 Walmsley Road	Residential (2 Storey)	33	25
15 Walmsley Road	Residential (2 Storey - raised due to terrain)	47	24
2 McKenzie Road	Residential	43	38
14 Walmsley Road	Residential (2 Storey)	50	61
6 Walmsley Road (1)	Residential	53	46
18 Walmsley Road	Residential	58	46
17 Walmsley Road	Residential	71	49
2A McKenzie Road (1)	Residential	60	55
2A McKenzie Road (2)	Residential	62	56
12 Walmsley Road (1)	Residential	69	62
6 Walmsley Road (2)	Residential	70	63
20 Walmsley Road	Residential	73	58

Address	Receiver Type	Nearest distance to piling (m)	Nearest distance to rock breaking (m)
1B Miller Road	Residential	72	72
12 Walmsley Road (2)	Residential	73	61
4 McKenzie Road	Residential	77	71
14A Walmsley Road	Residential	92	69
19 Walmsley Road	Residential	79	85
164 Coronation Road (1)	Heritage (2 storey)	88	90
68 Molesworth Place	Residential	89	91
6 McKenzie Road	Residential	91	85
22 Walmsley Road	Residential	101	83
3 Hall Avenue	Residential	102	87
164 Coronation Road (2)	Heritage	103	105

Note: where an address has two potential sensitive receiver buildings they are identified by a (bracketed number).

5 Noise and vibration assessment

5.1 Assessment approach

A preliminary assessment of construction noise and vibration has been undertaken based on an indicative construction methodology and durations informed by Healthy Waters' contractors as presented in Section 2.3.

To provide a reasonable assessment of noise exposure for individual receivers, this assessment has taken the approach of assessing the impact from the main significant noise generating activities from each stage of work:

- Site compound: Site establishment and main compound activities.
- Culvert demolition / rock breaking: 20 t excavator with breaker attachment, 30 t excavator.
- Bridge piling: Use of auger piles and hydraulic hammer piles with supporting cranes.
- Bridge construction: Earthworks using 12 t - 20 t excavators, cranes, roading.

The assessment assumes that only the noisiest equipment is in use for bridge piling (hydraulic hammer pile) and demolition work (20 t excavator with breaker attachment). This assumption provides a worst-case scenario under best practice option (BPO) as these sources as significantly louder than other sources under the same activities. A duty correction has been applied to equipment within each activity to account for usage of equipment over the 15 minute assessment period. (For example, grader – 75% on-time, rollers – 75% on time).

The Watercare's pipe strengthening works is located next to the main Walmsley Road Bridge works, at a lower ground level, with similar activities of piling (micro) and excavation but using smaller equipment. As such the pipe strengthening works are considered within the main noise generating activities and not assessed separately.

As the project moves through the detailed design process and as construction methodology is confirmed prior to start of works, it is likely that some details will change but overall the Project is expected to remain within the envelope of effects of worst-case scenarios assessed in this assessment. All figures and dimensions provided are approximate and will be confirmed during the detailed design stage.

5.2 Source information

Sound power levels are provided in Table 5.1 below for the likely significant construction noise sources on site. Façade sound pressure levels at different set back distances, calculated using NZS 6803:1999 principles, are also provided to give an indication of likely noise levels for short term activities.

Sound power levels are taken from NZS 6803:1999 (reproduced from BS 5228-1:2009[6]) or from T+T's library of measured levels. No form of mitigation, such as acoustic barriers or enclosures, has been included within these noise levels and they therefore represent a 'worst-case' scenario.

Not all items of construction plant associated with the Project will operate simultaneously or within the same area. Hand tools have the potential to produce relatively high noise levels, however, these are typically used for short durations and are normally straightforward to screen effectively. For vegetation clearance, all vegetation will be removed via an excavator with a selection grab and transported back to the main compound area before being chipped and stored. A woodchipper at the compound (located over 70 m from the nearest receiver) can be effectively screened and

[6] BS 5228-1:2009+A1:2014. *Code of practice for noise and vibration control on construction and open sites, Noise.*

managed via the CNVMP to meet daytime noise criterion. As such, no further assessment has been carried out for the use of the woodchipper.

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

Equipment	Sound power level dB LWA	Noise level dB L_{Aeq}					Set back distance to achieve 70 dB L_{Aeq} (m)
		10 m	20 m	30 m	40 m	50 m	
45t bore pile	111	86	80	76	73	71	52
Vibro piles	114	89	83	79	76	74	69
10t hydraulic hammer piles	117	92	86	82	79	77	91
20t excavator with rock breaker	120	95	89	85	82	80	120 ^
8t excavator	94	69	63	59	56	54	9
12t excavator	95	70	64	60	57	55	10
16t excavator	96	71	65	61	58	56	11
20t excavator (with and without selector grab)	102	77	71	67	64	62	22
30t excavator	110	85	79	75	72	70	48
25t rough terrain crane	104	79	73	69	66	64	28
150t mobile crane	101	76	70	66	63	61	20
120t crawler crane	101	76	70	66	63	61	20
25t crane	99	74	68	64	61	59	16
Concrete boom truck	103	78	72	68	66	64	25
8t Roller	105	80	74	70	67	65	30
Large roller	109	84	78	74	71	69	44
Asphalt paver	104	79	73	69	66	64	28
Grader	96	71	65	61	58	56	71
6 wheeler trucks	107	82	76	72	69	67	36
35 KvA generator	101	76	70	66	63	61	20
Woodchipper	124	99	93	89	86	84	174 *
Dewatering Pump	98	73	67	63	60	58	14
Small diesel generator	83	58	52	48	45	43	3

^ with partial screening (5 dB reduction) distance to meet 70 dB L_{Aeq} is reduced to 76 m.

* with effective screening (10 dB reduction) distance to meet 70 dB L_{Aeq} is reduced to 69 m.

The following table shows key equipment likely to generate vibration for the Project. Where available, measurements / estimates of vibration from that equipment have been included.

Whilst the hydraulic hammer piles generate higher vibration levels of approximately 10 – 15 mm/s PPV at 10 m, the dominant frequency of this source is between 12 – 24 Hz. DIN 4150-3:2016 criteria is frequency dependent and a higher PPV level is allowable at higher frequencies. As the dominant frequency from piling can vary dependent on factors such as the depth of the pile and ground conditions, the lower frequency criterion for 12 Hz will be used to present a worst-case assessment when considering impacts from hydraulic hammer piles.

