

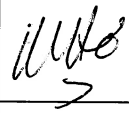


Greenhithe Bridge Watermain Duplication and Causeway

Technical Report G – Construction Noise and Vibration

May 2015

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EXECUTIVE SUMMARY

The proposed Greenhithe Bridge Watermain Duplication and Causeway works have the potential to result in temporary construction noise and vibration impacts at nearby receivers. Predictions of the noise and vibration levels associated with the construction works have been made, considering the distances to the nearest sensitive receivers and indicative construction equipment.

It has been found that, without specific mitigation or management measures, construction noise and vibration should meet the daytime criteria for all activities. Night-time and Sunday works would require the implementation of enhanced noise and vibration management procedures for most activities. Accordingly, noise management and mitigation measures have been identified.

Temporary removal of parts of the Hobsonville noise barrier will be required during construction. Removal of the barrier will be avoided as far as possible and will be considered during detailed design. There is the potential for operational road traffic noise levels to increase by up to 6 dB depending of the extent of barrier affected. The resulting noise change is not considered significant.

Appropriate mitigation and management measures will be confirmed when the specific construction methodology and equipment are known. These measures will be documented in a Construction Noise and Vibration Management Plan (CNVMP). With appropriate management of noise and vibration through a CNVMP, it is considered that both daytime and night-time effects will be acceptable.

1 INTRODUCTION

URS New Zealand Ltd has been commissioned by Watercare Services Limited (Watercare) to assess the potential noise and vibration effects related to the construction of Watercare's proposed Greenhithe Bridge Watermain Duplication (GBWD) and Causeway project.

The project comprises:

- The construction of a new watermain on the northern side of the Greenhithe Bridge to duplicate the existing North Harbour 1 Watermain already located on the southern side of the bridge, and
- Widening along the northern side of the existing State Highway 18 motorway causeway to accommodate the new watermain, as well as wastewater pipelines and associated facilities which form part of Watercare's proposed Northern Interceptor project.

The proposed water and wastewater infrastructure is required in order to maintain water and wastewater service levels and to provide for future growth.

The proposed Greenhithe Bridge Watermain Duplication and Causeway project requires various resource consents under the Resource Management Act 1991 ("RMA"). This technical report provides specialist input for the *Greenhithe Bridge Watermain Duplication and Causeway – Assessment of Effects on the Environment* report ("the AEE" report) prepared by URS New Zealand and Jacobs New Zealand Limited which supports the resource consent application. The works described in the AEE have been considered in the technical assessment presented in this report.

This report provides the following:

- A brief overview of the proposed works (in Section 2);
- Description of specific aspects of the project in relation to construction noise and vibration;
- A brief outline of the statutory framework relevant to construction noise and vibration;
- Description of the investigations undertaken to assess noise and vibration;
- An assessment of the actual or potential effects on the environment (construction, operation and maintenance), having reference to the statutory framework and any other environmental factors considered relevant. This includes the identification of activities that could result in adverse effects and, in turn, identifying design refinements or construction methodologies that could avoid, remedy or mitigate such effects;
- Recommended mitigation and management measures.

The new watermain will eventually form part of Watercare's future North Harbour 2 Watermain project. The proposed widening of the motorway causeway will also incorporate wastewater pipelines and associated facilities which form part of Watercare's proposed Northern Interceptor project. Separate technical reports have or will be prepared for the future North Harbour 2 Watermain project and for the balance of the Northern Interceptor project.

2 GREENHITHE BRIDGE WATERMAIN DUPLICATION AND CAUSEWAY RECLAMATION PROPOSED WORKS

The proposed Greenhithe Bridge Watermain Duplication and Causeway works assessed in this report are the construction, operation and maintenance of:

1. The proposed watermain from Station Street in Hobsonville, under the motorway to the coastal edge – this will involve open trenching from Station Street to the motorway, and trenchless construction under the motorway;
2. Proposed causeway widening to accommodate the proposed watermain and wastewater pipelines – the proposed widening is approximately 860 metres in length on the northern side of the existing motorway causeway. This consists of approximately 710 metres of 15 metre wide causeway, with a 150 metre long 50 metre wide section part way along the causeway;
3. The proposed watermain attached to the underside of the Greenhithe Bridge; and
4. A proposed watermain cross connection chamber close to the eastern abutment of the Greenhithe Bridge.

The proposed works, including design drawings, are described in detail in the AEE.

As is normal for projects that are at the preliminary design stage, a contractor has not yet been appointed, and the specific construction equipment and methodologies cannot be determined. Therefore, this report considers indicative construction activities to make a broad assessment of noise and vibration levels and to determine the extent of likely effects and whether those effects can be appropriately managed. Once the equipment and methodologies are confirmed by the contractor, a construction noise and vibration management plan (CNVMP) will be prepared to detail specific mitigation and management measures to be adopted.

