Appendix D: Noise and vibration - Assessment of change in effects

REPORT

Tonkin+Taylor

Grey Lynn Tunnel - Changes to the Tawariki Street Secondary Shaft

Noise and vibration - summary of change in effects

Prepared for
Watercare Services Ltd
Prepared by
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1 Introduction

The Grey Lynn Tunnel has two shafts originally proposed to be located within 44-48 Tawariki Street, Grey Lynn, known as the primary and secondary shafts. The construction and operation of these shafts was assessed as part of the Grey Lynn Tunnel application, with a supporting noise assessment[1] prepared by Marshall Day Acoustics (MDA) and a vibration assessment[2] prepared by McMillen Jacobs Associates.

Watercare now proposes to move the secondary shaft to 42 Tawariki Street, adjacent to 44 Tawariki Street but outside the current designation. Tonkin & Taylor Limited (T+T) has been engaged by Watercare to assess the change in noise and vibration effects associated with moving the secondary shaft approximately 20m west from 44 to 42 Tawariki Street to support the alteration to the designation that will be required for the relocation of the secondary shaft.

1.1 Background

Resource consents for the Grey Lynn Tunnel, including regional consents for the Tawariki Street shafts, were obtained from Auckland Council in 2019. Designation 9468 for the shafts at Tawariki Street was confirmed at the same time. The designation allows for the construction, operation and maintenance of wastewater infrastructure. Two shafts, known as the primary and secondary shaft, will be constructed. The primary shaft is the termination site of the Grey Lynn Tunnel and will allow for the retrieval of the tunnel boring machine (TBM) and connections to the Tawariki Local Sewer and Orakei Main Sewer. The secondary shaft allows for the connection of future sewers from the Combined Sewers Overflow (CSO) network.

It was originally proposed to construct the secondary shaft at least 2.5 years after the primary shaft. Watercare has now identified the potential to undertake the works concurrently for the two shaft sites, allowing for efficiencies in construction and for future local connections to be made sooner. Additionally, since consenting and designating the Grey Lynn Tunnel, Watercare has purchased the property at 42 Tawariki Street. It is now proposed to shift the secondary shaft to within this property to allow for more space at the construction site.

1.2 Proposed changes

The proposed alteration to the designation to include 42 Tawariki Street is shown in Figure 1. The area of the proposed extension of the designation was occupied by a residential property which has been removed, and the road reserve immediately adjacent.

The existing designation extends into the road reserve to the south and the neighbouring school to the east. This will not change.

[1] Marshall Day Acoustics. Grey Lynn Tunnel Assessment of noise effects. Rp 002 20180726 dated 13 February 2019

[2] McMillen Jacobs Associates. Grey Lynn Tunnel, Watercare Services Ltd. Vibration Assessment of Grey Lynn Tunnel and Tawariki Street Shafts. Rev 3, 5 April 2019

Figure 1: Site location plan, showing designation 9468 (maroon) and proposed extension (purple). Source: Auckland Council AUP Maps

42 Tawariki Street was considered in the original assessment as a noise sensitive receiver. When construction is undertaken on this site the adjacent property, 38 and 40 Tawariki Street (residential attached units), will now be the closest sensitive receivers. Residential properties to the south and west will also need to be considered, as well as the school building to the north.

In the original NoR the secondary shaft was proposed to be constructed at least 2.5 years after the primary shaft. Since consenting and designating of the Grey Lynn Tunnel, Watercare has identified the potential to undertake the works concurrently for the two shafts. This would allow for efficiencies in construction and for future local connections to be made sooner. As the original application was based on the separate construction periods, Watercare now seeks to alter the designation to allow for the option of constructing the two shafts in the one construction period (noting construction may still occur across two separate construction periods as already provided for in the existing designation).

For the purposes of this assessment, the change to be assessed is the construction of the secondary shaft in a new location (within 42 Tawariki Street) and potentially in the one construction period. No other changes are proposed; the methodology for constructing the shaft will be the same as was described in the original application (refer Section 1.3 below), and no changes are proposed to the primary shaft, Grey Lynn Tunnel alignment or other on-site works that would be outside the scope of the original application.