Table 5.2: Key construction equipment generating vibration

Equipment	PPV at 10 m
Vibro piles	4 - 5 mm/s
10t hydraulic hammer piles	10 – 15 mm/s
Large Roller (vibratory)	2 – 3 mm/s
Excavator with rock breaker attachment (20 t)	3 – 4 mm/s
20 - 30 t Excavator	1 – 2 mm/s

5.2.1 Activities sound power levels

Due to the nature and extent of the proposed works there will be a variety of construction plant used. Table 5.1 lists the expected significant items of plant. It is not feasible to provide an assessment of noise effects from all construction plant that will operate across these works.

To provide a reasonable assessment of noise exposure for individual receivers, the sound power levels and predicted set back distances for the main construction activities have been calculated in Table 5.3 assuming construction plant operates concurrently on site at the edge of the construction area (i.e. worst-case assessment).

Table 5.3: Activity sound power levels and compliance distance without mitigation

Activity	Activity sound power level, dB L_{Aeq}	Setback distance to achieve 70 dB L_{Aeq} without mitigation (m)
Site compound	105	30
Bridge piling	117	91
Bridge construction (civil)	110	48
Culvert Demolition / rock breaking	119	110
Bridge construction (Roading)	105	30
Concrete pouring	103	25*

Note: Bridge piling assumes only hydraulic hammer pile operating at 100% of the time, culvert demolition assumes only 20 t excavator with breaker attachment operating at 75% of the time. *Night-time set back distance is approximately 250 m to achieve 45 dB L_{Aeq}.

The presented sound power levels are indicative only, as the construction methodology has not yet been finalised. In reality, there is a low likelihood of all modelled equipment to be in one location at any given time. It is also recognised that there will be times during the day when there will be no working or minimal noise generating activities. As such, predictions present a worst case to account for any uncertainties in methodology and provide an envelope of effects. The sound power levels presented are similar to those for other major infrastructure projects in Auckland.

Based on the set back distances shown in Table 5.1, receivers located over 90 m from the nearest construction area have not been included as they are unlikely to experience noise above the relevant AUP permitted noise levels.

5.2.1.1 Noise model

A SoundPLAN computer model (version 9.0) implementing ISO 9613-2:1996 *"Acoustics – Attenuation of sound outdoors – Part 2: general method of calculation"* prediction algorithm has been used to predict noise levels from activities associated with the construction works of Walmsley Road bridge. The noise model takes into account ground contours, ground absorption (0.4), terrain, buildings and the location of works. The building footprints and Lidar digital elevation data have been obtained from the LINZ database. Buildings were adjusted for the number of floors (assuming 2.8 m height per floor with an average height of 6 m for two storey buildings).

It was considered SoundPLAN calculation is most appropriate for calculation of noise levels to account for the terrain changes around the stream bank.

For each receiver, the LwMax "total sound power located in one point" has been used to calculate the worst-case noise level based on the sound power levels as presented in Table 5.3, which is typically when equipment is operating at the closest location.

The following scenarios have been modelled for the activities closest to receivers, with the construction plant operating 100% of the 15-minute assessment period at the edge of the construction location (i.e. worst-case assessment):

- Site compound: source height at 1 m.
- Bridge piling: hydraulic hammer piles - source height at 3 m (to account for piles going in at a lower ground level).
- Bridge construction: source height at 1.5 m.
- Culvert demolition / rock breaking: 20t excavator with breaker attachment - source height at 1 m.

The roading of the bridge construction has not been separately assessed as the activity is 5 dB quieter than for civil works within the same location. As such assessment of the civil works to include roading aspect is considered a worst-case scenario. It is recognised that there will be times during the day when there will be no noisy works or minimal noise generating activities. As such, predictions present a worst case to account for any uncertainties in methodology and provide an envelope of effects.

5.3 Predicted construction noise and vibration levels

Façade noise maps for each modelled scenario have been calculated for nearby sensitive receivers. The full graphical façade noise maps are presented in Appendix B. The façade noise maps show the highest sound level experienced at each building, i.e. the closest, highest floor and most exposed façade to the source. Colour coding has been used to highlight the range of construction noise levels.

Grid noise maps are modelled at 1.5 m above ground level in accordance with NZS 6801:2008 noise measurement standard to enable comparison. Predicted façade levels may be greater than those shown on the grid noise contours.

Due to the height of piling works, effective screening is often difficult to provide for surround receivers. For this reason, this assessment assumes no screening for the majority of receivers near the piling rigs, except where other buildings are between the proposed works.

5.3.1 Noise level predictions

Table 5.4 summarises the predicted worst-case noise levels for receivers without screening. Exceedances of the 70 dB $L_{Aeq(15min)}$ Project criterion are identified in bold.

Table 5.4: Maximum predicted noise levels at nearest receivers (1 m from building façade) without mitigation

Address	Bridge Piling, dB L_{Aeq}	Culvert Demolition, dB L_{Aeq}	Bridge construction (roading), dB L_{Aeq}	Construction support areas, dB L_{Aeq}
4 Walmsley Road	**80**	**84**	**71**	70
8 Walmsley Road	**78**	**81**	**72**	69
15 Walmsley Road	**74**	**81**	66	70
2 McKenzie Road	**75**	**78**	66	65
14 Walmsley Road	**72**	**76**	65	62
6 Walmsley Road (1)	**74**	**79**	65	61
18 Walmsley Road	**73**	**77**	65	63
17 Walmsley Road	69	**75**	60	60
12 Walmsley Road (1)	70	**72**	64	58
2A McKenzie Road (2)	70	**75**	62	58
12 Walmsley Road (2)	70	**74**	62	58
19 Walmsley Road	67	**71**	58	57
20 Walmsley Road	70	**74**	60	60
22 Walmsley Road	68	**73**	60	59
14A Walmsley Road	69	**72**	61	56
68 Molesworth Place	66	70	60	56
1B Miller Road	**71**	**74**	61	64
6 Walmsley Road (2)	69	**72**	60	56
2A McKenzie Road (1)	68	68	60	57
164 Coronation Road – Heritage (1)	70	**71**	60	60
4 McKenzie Road	67	**72**	59	58
3 Hall Avenue	63	70	54	55
164 Coronation Road – Heritage (2)	68	70	59	58
6 McKenzie Road	67	69	57	57

Predicted noise levels indicate 19 receivers will exceed the daytime noise limit of 70 dB L_{Aeq} without mitigation due to a culvert demolition / rock breaking activities. Eight of the 19 receivers will also exceed the daytime noise limit during bridge piling works. With the exception of piling works which cannot be effectively screened, other activities of roading, support areas and culvert demolition using the breaker attachment can be partially (5 dB reduction) or fully screened (10 dB reduction) using acoustic barriers around the works and/or the use of a shroud.