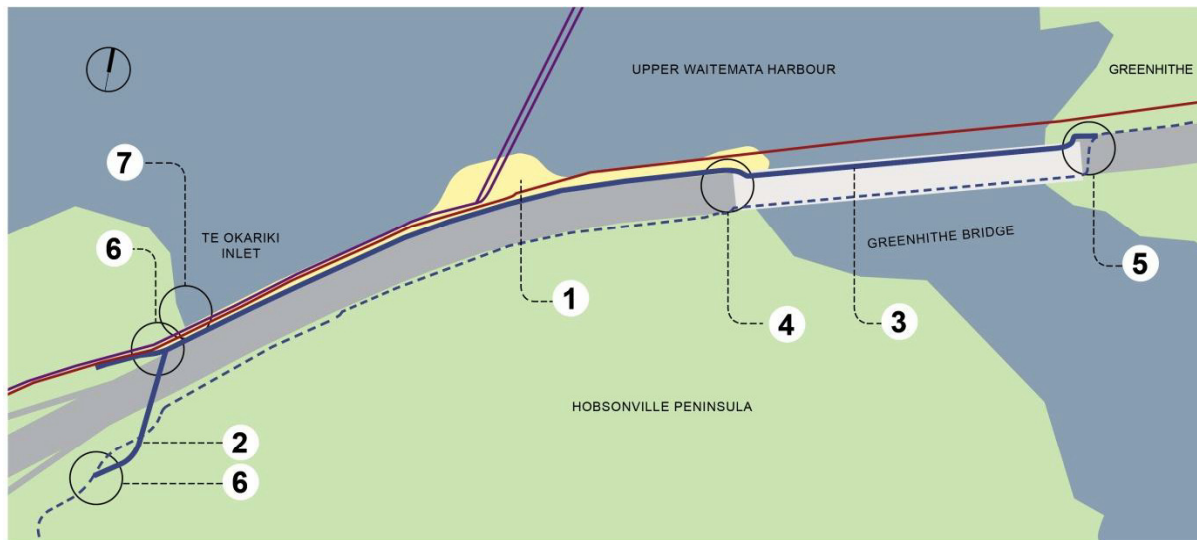
3 CONSTRUCTION AREAS AND ACTIVITIES

The GBWD and Causeway project will involve seven major Construction Elements (CE); these are listed in Table 3-1 and identified in Figure 3-1. The table also includes a list of the construction tasks involved with each construction element. By separating each construction element into several construction tasks a more realistic prediction of the noise levels can be made for a specific location and time.

Table 3-1 Indicative construction activities and sub-tasks

Construction Element	Activity	Sub-task
CE1	Causeway widening and extension and installation of new pipes within the causeway	Initial works
		Causeway widening
		Pipe installation
CE2	Connection pipe between NH1 and the new watermain – west end	Sheet piling
		Excavation
		Pipe jacking
		Steel pipe insertion
CE3	New watermain connection to the Greenhithe Bridge	Bracket installation
CE4	Watermain transition structure at the west end of the Greenhithe Bridge	Causeway extension
		Piling
		Thrust block construction
CE5	Connection between NH1 and the new watermain – east end	Sheet piling
		Chamber construction
		Pipe jacking
		Piling
		Thrust block construction
CE6	West end valve chambers	Sheet piling
		Excavation
		Chamber construction
CE7	Scour chamber	Sheet piling
		Excavation
		Chamber construction

An inventory of the likely construction equipment that will be used each construction element is included in Appendix A along with indicative noise source levels, quantities and expected percentage of time that the equipment will be operating. This information has been used for the noise predictions in Section 5.1.



Key

- GBWD pipeline
- - - NH1
- NI pipeline phase 1
- NI pipeline phase 2
- Causeway widening & extension

Figure 3-1 Map of the Greenhithe Bridge Watermain Duplication and Causeway work areas

4 CRITERIA

4.1 Noise and vibration levels

Rule 1.1 within the General Noise Standard of the Waitakere District Plan and Rule 10.5.i) of the North Shore District Plan state that construction, maintenance and demolition noise shall comply with the provisions of NZS 6803P:1984¹, while the Proposed Auckland Unitary Plan (PAUP) refers to NZS 6803:1999² for construction noise limits and DIN 4150-3:1999³ for pile driving vibration limits. For construction of infrastructure in urban areas it is often not practicable to achieve full compliance with the criteria, and in those cases enhanced noise and vibration management practices are detailed in the CNVMP to manage any adverse effects.