Operational noise is expected to be limited to emissions from the plant room and shaft ventilation system, as per the MDA assessment[3]. The location of these noise sources is not proposed to change, hence there will be no change in effects.

Similarly, no changes are proposed to construction traffic and associated traffic noise from that assessed in the original application and provided for under Designation 9468.

1.3 Construction methodology

The Grey Lynn Tunnel Assessment of Environmental Effects (AEE) and MDA assessment detail the construction methodology of the primary and secondary shafts, which will remain the same. In summary:

- The secondary shaft construction is a 25 m deep drop shaft with an external diameter of approximately 10.2 m, and a sewer pipe constructed by pipe-jacking to connect the secondary shaft to the main shaft.
- The shaft will be excavated by conventional mechanical equipment (e.g. CAT 330 medium hydraulics excavator or similar) through overburden soils and East Coast Bay Formation ("ECBF") bedrock. Blasting will not be used. Bored piling or similar will be used.
- Permanent lining and interior shaft structures will be constructed of either cast-in-situ concrete, precast concrete, and potentially of other corrosion resistant materials. Sheet piling may be required as part of the construction (during shaft/chamber excavation).
- Shaft site construction activities are anticipated to occur between 7 am to 6 pm Monday to Friday, 8 am to 6 pm Saturday; and truck movements 7 am to 6 pm Monday to Friday, 8 am to 6 pm Saturday. Occasionally work may be required outside of these hours.

[3] For operational noise from the above ground plant room, MDA predicted noise levels at surrounding dwellings are at least 2 dB below the night-time noise limit and therefore compliant with AUP-OP limits. There is no change to these components of the works.

2 Summary of previous noise and vibration assessments

2.1 Construction noise assessment

MDA assessed the potential noise levels (with and without mitigation) generated from construction activities at the shaft site.

Setback distances are provided in the MDA assessment for all anticipated equipment. Screening from site hoarding is assumed to provide 10 dB of attenuation for all sources except sheet piling, where the noise source is elevated, and screening is generally not practicable. The highest noise levels are predicted for sheet piling exceeding the daytime construction noise limit of 70 dB LAeq for 11 nearby properties by up to 14 dB (84 dB LAeq predicted at 41 Tawariki Street).

Mitigation and noise management measures are presented in the MDA assessment, including:

- Consultation and communication, particularly around higher noise activities.
- Timing of activities, such as avoiding noise from trucks queuing / idling prior to 7:30 am.
- Noise barriers.
- Avoidance of unnecessary noise including fitting of mufflers to trucks, maintenance of equipment and avoiding tonal reversing alarms.
- Implementation of a construction noise and vibration management plan (CNVMP).

MDA concludes that with management and mitigation measures in place, effects from construction noise can be acceptably managed.

We note that these recommendations have been incorporated into Designation 9468 conditions – namely conditions 3.1 to 3.9.

2.2 Vibration assessment

The assessment of vibration effects undertaken by McMillen Jacobs Associates identifies a range of potential vibration sources including pile driving, crane operation and installation, and the excavation of shaft spoil, all within proximity to existing residential properties. The assessment identifies that the greatest potential for vibration effects is from the use of the sheet pile vibratory hammer. Geological ground conditions are expected to attenuate vibration.

42 Tawariki Street (the closest receiver and the property now owned by Watercare) is 15 m from the secondary shaft site, while receivers on the other side of the road (35, 37, 39 and 41 Tawariki Street) are 20 - 40 m from the shaft. Worst case vibration levels are predicted in the McMillen Jacobs assessment at 15 m for different construction equipment. The assessment found that while the use of the sheet pile vibratory hammer will comply with the short-term standards of DIN 4150-3 at 42 Tawariki St, it would not comply with the long-term standards of DIN 4150-3 by up to 0.95mm/sec.

The Vibration Assessment concluded that vibration effects could be appropriately addressed through communication with affected residents, the use of a CNVMP, and avoiding night-time works between 6 pm and 7 am. Construction vibration is also required to comply with the relevant guideline limits except where specific requirements are met in relation to a building assessment and the written agreement of the building owner.

The vibration management and mitigation measures recommended in the McMillen Jacobs assessment have been incorporated into the designation conditions (in particular conditions 3.6 to 3.8).