With mitigation in place where practicable, seven receivers are predicted to exceed the daytime noise limit.

5.3.2 Vibration level predictions

Table 5.5 summarises the predicted worst-case vibration levels for receivers. Exceedances of the DIN 4150-3:2016 criterion (3 mm/s PPV for heritage buildings, 5 mm/s PPV for residential buildings) are identified in bold. Only three pieces of equipment generating high vibration levels have been assessed, all other equipment will fall below or within the highest predicted vibration levels presented.

Table 5.5: Maximum predicted vibration levels at nearest receivers

Address	Bridge piling – Hammer Piles, mm/s PPV	Culvert demolition – 20t excavator with breaker, mm/s PPV	Bridge construction – vibratory roller, mm/s PPV
4 Walmsley Road	**9 - 10**	2 - 3	1 - 2
8 Walmsley Road	**7 - 8**	2 - 3	1 - 2
15 Walmsley Road	**6 - 5**	2 - 3	1 - 2
2 McKenzie Road	**5 - 7**	1 - 2	1 - 2
14 Walmsley Road	**5 - 6**	1 - 2	1
6 Walmsley Road (1)	**4 - 6**	1 - 2	1
18 Walmsley Road	4 - 5	1 - 2	1 - 2
17 Walmsley Road	3 - 5	1 - 2	1 - 2
2A McKenzie Road (1)	4 - 5	1 - 2	< 1
2A McKenzie Road (2)	4 - 5	1 - 2	< 1
12 Walmsley Road (1)	3 - 5	1 - 2	< 1
6 Walmsley Road (2)	3 - 5	1 - 2	< 1
20 Walmsley Road	3 - 5	1 - 2	1 - 2
1B Miller Road	3 - 5	1 - 2	< 1
12 Walmsley Road (2)	3 - 5	1 - 2	< 1
4 McKenzie Road	3 - 4	1 - 2	< 1
14A Walmsley Road	3 - 4	1 - 2	< 1
19 Walmsley Road	3 - 4	1	< 1
164 Coronation Road - heritage (1)	**3 - 4**	< 1	< 1
68 Molesworth Place	3 - 4	< 1	< 1
6 McKenzie Road	3 - 4	1	< 1
22 Walmsley Road	2 - 4	1	< 1
3 Hall Avenue	2 - 4	< 1	< 1
164 Coronation Road - heritage (2)	**2 - 4**	< 1	< 1

Vibration levels indicate six residential receivers, and two heritage buildings are predicted to exceed DIN 4150-3:2016 of 5 mm/s PPV for residential and 3 mm/s PPV for sensitive / heritage building limits.

Approximately 100 properties within 190 m of hammer piling works may experience vibration levels above the 2 mm/s amenity levels. A map showing the 190 m buffer zone and a table of receivers is included in Appendix C.

5.3.3 Works outside of standard construction hours

Concrete pours are a common element to all projects requiring road construction and for this Project the majority of concrete pours will take place during the standard construction hours. As mentioned in section 2.3.2, early morning concrete pours (from 4 am onwards) and nighttime roading may be required 3 - 5 times through the Project to accommodate tie ins to the existing roads.

Without mitigation, concrete pours require a setback of 250 m to meet the night-time noise limit of 45 dB L_{Aeq}. With partial screening, a setback distance of 160 m is required to meet night-time noise limit. Exceedance of the night-time 45 dB L_{Aeq} criterion will likely occur at receivers for both options.

Dewatering pumps powered by a diesel generator may be required with potential for overnight use during streambank enhancements for up to four months throughout the project. There is potential for dewatering during installation and removal of temporary stream diversions and during excavations associated with both the stream profile and abutments of the bridge. Noise mitigation such as noise barriers and/or enclosure for overnight dewatering will be used.

Without mitigation, noise levels due to dewatering pump at a minimum 50 m (located within the main support area) from nearest receiver is predicted to be 58 dB L_{Aeq}. With appropriate screening in place, predicted noise level can reduce to 48 dB L_{Aeq}. Depending on the placement and specification of the unit, noise levels can be effectively mitigated for overnight pumping. This can be managed via the CNVMP.

5.3.4 Construction traffic movements

Although the AUP does not require noise from construction truck movements to be assessed[7], noise impacts have been considered due to the close proximity (less than 20 m) of the construction areas to nearby receivers.

The existing environment around the sites is such that the local environment is already dominated by traffic noise from the arterial roads and the nearby SH20. Additional construction truck movements will generally be inseparable from general traffic on the existing roads during the day but may be distinguishable along the local residential roads where heavy vehicles do not typically go.

It is understood from review of the Integrated Transport Assessment (ITA), a full road closure of Walmsley Road will result in diversions across the wider road network. Whilst this falls outside the scope of the construction noise, it is noted that the increase in traffic flow[8] along some of the proposed diversion route may result in a perceptible traffic noise increase between 28% to 160%. A change in traffic volume data by +25% or – 20% volume results in 1 dB change in predicted noise level, which would be imperceptible. The diversions will be temporary but a doubling of traffic volumes will result in a perceptible noise change, in particular for Elmdon street and Hall Avenue.

Based on the anticipated construction traffic movements[9] of 90 vehicles per day per stage. The construction traffic movements are considered to be negligible.