For NZS 6803 the 1984 provisional version and 1999 final version have similar criteria, but the 1999 version uses the current “ L_{Aeq} ” parameter so has been used for this assessment. The most stringent criteria from NZS 6803 for ‘long-term’ activities, exceeding 20 weeks, have been used. The noise criteria are outlined in Table 4-1 and apply at 1 metre outside residential buildings. These are specified in terms of the A-weighted time average sound level (L_{Aeq}) and maximum A-weighted sound level (L_{AFmax}).

Table 4-1 Long-term construction noise criteria

Time of week	Time period	L_{Aeq} (dB)	L_{AFmax} (dB)
Weekdays	0630-0730	55	75
	0730-1800	70	85
	1800-2000	65	80
	2000-0630	45	75
Saturdays	0630-0730	45	75
	0730-1800	70	85
	1800-2000	45	75
	2000-0630	45	75
Sundays and public holidays	0630-0730	45	75
	0730-1800	55	85
	1800-2000	45	75
	2000-0630	45	75

The vibration limits in DIN 4150-3:1999³ are included in Table 4-2 for residential and commercial buildings, as required by the district plan. These criteria are frequency dependent, varying linearly between the lower and upper frequency bounds. The guideline values in DIN 4150-3:1999 for evaluating the effects on buried pipework are also included in Table 4-3 to evaluate the effects on buried services. The values are Peak Particle Velocities (PPV), i.e. the highest instantaneous vibration level.

¹ NZS 6803P:1984 – The measurement and assessment of noise from construction, maintenance, and demolition work

² NZS 6803:1999 – Acoustics – Construction Noise

³ DIN 4150-3:1999 – Structural vibration: Effects of vibration on structures.

Table 4-2 Construction vibration criteria – structures

Type of structure	Vibration at foundation		
	1 – 10 Hz	10 – 50 Hz	50 – 100 Hz
Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20 mm/s	20 – 40 mm/s	40 – 50 mm/s
Dwellings and buildings of similar design and/or occupancy	5 mm/s	5 – 15 mm/s	15 – 20 mm/s

Table 4-3 Construction vibration criteria – buried pipework

Pipe material	Vibration at pipe
Steel (including welded pipes)	100 mm/s
Clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80 mm/s
Masonry, plastic	50 mm/s

4.2 Identification of sensitive receivers

Residential receivers have been identified as sensitive to construction noise and vibration. Consideration has also been given to the effects of construction vibration on buried pipework and the bridge structure. Distances between the work site and the nearest residential receivers are included in Table 4-4; the nearest residential receivers are shown graphically in Figure 4-1.

Table 4-4 Closest sensitive receivers to each work area

Construction Element	Description	Closest sensitive receiver	Distance
CE1	Causeway widening and extension and installation of new pipes within the causeway	15 Buckley Avenue, Hobsonville	70 m
		1 Squadron Drive, Hobsonville	90 m
		2 Squadron Drive, Hobsonville	230 m
CE2	Connection pipe between NH1 and the new watermain – west end	29 Station Street, Hobsonville	12 m
		1 Squadron Drive, Hobsonville	90 m
		2 Squadron Drive, Hobsonville	200 m
CE3	New watermain connection to the Greenhithe Bridge	4 Beach Road, Hobsonville	125 m
		8 Marine Parade, Hobsonville	170 m
		15 Buckley Avenue, Hobsonville	180 m
CE4	Watermain transition structure at the west end of the Greenhithe Bridge	4 Beach Road, Hobsonville	125 m
		15 Buckley Avenue, Hobsonville	150 m
		8 Marine Parade, Hobsonville	200 m
CE5	Connection between NH1 and the new watermain – east end	23 Austin Road, Greenhithe	200 m
		14 The Knoll, Greenhithe	220 m
		12 The Knoll, Greenhithe	240 m
CE6	West end valve chambers	29 Station Street, Hobsonville	12 m
		1 Squadron Drive, Hobsonville	90 m
		2 Squadron Drive, Hobsonville	200 m
CE7	Scour chamber	1 Squadron Drive, Hobsonville	110 m
		29 Station Street, Hobsonville	210 m
		2 Squadron Drive, Hobsonville	270 m



Figure 4-1 Nearest residential receivers to the work site (red shading)

The sensitive receivers identified above include the retirement village and the private residence on Squadron Drive. Whilst there are other properties near to the work areas, the receivers listed above are the closest and hence most affected properties. Properties at greater distances from the work areas will experience lower noise levels due to the increased separation.

5 PREDICTIONS

5.1 Noise

Noise assessments have been undertaken to predict indicative levels of noise from each construction element at the nearest residence and at increased distances. The calculations have been made using the method in NZS 6803² and do not take into account the effects of screening by the terrain or any noise mitigation and management procedures such as the use of temporary noise barriers or low noise equipment. Table 5-1 to Table 5-7 include the predicted L_{Aeq} noise levels. These have been separated into several tasks for each construction element, which are expected to be performed in a sequential manner.