3 Designation Conditions

The requirements relating to construction noise and vibration are set out in designation conditions 3.1 to 3.9.

The construction noise limits for the designation are set out in condition 3.2 and are reproduced below. The construction noise limits are slightly more stringent than the permitted activity levels for construction noise in the AUP-OP (i.e. no "shoulder period" in the early morning or evening). Watercare proposes that these limits would also apply to 42 Tawariki Street through the alteration to designation.

Table 3.1: Construction noise levels for Designation 9468 (reproduced from Condition 3.2 of Designation 9468)

Time and day	Noise limits	
	LAeq dB	LAmax dB
Monday to Saturday 7:30am – 6pm	70	85
At all other time and Public Holidays	45	75

Condition 3.5 provides for the preparation of an Activity Specific Construction Noise Management Plan (ASCNMP) where a particular activity is unable to meet the limits set out in Condition 3.2.

Construction vibration is required to comply with the guideline vibration limits set out in DIN 4150-3 (condition 3.7). An exception to this is allowed by condition 3.8 where the Requiring Authority can demonstrate to the satisfaction of the Council:

a) That the receiving building(s) are capable of withstanding higher levels of vibration and what the new vibration limit is. The investigation required to demonstrate this must include an assessment of the building(s) by a suitably experienced and qualified structural engineer and a full pre-condition survey; and
b) That the Requiring Authority has obtained the written agreement of the building owner(s), that a higher limit may be applied (noting that a change is sought to this condition to provide for consultation with the building owner).

The frequency dependent short-term vibration limits from DIN 4150-3 are shown in Figure 3.1 below, which are applicable to sheet piling. Other conditions in section 3 relate to the requirements for construction noise and vibration management plans.

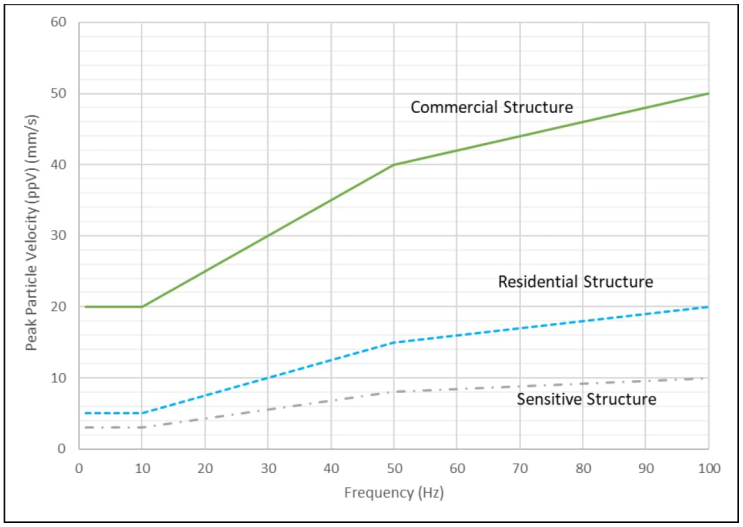

Figure 3.1: DIN 4150-3 short-term standard baseline curves

4 Change in noise effects

4.1 Construction noise effects

The construction methodology is not proposed to change. The same equipment and activities are expected to occur for the construction of the primary and secondary shaft as detailed in the original AEE and MDA assessment. Construction of the two shafts may occur in the one construction period (noting construction may still occur across two separate construction periods as already provided for in the existing designation).

If required, the most significant noise-generating activity is still expected to be sheet piling to support the shaft excavation. Whilst sheet piling is not usually required for shaft construction, to provide a 'worst-case' potential envelope of effects, this report assesses the potential noise effects associated with sheet piling in the vicinity of the secondary shaft. It is important to note that sheet piling (if required) would occur intermittently and for a relatively short duration.

The revised location of the secondary shaft is shown in Figure 4.1 below. It has been assumed that sheet piling may be required around the perimeter of the shaft, i.e. approximately 6 m (or less) from the western boundary and 4 m (or less) from the southern boundary of 42 Tawariki Street.