As set out in the construction methodology, there may be some circumstances where out of hours traffic movements will be required, including early deliveries of beams and equipment. These movements will generally be low speed and will not be a regular occurrence. Again, the noise

[7] The AUP excludes traffic noise – see AUP E25.1 Background.
[8] Source Table 9.1 - Te Ararata Flood Resilience Works – Walmsley Road Bridge Integrated Transport Assessment (ITA), Oct 2024.
[9] Sourced from Table 6.3 - Te Ararata Flood Resilience Works – Walmsley Road Bridge Integrated Transport Assessment (ITA), Oct 2024.

generated by construction vehicles will generally be inseparable from other vehicle movements that may occur in the local area. The noise of these movements will be managed by the CNVMP.

6 Assessment of effects

6.1 Potential noise effects

The degree of the Project's noise effects will depend upon the magnitude, frequency of occurrence and duration of the noise exposure. The effects of noise are also dependent upon the time of day at which it occurs. This is due to acoustic factors, such as the relative level of background noise, and non-acoustic factors, such as the activities being disturbed and people's expectations of noise levels at different times of the day.

Residents will experience noise inside and outside their dwellings if they are at home. An indication of the potential effects is provided in Table 6.1. Depending on the construction of the building, facades may provide a 25 – 30 dB reduction for typical residential buildings.

Note the adjustment factor between the external noise level and the internal noise level in Table 6.1 is based on a 20 decibel reduction as allowed for in NZS 6803:1999. The table does not correct for façade effects to simplify the presentation of internal noise levels.

Table 6.1: Subjective response to environmental noise (daytime) – residential building occupiers

External sound level (L_{Aeq})	Potential daytime effects outdoors	Corresponding internal sound level (L_{Aeq})	Potential daytime effects indoors
Up to 65 dB	Conversation becomes strained, particularly over longer distances.	Up to 45 dB	Noise levels would be noticeable but unlikely to interfere with residential activities.
65 to 70 dB	People would not want to spend any length of time outside.	45 to 50 dB	Concentration would start to be affected. TV and telephone conversations would begin to be affected.
70 to 75 dB	Outdoor users would experience considerable disruption.	50 to 55 dB	Phone conversations would become difficult. Personal conversations would need slightly raised voices. For residential activity, TV and radio sound levels would need to be raised.
75 to 80 dB	Some people may choose hearing protection for long periods of exposure. Conversation would be very difficult, even with raised voices.	55 to 60 dB	People would actively seek respite when exposed for a long duration.
80 to 90 dB	Hearing protection would be required for prolonged exposure (8 hours at 85 dB) to prevent hearing loss.	60 to 70 dB	Untenable for residential environments. Unlikely to be tolerated for any extent of time.

Note - this table relates to noise experienced during non-sleeping hours.

6.1.1 Bridge piling

External noise levels without any mitigation in place for the loudest bridge piling works of hydraulic hammer piling is predicted to exceed the daytime construction noise criterion of 70 dB L_{Aeq} at eight receivers.

The eight receivers at 4, 6, 8, 14, 15, 18 Walmsley Road, 1B Miller Road and 2 McKenzie Road are predicted to exceed 70 dB L_{Aeq}, with a maximum predicted noise level of 80 dB L_{Aeq} at 4 Walmsley Road.

Noise levels will vary during construction of the various bridge piles. The maximum noise levels presented in Table 5.4 are only likely to occur when the hydraulic hammer pile works are nearest to the receivers. Other piling options of bored pile and vibro piling will generate significantly lower noise levels than those presented. Piling works is anticipated to last for 3 - 4 weeks on each end of the Walmsley Road bridge abutment, and if required, the temporary bailey bridge will require 2 - 3 weeks at each abutment. Based on the piling methodology proposed with bored piles followed by hammer piles, noise at the predicted levels will not be continuous through the construction period and will not be at the closest point throughout (3 – 4 weeks before moving along). In reality, maximum noise levels may only occur for a relatively short period and intermittently throughout the days within the duration of the piling works and not throughout the whole project. Once the closest support pile has been constructed, works will move away to the next location reducing the maximum noise levels.

Due to the heights of the piles and nearby two storey buildings, noise from piling works cannot be effectively mitigated as 5 m high noise barriers would be required to achieve the Project's noise criterion. Temporary barriers this high would be impracticable to construct and maintain.

With a standard 1.8 m barriers around the localised construction areas in place as part of the recommended mitigation, a 1 – 2 dB partial reduction can potentially be achieved at first floor with and a 5 – 8 dB reduction at ground floor locations. This will be dependent on terrain feasibility.

A maximum predicted piling noise level of 80 dB L_{Aeq} would usually equate to an internal noise level 20 – 25 dB lower, i.e. 55 - 60 dB L_{Aeq} depending on the glazing and façade construction. An internal noise level between 55 – 60 dB L_{Aeq} may interfere with normal residential activities for extended periods of time but may be tolerable for short intermittent durations with prior notice. Management via consultation for receivers predicted to experience external noise levels over 80 dB L_{Aeq} will be required. If people are aware of the presence of a noise source, they are less likely to be adversely affected when it occurs.

High external noise levels for piling are not uncommon for this type of work close to residential receivers and has been successfully managed on other Auckland based projects, such as Herne Bay and Central Interceptor, which includes industry standard practice for piling mitigation such as avoiding unnecessary noise, selecting suitable equipment size for the task and advance communication and consultation with receivers around timing and duration. Similar management using a CNVMP will be adopted for this Project.

When construction works are within the road reserve, AUP noise limits do not apply with the submission of an CNVMP.

With the exception of the eight receivers discussed above, due to the relatively limited duration and intermittent nature of piling, along with the implementation of the CNVMP to appropriately manage piling activities, it is considered that noise effects from piling on surrounding residents will be reasonable, i.e. within an acceptable range of construction noise levels (75 dB L_{Aeq}) for the majority of receivers.

6.1.2 Culvert demolition / rock breaking

19 receivers are predicted to exceed the daytime noise limit of 70 dB L_{Aeq}, with a maximum predicted noise level of 84-81 dB L_{Aeq} at 4, 8 and 15 Walmsley Road.