The predicted noise levels are colour coded based on the noise criteria in Table 4-1. These are as follows:

- Day (D), weekday and Saturday,

meets limit, ≤ 70 dB	Green
exceeds limit > 70 dB	Red
- Night (N), all days

meets limit ≤ 45 dB	Green
exceeds limit > 45 dB	Red

Table 5-1 Indicative noise levels for the causeway widening and extension and installation of new pipes within the causeway

Construction element	Task	70 m		90 m		230 m	
		15 Buckley Ave		1 Squadron Dr		2 Squadron Dr	
CE1 – Causeway widening and extension and installation of new pipes within the causeway	Initial works	65 dB	D N	62 dB	D N	54 dB	D N
	Causeway construction	67 dB	D N	65 dB	D N	57 dB	D N
	Pipe installation	66 dB	D N	64 dB	D N	55 dB	D N

Table 5-2 Indicative noise levels for the connection pipe between NH1 and the new watermain – west end

Construction element	Task	12 m		90 m		200 m	
		29 Station St		1 Squadron Dr		2 Squadron Dr	
CE2 – Connection pipe between NH1 and the new watermain – west end	Sheet piling	90 dB	D N	72 dB	D N	65 dB	D N
	Excavation	75 dB	D N	57 dB	D N	51 dB	D N
	Pipe jacking	74 dB	D N	57 dB	D N	50 dB	D N
	Steel pipe insertion and grouting	80 dB	D N	63 dB	D N	56 dB	D N

Table 5-3 Indicative noise levels for the new watermain connection to the Greenhithe Bridge

Construction element	Task	125 m		170 m		180 m	
		4 Beach Rd		8 Marine Pde		15 Buckley Ave	
CE3 – New watermain connection to the Greenhithe Bridge	Bracket installation	70 dB	D N	69 dB	D N	66 dB	D N

Table 5-4 Indicative noise levels for the watermain transition structure at the west end of the Greenhithe Bridge

Construction element	Task	125 m			150 m			200 m		
		4 Beach Rd			15 Buckley Ave			8 Marine Pde		
CE4 – Watermain transition structure at the west end of the Greenhithe Bridge	Causeway extension	60 dB	D	N	58 dB	D	N	56 dB	D	N
	Piling	60 dB	D	N	58 dB	D	N	56 dB	D	N
	Thrust block construction	61 dB	D	N	59 dB	D	N	57 dB	D	N

Table 5-5 Indicative noise levels for the connection between NH1 and the new watermain – east end

Construction element	Task	200 m			220 m			240 m		
		23 Austin Rd			14 The Knoll			12 The Knoll		
CE5 – Connection between NH1 and the new watermain – east end	Sheet piling	65 dB	D	N	63 dB	D	N	62 dB	D	N
	Chamber construction	58 dB	D	N	56 dB	D	N	54 dB	D	N
	Pipe jacking	50 dB	D	N	48 dB	D	N	46 dB	D	N
	Piling	56 dB	D	N	54 dB	D	N	52 dB	D	N
	Thrust block construction	57 dB	D	N	55 dB	D	N	53 dB	D	N

Table 5-6 Indicative noise levels for the west end valve chambers

Construction element	Task	12 m			90 m			200 m		
		29 Station St			1 Squadron Dr			2 Squadron Dr		
CE6 – West end valve chambers	Sheet piling	90 dB	D	N	72 dB	D	N	65 dB	D	N
	Excavation	75 dB	D	N	57 dB	D	N	51 dB	D	N
	Chamber construction	82 dB	D	N	65 dB	D	N	58 dB	D	N

Table 5-7 Indicative noise levels for the scour chamber

Construction element	Task	110 m			210 m			270 m		
		1 Squadron Dr			29 Station St			2 Squadron Dr		
CE7 – Scour chamber	Sheet piling	70 dB	D	N	65 dB	D	N	62 dB	D	N
	Excavation	56 dB	D	N	50 dB	D	N	48 dB	D	N
	Chamber construction	63 dB	D	N	57 dB	D	N	55 dB	D	N

5.1.1 Construction traffic

The proposed construction access road is located behind the Hobsonville noise barrier (shown in drawing 2010673.850 rev 2), with a minimum distance of approximately 50 m to the nearest sensitive receivers at 1 and 2 Squadron Drive. Predictions of the noise level at the nearest sensitive receiver have been conducted using the method in Annex D of NZS 6803:1999. For an average vehicle speed of 20 km/h with 9 vehicles per hour the resulting noise level will be 45 dB L_{Aeq} at the nearest sensitive receiver.

The cumulative effects of construction traffic on existing traffic flows would not result in a significant noise change (a doubling in traffic flows would equate to a 3 dB increase in noise level which would be considered to be the onset of a significant change in road-traffic noise level; anything less would be considered an insignificant change).