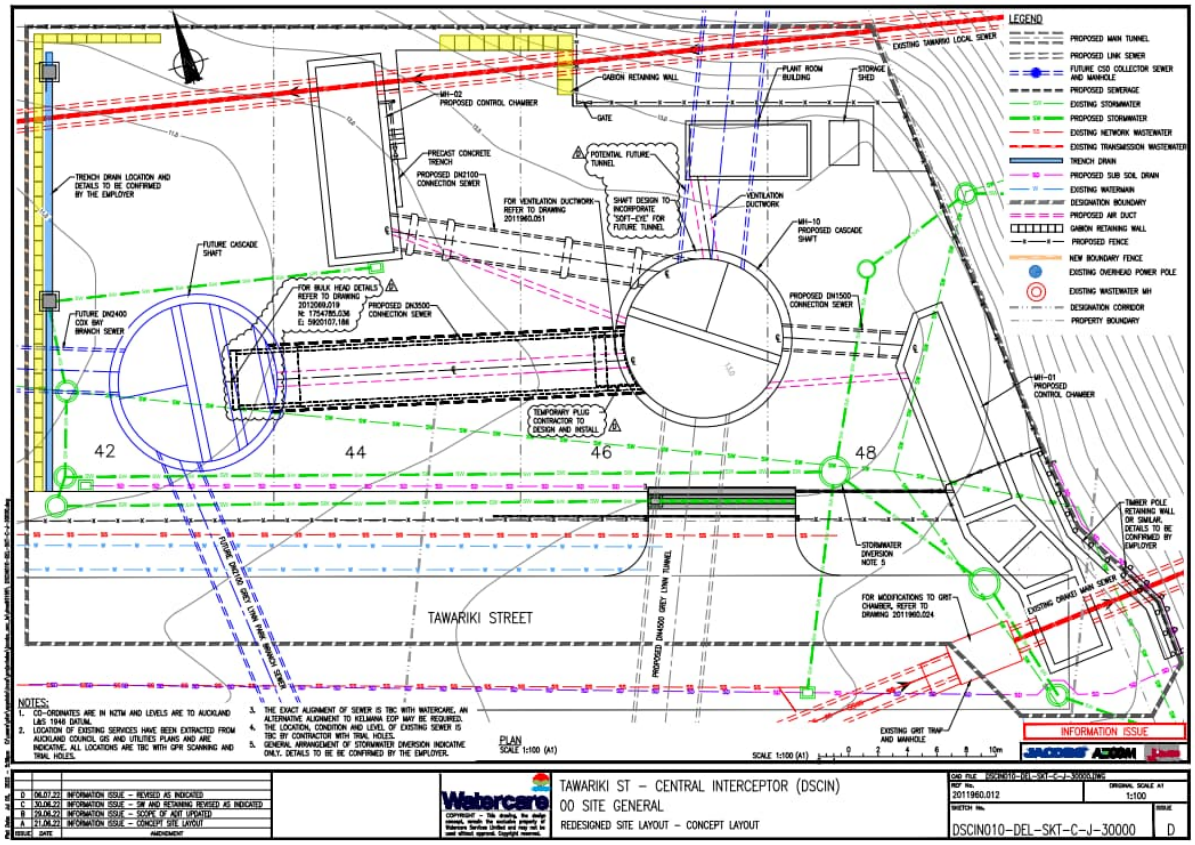

Figure 4.1: General site layout, secondary shaft shown in blue. Source: Watercare

4.2 Distances of receivers

The original noise assessment considered receivers that are within 50 m of the designation. This extended to 36 Tawariki Street on the northern side of Tawariki Street, and 29 Tawariki Street on the southern side. The school building to the north was also included.

As the proposed works extend further to the west, additional noise and vibration sensitive receivers have been considered within 50 m of the works area. These receivers are identified in Table 4.1 below along with the distances to the nearest boundary of the works and to the nearest location of sheet piling. Where the distance is unchanged from the original assessment this is greyed out.