Noise levels will vary during the use of the excavator with breaker attachment for culvert demolition and rock breaking activities. The maximum noise levels presented in Table 5.4 are only likely to occur when the works are at the closest location to receivers and with no mitigation of acoustic barriers or shrouding in place. Due to the distance from works and the terrain of the stream bank, partial screening (5 dB reduction) is likely achievable, reducing maximum predicted noise level to 79 dB L_{Aeq} with seven receivers exceeding daytime noise limits. An external noise level of 79 dB L_{Aeq} is not uncommon for rock breaking and demolition works for large construction projects and can be effectively managed on site. Industry standard practice for rock breaking mitigation includes using a smaller size excavator / breaker, fitting a shroud to the breaker, and consultation with receivers around timing and duration.

An internal noise level of 55 – 60 dB L_{Aeq} is likely to be acceptable for a limited duration of rock breaking and demolition works with prior notification. Scheduling of works around sensitive times may be required.

It is anticipated rock breaking and culvert demolition may take approximately 3 – 4 weeks moving progressively along the stream. Predicted maximum noise levels may only occur for a relatively short period and intermittently throughout the day within the duration of the rock breaking works and not throughout the whole project. As work moves away from receivers, maximum noise levels will reduce.

Overall, due to the reasonably limited duration and intermittent nature of rock breaking, it is considered noise levels can be effectively managed by the implementation of the CNVMP along with engagement with local receivers to manage noise effects.

6.1.3 Bridge construction

Two receivers at 4 and 8 Walmsley Road are predicted to exceed the 70 dB L_{Aeq} noise limit (72 dB L_{Aeq}) due to bridge construction activities at Walmsley Road bridge. With acoustic barriers in place, a minimum 2 – 5 dB reduction can be achieved, and compliance with 70 dB L_{Aeq} can be achieved and will be managed via the CNVMP.

6.1.4 Construction support area

Assuming a worst-case scenario of all supporting sources are operating at the closest location along the boundary of the construction areas, predicted noise levels indicated support activities can comply with the daytime noise limit of 70 dB L_{Aeq} with no additional mitigation required.

In reality, the main support area (on Black Bridge reserve) is located over 20 m further away than the construction site boundary and noise levels are likely to be much lower than the maximum predicted noise level of 70 dB L_{Aeq}.

Noise levels due to the support areas can be effectively managed via the CNVMP.

6.1.5 Works outside of standard hours

Works outside of standard hours is required for early deliveries, concrete pours, road tie ins and dewatering. Concrete pours and the use of asphalt paving machine will generate noise levels above the noise limits at the nearest receivers but for limited durations of around 3 – 5 nights / early mornings for each activity. Where works will be solely within the road reserve, the early morning concrete pours and road tie in activities is permitted if exceedance of the AUP limits at receivers is 3 night or less.

Noise levels from concrete pours can be minimise by locating the concrete truck away from residential receivers, acoustic barriers and other practicable controls such as locating the high speed mixing away from dwellings to achieve a lower sound pressure level. This activity can be managed via the CNVMP to reduce the effects on receivers via consultation, advance notification and scheduling of works.

For dewatering activities, the exact locations, specification of pump and corresponding noise levels are unknown at this stage but it is expected that noise effects at night-time (most conservative) can be mitigated by the use of appropriate screening, specification of a low noise pump unit and placement of the unit away from residential receivers. This will be managed via the CNVMP.

6.2 Potential vibration effects

Construction activities for this project will be generating high vibration levels at perceptible levels. For both options, exceedances at the same properties are predicted. Piling locations for the main bridge are within the road reserve and AUP amenity limit of 2 mm/s do not apply for compliance purposes.

The assessment shows that 97 properties within 190 m of the piling location are predicted to experience vibrations above the 2 mm/s amenity level but under the 5 mm/s DIN 4150-3:2016 threshold for cosmetic damage. Vibration levels of 2 mm/s may be perceivable by occupants and they may be disturbed by such occurrences, but based on experience with other construction projects, vibrations at this level will generally be acceptable to receivers provided they have received prior warning (this is so that the receivers are not surprised or startled when the vibrations occur).

Six residential properties at 4, 6, 8, 14, 15 Walmsley Road and 2 McKenzie Road are predicted to experience vibration levels over 5 mm/s. A worst case of 9 – 10 mm/s PPV is predicted at 4 Walmsley Road located 24 m from the closest piling works. At these levels, vibration will be tolerable only for very short periods of time with prior warning and explanation.

Additionally, two properties listed as Heritage buildings at 164 Coronation Road (comprise of two buildings) are predicted to exceed the DIN 4150-3:2016 3 mm/s PPV limit for sensitive buildings with a maximum predicted level of 3 - 4 mm/s PPV. These worst-case exceedances are predicted during use of the hydraulic hammer piles; vibration levels will be short in duration and not cause continuous vibration levels. If the property is occupied, vibration is likely to be tolerable for a short period and consultation and mitigation measures as set out in Section 7.1.6 will be required.

The DIN 4150-3:2016 thresholds are set to be protective of cosmetic damage (refer to section 3.3) and 5 mm/s is applicable for frequencies between 1 – 10 Hz. Equipment used for this Project are likely to operate at frequencies greater than 10 Hz resulting in a higher threshold as illustrated in Figure 3.1. In reality, structural damage is unlikely to occur in residential buildings at less than 50 mm/s. Therefore, a worst case predicted vibration level for the Project of 10 mm/s at 4 Walmsley Road is unlikely to cause structural damage but a building condition survey will be required and monitoring undertaken during closest works to minimise any adverse effects where possible.

Effects will be managed via the CNVMP through the use of monitoring and appropriate construction practices to minimise the potential to exceed 5 mm/s when properties are occupied. For all properties predicted to exceed the DIN 4150-3:2016 identified in Table 5.1, a pre and post-construction building condition survey is recommended as described in Section 7.1.6.1 before piling works begin.

Consultation with the building owners and occupants will be carried out prior to construction work starting. Effects will be managed through vibration monitoring and consultation with the occupants prior to construction works starting.

7 Noise and vibration management

7.1 Construction Noise and Vibration Management Plan (CNVMP)

It is common practice for infrastructure projects to implement a CNVMP as part of the construction management plan. Implementing noise management and mitigation measures via a CNVMP is the most effective (and best practice) way to control construction noise and vibration impacts. The objective of the CNVMP should be to provide a framework for the development and implementation of best practicable options to avoid, remedy or mitigate the adverse effects on receivers of noise and vibration resulting from construction. A draft CNVMP identifying the minimum level of information as set out in AUP E25.6.29(5) for the works has been prepared in support of the resource consent.