5.1.2 Hobsonville noise barrier

Temporary removal of parts of the Hobsonville noise barrier will be required during construction. Removal of the barrier will be avoided as far as possible and will be considered during detailed design.

The noise barrier was constructed to reduce noise levels from State Highway 18 at two noise sensitive receivers to the north of the highway (retirement village and the private residence on Squadron Drive). The removal of the parts of the barrier has the potential to increase operational road traffic noise levels and therefore an assessment has been undertaken of the likely effects of these works. Should the barrier need to be removed, it is understood that sections will be removed for approximately 80 days to allow construction of the western valve and scour chambers and the section of the causeway immediately behind the barrier.

The barrier consists of timber posts with plywood panels and can be removed and reconstructed using hand-held power tools and mobile work platforms. Construction noise associated with the removal and reconstruction of the barrier will be minimal and the effects of the works would be less than minor.

The potential change in noise due to the temporary removal of the barrier has been undertaken by comparing the predicted level of current road traffic noise with and without the barrier.

Indicative road traffic noise calculations have been undertaken using an assumed 37,000 vehicles per day (AADT) of which 4% are heavy vehicles with a speed of 100 km/h (2013). The nearest residential dwellings are approximately 120 m from the highway and the average height of the barrier to be removed is 3.6 m. An increase of 6 dB is predicted to occur with the removal of the barrier (52 to 58 dB $L_{Aeq, 24h}$). Although a noise change of this magnitude would be perceptible to residents, it is not deemed to be a major change in noise level and would not be a permanent effect. The most sensitive time period will be at night where there is the potential for sleep disturbance effects to occur. The removal of the barrier will not alter the character of the road traffic noise, rather it will simply elevate existing noise levels. At night, NZS 6802:2008⁴ recommends a night time limit of 45 dB L_{Aeq} so that residents can sleep with windows open. With windows closed the external limit increases to approximately 55 dB L_{Aeq} . Whilst there is no predicted night-time noise data (as the available traffic flow data is not broken down into day versus night time flows), the diurnal difference between day time and night time road traffic noise levels is typically 6-8 dB for a busy highway. Hence if the 24 hour predicted L_{Aeq} is 58 dB then the night time level is likely to be below 55 dB L_{Aeq} , and the potential for adverse sleep disturbance effects would be less than minor with closed windows.

During periods when the barrier is removed, the change in operational road traffic noise from SH18 at the closest receivers can be minimised by:

- Removing only those sections of barrier necessary for construction
- Minimising the length of time that the panels are removed for
- Installing a temporary noise barrier when and where practicable

In any case any changes to the Hobsonville noise barrier will need to be agreed with NZ Transport Agency and communicated to the affected residents.

⁴ NZS 6802:2008 – Acoustics – Environmental Noise

5.2 Vibration

Vibratory sheet piling may be used at the pipe connection and chamber locations, the nearest residence could be as close as 12 m from the works. If sheet piling is required on the southern side of State Highway 18, i.e. adjacent to the residences on Station Street, high levels of vibration may be experienced at the nearest residences.

Piles are expected to be installed during the construction of each of the two pipe transition structures. The shortest distance between these structures and the nearest property is approximately 125 m. The piling is expected to be performed using screw / auger piling techniques with low vibration levels; however, indicative vibration levels from impact piling in this area are included as an indication of the worst case construction vibration levels. Vibratory compaction may be performed during construction of the causeway with the nearest residence being approximately 70 m away. Consideration is also given to the effects of construction activities on buried services and the bridge structure.

Vibration predictions have been made using the calculation method in Annex E of BS 5228-2⁵ for vibratory compaction, and percussive and vibratory piling through medium dense granular soils. The calculation method makes use of empirical formulae that have been derived from field measurements. The resultant values are in the form of PPV, which can be readily compared to the DIN 4150-3 limits.

The calculation results are included in Table 5-8 for the nearest residential buildings. In all cases the DIN 4150-3 limits are met and no adverse effects on building structures are anticipated.

Table 5-8 Indicative vibration levels – residential buildings

Activity	Distance to receiver	PPV
Vibratory sheet piling	12 m	5.0 mm/s
Impact piling	125 m	1.3 mm/s
Vibratory compaction	70 m	0.6 mm/s

Vibration on buried pipework due to sheet piling may exceed the recommended 50 mm/s when located within 2 m of the pipework. Vibration on buried plastic pipework due to impact piling will not exceed the recommended 50 mm/s at all practical piling locations.

The bridge has been designed to withstand a 1 in 1000 year seismic event in accordance with NZS 4203 (which was current at the time the bridge was designed). The effect of vibration from either auger or impact piling is considered to be negligible in comparison to a seismic event and therefore there would be no risk of structural damage to the bridge from piling activity.

5.3 Operational

The proposed works do not result in any operational noise sources, such as pump stations. The ongoing operational noise effects associated with this project will be negligible.

⁵ BS 5228-2:2009 – Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration

6 MITIGATION AND MANAGEMENT

6.1 Daytime works

The recommended daytime noise criterion (70 dB, Monday to Saturday) is expected to be met for the majority of construction activities (including traffic on haul roads) without the need for noise mitigation and management procedures. The daytime noise limit is exceeded for some residences during the construction of CE2 and CE6. This predominantly affects the residences on Station Street where construction will take place in close proximity to residences. Enhanced noise management and mitigation measures will need to be investigated as part of the CNVMP. This will include the use of low noise equipment where available, positioning noisy equipment as far away from sensitive receivers as possible, limiting vehicle idling and the use of temporary noise barriers where practicable. At locations where the noise limits are exceeded, engagement with the residents will be undertaken prior to conducting the works; this process will be outlined in the CNVMP.

Sheet piling activities conducted adjacent to the residences on Station Street may result in noise levels that exceed the criterion by up to 20 dB. Such activities would be of relatively short duration and could be appropriately managed through communication with the property owners and the use of the enhance noise mitigation measures identified above.

Cumulative noise from the works may be slightly higher than the predicted levels where work is being conducted simultaneously at multiple locations; however, due to the spatial distribution of construction activities and receiver locations, the cumulative noise is generally expected to remain below the recommended daytime noise criteria (70 dB, Monday to Saturday).

Vibration levels will meet the DIN 4150-3 limits (5 mm/s PPV) at the nearest properties. Ground vibration may be perceptible to nearby residents and it would be appropriate to advise those affected of the expected times when piling will occur. Should sheet piling be required within 12 metres of a residence then construction should only proceed with appropriate monitoring of the vibration levels by a suitably qualified expert.

A horizontal buffer distance of 2 metres should be maintained between sheet piling and buried pipework. If impact and sheet piling is required within the stated buffer distances then further investigations should be undertaken by a suitably qualified expert. This could include measurements to determine source vibration levels once specific construction equipment has been confirmed, as well as monitoring of ground and bridge vibration levels during the works. This should be considered as part of a detailed assessment in the CNVMP.

6.2 Night-time and Sunday works

Without mitigation the night-time criterion of 45 dB and Sunday daytime criterion of 55 dB may be exceeded for a number of activities at the nearest residences. In most cases regular night-time works are not expected to be required.

Where construction is required during these times and the activities exceed the noise criteria, low noise equipment, equipment positioning, task scheduling and limiting haulage traffic will be investigated as part of a detailed assessment in the CNVMP. Engagement with affected residents will be undertaken prior to the works, and this process will be outlined in the CNVMP.

Should the temporary removal of the Hobsonville noise barrier be required this will elevate road traffic noise levels from State Highway 18. It is recommended that the barrier is reinstated as soon as practicable and that installation of a temporary noise barrier be considered where practicable.

While there are no separate night-time vibration limits in the district plan, ground vibration in excess of 0.3 mm/s may be perceptible at the nearest properties at night. If ground vibration generating activities are to be performed at night then task scheduling and communication with the affected residents should be considered as part of a CNVMP.

7 ASSESSMENT OF EFFECTS

The construction activities are expected to meet the daytime (Monday to Saturday) noise and vibration criteria at most receivers. Construction work may be heard and/or felt by the nearest residents; however, no adverse noise and vibration effects are anticipated. Where the noise limits are exceeded adverse noise effects can be avoided with the implementation of suitable noise mitigation and management measures. Where impact and sheet piling is required in close proximity to properties, the effects can be appropriately managed through direct communication with the residents.

Should work be required at night or on Sundays enhanced mitigation and management measures, as described above, will be required to comply with noise criteria. With these measures the noise and vibration levels should not cause sleep disturbance for most people and the effects are again considered acceptable.

Elevated levels of road traffic noise would occur if the Hobsonville noise barrier is temporarily removed; however, the anticipated levels of daytime and night-time noise would not adversely affect residential amenity, i.e. increased likelihood of general daytime annoyance and sleep disturbance effects.

8 CONCLUSIONS

An assessment of the construction noise and vibration effects has been conducted for the proposed Greenhithe Bridge Watermain Duplication and Causeway project. Predictions of the noise and vibration levels associated with the construction works have been made, considering the distances to the nearest sensitive receivers and indicative construction equipment.

It has been found that, without specific mitigation or management measures, construction noise and vibration should meet the daytime criteria for most activities. Night-time and Sunday works, when necessary, would require the implementation of enhanced noise and vibration management procedures for some activities. Noise management and mitigation measures have been identified.