A CNVMP will be implemented for the work site with specific sections on activities that are predicted to exceed the Project's adopted noise and vibration limits. The CNVMP will be updated to reflect detailed design before commencement of work and kept up to date regarding actual timing / equipment used and methodologies.

The CNVMP should include, but not be limited to, the following recommended mitigation and management measures.

7.1.1 General noise mitigation

- 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.
- Orient machinery to maximise the distance between the engine exhaust and the nearest sensitive building façade (e.g. excavators).
- Selection of equipment and methodologies to restrict noise.
- Locate equipment at a distance greater than the minimum set back distances where practicable.
- Utilise noise barriers and/or enclosures where appropriate. Noting that there will be negligible benefit if there is line of sight between the receiver and the source of noise.
- Liaising with neighbours so they can work around specific activities.

7.1.2 Communication and consultation

The key element of noise and vibration management is ensuring that appropriate communication occurs with affected neighbours. Such measures include:

- Prior notification of the works via a letterbox drops or supplemented by other means (news article, website, emails etc) to affected neighbours and properties within the areas identified in this assessment. The letterbox drop will provide contact details and will detail the overall nature and expected duration of the works.
- Prior to any particularly noisy process being identified, the most affected neighbours as identified in Table 5.4 and Table 5.5 will be contacted individually. Neighbours will be informed of the proposed timing of the specific works. Ongoing consultation and communication with neighbours less than 50 m from any construction works should be undertaken.

7.1.3 Noise barriers

Where practicable, panels should be positioned as close as possible to the construction activity to block line-of-sight between the activity and noise sensitive receivers. For rock breaking within the stream, barriers should be placed along the top of the bank where practicable.

Additional local barriers may be necessary near the activity to ensure effective mitigation for sensitive receivers on upper floor levels. The panels should be a minimum height of 1.8 m, and higher if practicable to block line-of-sight[10]. The 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’ (NZ).
- Flexshield ‘Sonic Curtain with 4 kg/m^2 mass loaded vinyl backing’ (NZ).

7.1.4 Specific mitigation

If barrier is not feasible to be installed during rock breaking / culvert demolition due to terrain, the following alternative mitigation should be adopted where practicable:

- The use of a shroud around the breaker attachment.
- A three-sided screen around the immediate area of the works.
- Use of a smaller machine and attachment to reduce noise levels.

7.1.5 Works outside of standard construction hours

Where practicable all works should be undertaken during the standard construction hours (see Section 2.3.2).

Where there are no practicable alternative options to complete works within standard hours 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.
- Offer temporary relocation to affected residents if unreasonable noise and/or vibration levels cannot be avoided.

7.1.6 Vibration mitigation

A hierarchy of vibration mitigation measures should be adopted through the 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 5 mm/s PPV and at heritage buildings.
- Where vibration levels are predicted to exceed the applicable DIN 4150-3:2016 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 7.1.6.1.

[10] Temporary barriers greater than 3-4 m are generally impracticable to construct due to wind loading constraints.

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

7.1.6.1 Building condition surveys

A pre-construction building condition survey will be undertaken at all of the identified buildings exceeding the applicable DIN 4150-3:2016 limit detailed in Table 5.5 before the main construction works begins.

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.
  - Photographic evidence.
- The Project team will provide the building condition survey report to the property owner; and
- 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 (i.e. below the DIN 4150-3:2016 threshold).

During construction if complaints are made about vibration or if monitoring determines it necessary, further building condition surveys may be undertaken. 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 Healthy Waters' cost.

8 Conclusion

An assessment of noise and vibration has been carried out for the proposed flood resilience works at Walmsley Road Bridge based on full road closure traffic option with works within the stream for widening. A construction support area is proposed to be established on Black Bridge Reserve.

The main proposed works on Walmsley Road Bridge is within the road reserve and as such are a permitted activity in accordance with the AUP Section E25.6.29 (3)(b) for noise and Section E25.6.29(4A) for vibration with the submission of a CNVMP. The construction of the support areas are within a park reserve and stream works are subjected to standard AUP construction noise and vibration limits. The works described in this report are typical for construction works carried out for larger infrastructure projects across Auckland.

Predicted noise and vibration levels have been assessed against relevant AUP performance standards to assess the potential effects for management and mitigation purposes. The assessment is based on an indicative construction methodology for a worst-case scenario based on no mitigation applied. Bridge piling whilst using a hydraulic hammer pile is predicted to generate the highest noise and vibration levels at nearby receivers as standard mitigation (such as acoustic barriers) cannot be effectively implemented due to the height of the piles. Other activities assessed can be at least partially screened to reduce overall noise levels and can be effectively managed by the implementation of the CNVMP along with engagement with local receivers to manage noise effects. Activities outside of standard construction hours may exceed the relevant noise limit.

8.1 Noise

For Bridge piling works, eight residential receivers (4, 6, 8, 14, 15, 18 Walmsley Road, 1B Miller Road and 2 McKenzie Road) are predicted to exceed the daytime construction noise limit of 70 dB L_{Aeq}. A maximum noise level of 80 dB L_{Aeq} is predicted at 4 Walmsley Road with no mitigation in place. The maximum noise levels at façades are not expected to be continuous (it will be intermittent in nature and temporary) and are only likely to occur as a worst-case scenario when piling is occurring at the closest location to receivers. Due to the reasonably short duration and intermittent nature of the piling activities, it is considered noise effects can be effectively managed via the CNVMP. Noise levels at all other receivers are predicted to comply with the AUP limit.

Predicted noise levels also indicate culvert demolition / rock breaking activities may exceed the daytime construction noise limit at 19 receivers (no mitigation in place) with a maximum noise level of 84 dB L_{Aeq} at 4 Walmsley Road. Due to the local terrain of the works, partial screening is likely achievable and maximum noise levels can be reduced to 76 - 79 dB L_{Aeq} with seven receivers exceeding the daytime noise limit. An external noise level of 76 - 79 dB L_{Aeq} is not uncommon for rock breaking and demolition works for large construction projects and can be effectively managed on site.