Appropriate mitigation and management measures should be confirmed when the specific construction methodology and equipment are known, and should be documented in a CNVMP.

With appropriate management of noise and vibration through a CNVMP, it is considered that both daytime and night-time effects will be acceptable.

APPENDIX A CONSTRUCTION ACTIVITIES AND EQUIPMENT

Table A-1 Construction equipment and noise source levels for the causeway widening and extension and installation of new pipes within the causeway

Construction equipment	Description	Noise source data		Initial works		Causeway construction		Pipe installation	
		LAeq at 10 m	Reference	Quantity	Duty	Quantity	Duty	Quantity	Duty
Excavator a	22t tracked	71 dB	BS 5228-1 C.2.21	2	100%	-	-	1	50%
Excavator b	Long reach	71 dB	BS 5228-1 C.2.21	-	-	1	100%	-	-
Articulated dump truck a	Driving	70 dB	Estimate	1	50%	1	50%	1	50%
Articulated dump truck b	Tipping fill	79 dB	BS 5228-1 C.2.30	1	50%	1	50%	1	50%
Compaction	Dozer towing roller	81 dB	BS 5228-1 C.2.36	-	-	1	50%	1	20%
Mobile crane	55t tracked	70 dB	BS 5228-1 C.3.29	-	-	-	-	1	50%
Welding machine	Hand-held	73 dB	BS 5228-1 C.3.31	-	-	-	-	1	50%
Generator (welding)	Diesel (4 kW)	66 dB	BS 5228-1 C.4.85	-	-	-	-	1	50%

Table A-2 Construction equipment and noise source levels for the connection pipe between NH1 and the new watermain – west end

Construction equipment	Description	Noise source data		Sheet piling		Excavation		Pipe jacking		Steel pipe insertion and grouting	
		LAeq at 10 m	Reference	Quantity	Duty	Quantity	Duty	Quantity	Duty	Quantity	Duty
Sheet piling rig	52t	88 dB	BS 5228-1 C.3.8	1	100%	-	-	-	-	-	-
Sheet piling power pack	147kW	68 dB	BS 5228-1 C.3.10	1	100%	-	-	-	-	-	-
Mobile crane	55t tracked	70 dB	BS 5228-1 C.3.29	1	100%	-	-	-	-	-	-
Excavator	22t tracked	71 dB	BS 5228-1 C.2.21	-	-	1	100%	-	-	-	-
Trucks (idle)	Material delivery, spoil removal	70 dB	Estimate	-	-	1	100%	1	100%	1	100%
Pipe jacking plant	Hydraulic pump	70 dB	Estimate	-	-	-	-	1	100%	-	-
Concrete pump	59 kW, 180mm diameter	78 dB	BS 5228-1 C.4.24	-	-	-	-	-	-	1	100%

Table A-3 Construction equipment and noise source levels for the new watermain connection to the Greenhithe Bridge

Construction equipment	Description	Noise source data		Bracket installation	
		L _{Aeq} at 10 m	Reference	Quantity	Duty
Drill	Electric percussion	89 dB	BS 5228-1 D.4.54	1	100%
Mobile crane	55t tracked	70 dB	BS 5228-1 C.3.29	1	100%
Bridge over service unit	Truck mounted	77 dB	BS 5228-1 C.4.53	1	100%

Table A-4 Construction equipment and noise source levels for the watermain transition structure at the west end of the Greenhithe Bridge

Construction equipment	Description	Noise source data		Causeway extension		Piling		Thrust block construction	
		L _{Aeq} at 10 m	Reference	Quantity	Duty	Quantity	Duty	Quantity	Duty
Articulated dump truck	Tipping fill	79 dB	BS 5228-1 C.2.30	1	100%	-	-	-	-
Piling	Crane mounted auger	79 dB	BS 5228-1 C.3.16	-	-	1	100%	-	-
Hiab truck	Delivering precast elements	77 dB	BS 5228-1 C.4.53	-	-	-	-	1	50%
Trucks (idle)	Material delivery	70 dB	Estimate	-	-	-	-	1	50%
Concrete pump	59 kW, 180mm diameter	78 dB	BS 5228-1 C.4.24	-	-	-	-	1	50%
Minor works	Manual tasks	70 dB	Estimate	-	-	-	-	1	100%
Angle grinder	Grinding steel (2.3 kW)	80 dB	BS 5228-1 C.4.93	-	-	-	-	1	20%
Generator (grinding)	Diesel (4 kW)	66 dB	BS 5228-1 C.4.85	-	-	-	-	1	20%

Table A-5 Construction equipment and noise source levels for the connection between NH1 and the new watermain – east end

Construction equipment	Description	Noise source data		Sheet piling		Chamber construction		Pipe jacking		Piling		Thrust block construction	
		L _{Aeq} at 10 m	Reference	Quantity	Duty	Quantity	Duty	Quantity	Duty	Quantity	Duty	Quantity	Duty
Sheet piling rig	52t	88 dB	BS 5228-1 C.3.8	1	100%	-	-	-	-	-	-	-	-
Sheet piling power pack	147kW	68 dB	BS 5228-1 C.3.10	1	100%	-	-	-	-	-	-	-	-
Mobile crane	55t tracked	70 dB	BS 5228-1 C.3.29	1	100%	1	100%	-	-	-	-	-	-
Excavator	22t tracked	71 dB	BS 5228-1 C.2.21	-	-	1	50%	-	-	-	-	-	-
Trucks (idle)	Material delivery	70 dB	Estimate	-	-	1	100%	1	100%	-	-	1	50%
Concrete pump	59 kW, 180mm diameter	78 dB	BS 5228-1 C.4.24	-	-	1	50%	-	-	-	-	1	50%
Angle grinder	Grinding steel (2.3 kW)	80 dB	BS 5228-1 C.4.93	-	-	1	50%	-	-	-	-	1	20%
Welding machine	Hand-held	73 dB	BS 5228-1 C.3.31	-	-	1	50%	-	-	-	-	-	-
Generator (welding/grinding)	Diesel (4 kW)	66 dB	BS 5228-1 C.4.85	-	-	1	50%	-	-	-	-	1	20%
Minor works	Manual tasks	70 dB	Estimate	-	-	-	-	-	-	-	-	1	100%
Pipe jacking plant	Hydraulic pump	70 dB	Estimate	-	-	-	-	1	100%	-	-	-	-
Piling	Crane mounted auger	79 dB	BS 5228-1 C.3.16	-	-	-	-	-	-	1	100%	-	-
Hiab truck	Delivering precast elements	77 dB	BS 5228-1 C.4.53	-	-	-	-	-	-	-	-	1	50%

Table A-6 Construction equipment and noise source levels for the west end valve chambers

Construction equipment	Description	Noise source data		Sheet piling		Excavation		Chamber construction	
		L _{Aeq} at 10 m	Reference	Quantity	Duty	Quantity	Duty	Quantity	Duty
Sheet piling rig	52t	88 dB	BS 5228-1 C.3.8	1	100%	-	-	-	-
Sheet piling power pack	147kW	68 dB	BS 5228-1 C.3.10	1	100%	-	-	-	-
Mobile crane	55t tracked	70 dB	BS 5228-1 C.3.29	1	100%	-	-	1	100%
Excavator	22t tracked	71 dB	BS 5228-1 C.2.21	-	-	1	100%	1	50%
Trucks (idle)	Material delivery, spoil removal	70 dB	Estimate	-	-	1	100%	1	100%
Angle grinder	Grinding steel (2.3 kW)	80 dB	BS 5228-1 C.4.93	-	-	-	-	1	50%
Welding machine	Hand-held	73 dB	BS 5228-1 C.3.31	-	-	-	-	1	50%
Generator (welding/grinding)	Diesel (4 kW)	66 dB	BS 5228-1 C.4.85	-	-	-	-	1	50%
Concrete pump	59 kW, 180mm diameter	78 dB	BS 5228-1 C.4.24	-	-	-	-	1	50%

Table A-7 Construction equipment and noise source levels for the scour chamber

<i>Construction equipment</i>	<i>Description</i>	<i>Noise source data</i>		<i>Sheet piling</i>		<i>Excavation</i>		<i>Chamber construction</i>	
		<i>LAeq at 10 m</i>	<i>Reference</i>	<i>Quantity</i>	<i>Duty</i>	<i>Quantity</i>	<i>Duty</i>	<i>Quantity</i>	<i>Duty</i>
Sheet piling rig	52t	88 dB	BS 5228-1 C.3.8	1	100%	-	-	-	-
Sheet piling power pack	147kW	68 dB	BS 5228-1 C.3.10	1	100%	-	-	-	-
Mobile crane	55t tracked	70 dB	BS 5228-1 C.3.29	1	100%	-	-	1	100%
Excavator	22t tracked	71 dB	BS 5228-1 C.2.21	-	-	1	100%	1	50%
Trucks (idle)	Material delivery, spoil removal	70 dB	Estimate	-	-	1	100%	1	100%
Angle grinder	Grinding steel (2.3 kW)	80 dB	BS 5228-1 C.4.93	-	-	-	-	1	50%
Welding machine	Hand-held	73 dB	BS 5228-1 C.3.31	-	-	-	-	1	50%
Generator (welding/grinding)	Diesel (4 kW)	66 dB	BS 5228-1 C.4.85	-	-	-	-	1	50%
Concrete pump	59 kW, 180mm diameter	78 dB	BS 5228-1 C.4.24	-	-	-	-	1	50%