Predicted noise levels for other activities assessed are lower than for the two worst case scenarios of bridge piling and culvert demolition but may still exceed the 70 dB L_{Aeq} daytime limit at up to two receivers. Consent is required to exceed the noise limits for works outside the road reserve.

Noise mitigation measures and consultation will be required to manage noise. With mitigation in place, overall effects can be appropriately managed and reduced to ensure construction noise effects are acceptable and no more than minor. Resource consent is required to exceed the daytime noise limits at the receivers identified.

8.1.1 Vibration

With the exception of eight properties, construction vibration at the majority of receivers is not likely to exceed the relevant DIN 4150-3:2016 limits for cosmetic building damage.

Six properties (4, 6, 8, 14, 15 Walmsley Road and 2 McKenzie Road) may experience vibration levels above the 5 mm/s during the use of the hammer pile and two listed Heritage building (164 Coronation Road) are predicted to experience vibration over the 3 mm/s threshold for sensitive structures. Consent is required to exceed the vibration limits for piling works outside the road reserve.

Vibration at these properties will be managed via consultation and monitoring addressed in the CNVMP and building condition surveys will be undertaken prior to the commencement of any piling construction works. Resource consent will be required to exceed the DIN 4150-3:2016 thresholds.

97 properties within 190 m of hammer pile works may experience vibration levels over the 2 mm/s amenity limit but under the 5 mm/s DIN threshold. Notification at these properties will be undertaken prior to construction works and managed via the CNVMP.

9 Applicability

This report has been prepared for the exclusive use of our client Auckland Council, 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
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SHYU
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Appendix A Glossary

Table Appendix A.1 : Glossary

Term	Definition
dB	A unit of measurement on a logarithmic scale which describes the magnitude of sound pressure with respect to a reference value (20 µPa).
$L_{Aeq(t)}$	The A-weighted time-average sound level over a period of time (t), measured in units of decibels (dB).
L_{WA}	Sound power level.
PPV	Peak particle velocity. This is the instantaneous maximum velocity reached by the vibrating surface as it oscillates about its normal position.
Noise	Unwanted sound.

Every 10 dB increase in sound level doubles the perceived noise level. A sound of 70 dB is twice as loud as a sound level of 60 dB and a sound level of 80 dB is four times louder than a sound level of 60 dB. An increase or decrease in sound level of 3 dB or more is perceptible. A change in sound level of less than 3 dB is not usually discernible.

As sound level is measured on a logarithmic scale, the following table provides examples of typical sources of noise.

Decibel (dB)	Example
0	Hearing threshold
20	Still night-time
30	Library
40	Typical office room with no talking
50	Heat pump running in living room
60	Conversational speech
70	10 m from edge of busy urban road
80	10 m from large diesel truck
90	Lawn mower - petrol
100	Riding a motorcycle at 80 kph
110	Rock band at a concert
120	Emergency vehicle siren
140	Threshold of permanent hearing damage

Appendix B Noise Contours

Sensitivity: General

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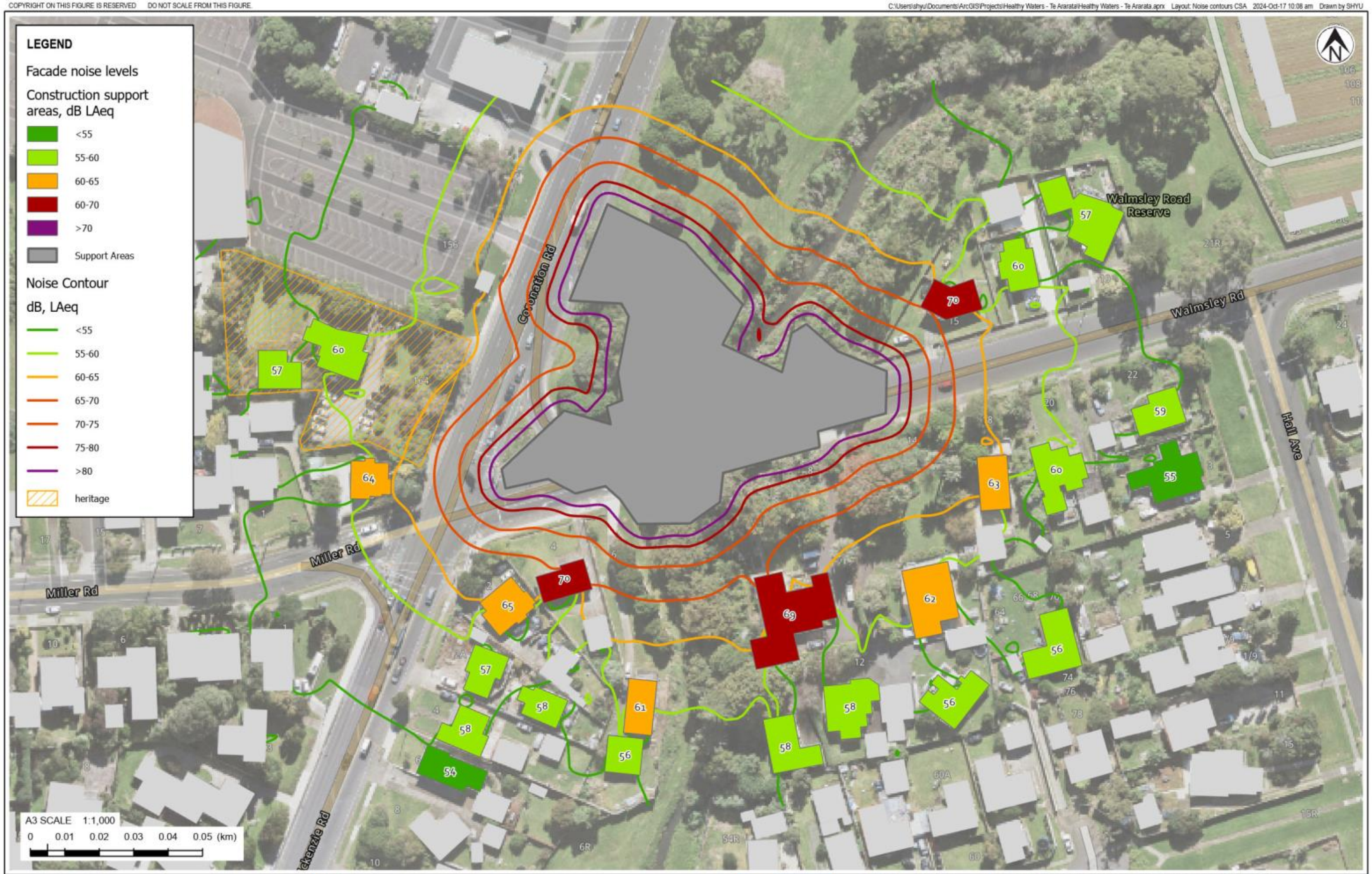
C:\Users\shyu\Documents\ArcGIS\Projects\Healthy Waters - Te Ararata\Healthy Waters - Te Ararata.aprx Layout: Noise contours CSA 2024-Oct-17 10:08 am Drawn by SHYU



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REV	DESCRIPTION	GIS	CHK	DATE
0	First version	XXXX	2024	16/10/24

LOCATION PLAN: Auckland

PROJECT No.	1017033	
DESIGNED	SHYU	OCT.24
DRAWN	SHYU	OCT.24
CHECKED	LILE	OCT.24
APPROVED		DATE

CLIENT AUCKLAND COUNCIL HEALTHY WATERS

PROJECT TE ARARATA - WALMSLEY BRIDGE

TITLE NOISE CONTOURS - CONSTRUCTION SUPPORT AREAS

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

Sensitivity: General

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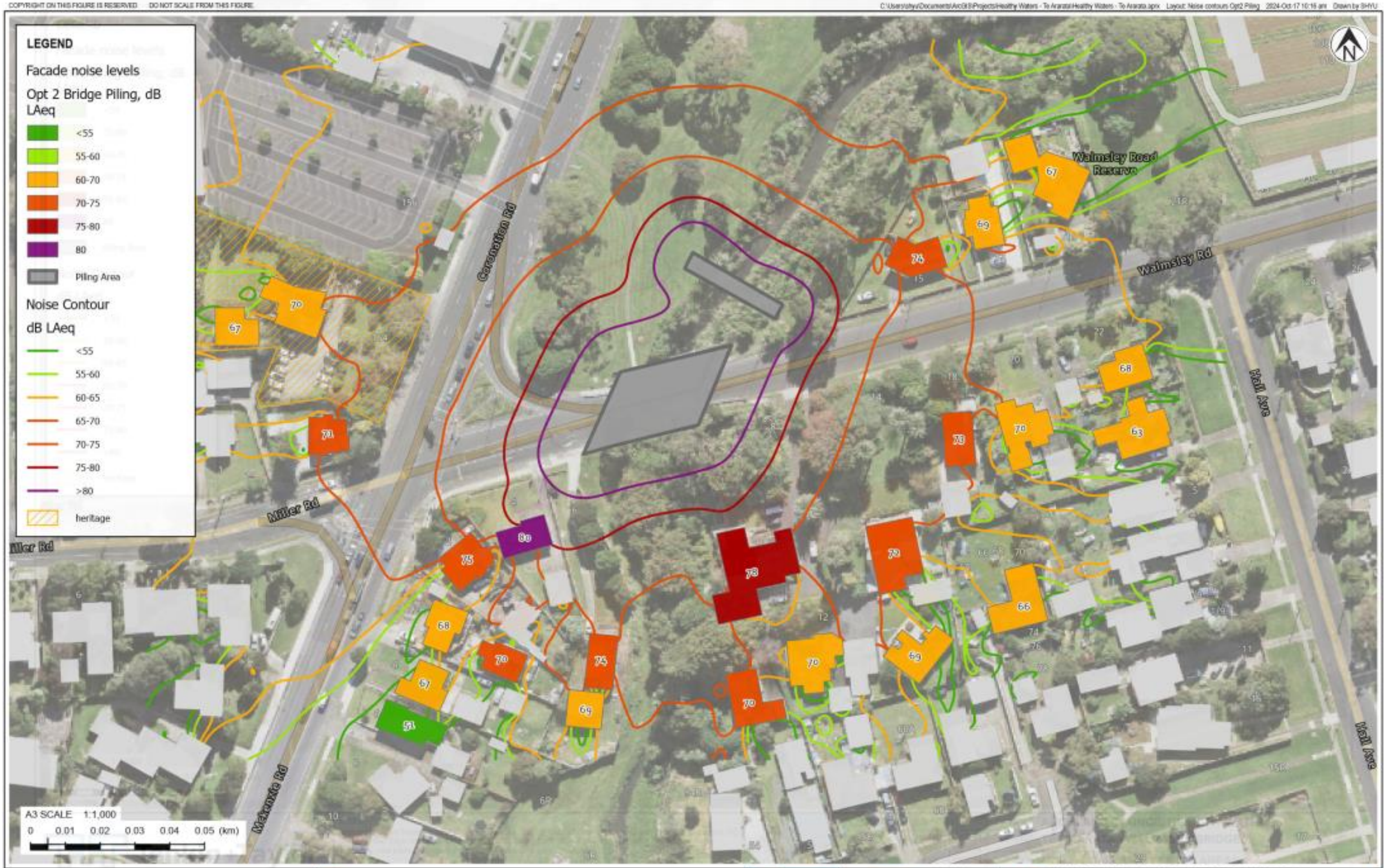
CLIENT AUCKLAND COUNCIL HEALTHY WATERS

PROJECT TE ARARATA - WALMSLEY BRIDGE

TITLE NOISE CONTOURS - ROCK BREAKING/CULVERT DEMOLITION

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



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CLIENT AUCKLAND COUNCIL HEALTHY WATERS
PROJECT TE ARARATA - WALMSLEY BRIDGE
TITLE NOISE CONTOURS - PILING AREAS

SCALE (A3) 1:1,000   FIG No. APPENDIX B FIGURE 3   REV 0

Appendix C Vibration buffers

Sensitivity: General

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CLIENT AUCKLAND COUNCIL HEALTHY WATERS
PROJECT TE ARARATA - WALMSLEY BRIDGE
TITLE RECEIVERS WITHIN 190 M OF PILING WORKS
SCALE (A3) 1:1,800   FIG No. APPENDIX C FIGURE 1   REV 0