Table 4.1: Distance of receivers from works

Address / location	Zoning / usage	Approx. distance to works, m		Approx. distance to nearest sheet piling, m	
		MDA assessment	Proposed	MDA assessment*	Proposed
34 Tawariki Street	Residential / dwelling	NA	42	NA	47
36 Tawariki Street	Residential / dwelling	NA	26	NA	31
38 Tawariki Street	Residential / dwelling	30	12	40	17
40 Tawariki Street	Residential / dwelling	21	5	28	10
Marist Catholic School	Special purpose / School	40	40	50	50
25 Tawariki Street	Residential / dwelling	NA	49	NA	58
27 Tawariki Street	Residential / dwelling	NA	38	NA	46
29 Tawariki Street	Residential / dwelling	40	27	58	35
33 Tawariki Street	Residential / dwelling	27	23	47	28
35 Tawariki Street	Residential / dwelling	25	25	38	28
37 Tawariki Street	Residential / dwelling	25	25	35	35
39 Tawariki Street	Residential / dwelling	22	22	24	24
41 Tawariki Street	Residential / dwelling	20	20	22	22

*Estimated from diagrams of modelling of sheet piling in Appendix G of MDA assessment

4.3 Predicted noise levels

Setback distances from equipment to meet 70 dB LAeq remain the same as in the MDA assessment. It is possible there may be some exceedances of the construction noise limits in Designation 9468 when works other than sheet piling take place close to the boundary with 38 and 40 Tawariki Street[4]. As provided for through the conditions of the designation, this can best be managed via the CNVMP.

As sheet piling (if required) is the most significant noise generating activity, the below assessment focuses on the potential noise levels associated with sheet piling in vicinity of the secondary shaft site. This provides a 'worst-case' assessment of the potential construction noise from constructing the secondary shaft within 42 Tawariki St. Predictions of noise levels from sheet piling are shown in Table 4.2 below. These predictions are based on the distances to works shown in Table 4.1 plus assumed screening from buildings for 34 and 36 Tawariki Street. It has also been assumed that the site hoarding will screen 40 Tawariki Street effectively due to its height and proximity to the house[5]. This is consistent with the MDA modelling.

[4] The MDA assessment identified potential exceedances for grout pumping, concrete truck and pump, and plate compactor where this occurs at a distance of 10 m from the façade of neighbouring dwellings.

[5] Site hoarding will be less effective as screening for 38 Tawariki St as the sheet piling noise source is elevated and the dwelling at 38 Tawariki St is set back from the hoarding.

Table 4.2: Predicted façade noise levels from sheet piling

Address / location	Predicted sound pressure level dB LAeq		Change in noise level dB
	MDA assessment	Proposed alteration to designation	
34 Tawariki Street*	NA	66	NA
36 Tawariki Street	73	79	+8
38 Tawariki Street	76	86	+10
40 Tawariki Street*	77	81	+4
Marist Catholic School	72	78	+6
25 Tawariki Street	NA	74	NA
27 Tawariki Street	NA	76	NA
29 Tawariki Street	72	79	+7
33 Tawariki Street	73	82	+9
35 Tawariki Street	76	82	+6
37 Tawariki Street	79	79	No change
39 Tawariki Street	82	82	No change
41 Tawariki Street	84	84	No change

*Screening of -10dB assumed due to buildings / noise barrier

The largest change in noise levels is predicted at 29, 33, 36 and 38 Tawariki Street[6] with increases of 7-10 dB, due to closer proximity to sheet piling works associated with the secondary shaft (noting exceedances of the noise limits were already expected for these properties in the original MDA assessment as shown in Table 4.2 above). The predicted levels are comparable to the MDA results for properties at similar distances. The maximum noise level predicted from sheet piling is 86 dB LAeq at 38 Tawariki Street.

An external noise level of 86 dB LAeq would usually equate to an internal noise level 20-25 dB lower, i.e. 61-66 dB LAeq depending on the glazing and façade construction. This is a relatively high internal noise level in a residential environment but not uncommon for this type of works close to residential receivers and is typically managed through a ASCNMP as is provided for in the existing designation conditions. Sheet piling (if required) will be carried out on an intermittent basis and for a relatively short duration.

As demonstrated by Table 4.2, these changes in noise level do not materially change the nature of the construction noise effects for the project. It was always anticipated that sheet piling (if it was required) would result in exceedances of the noise limits set in condition 3.2, and consequently, the designation conditions provide for an ASCNMP. Consultation with residents around timing and duration of sheet piling will be an important aspect of noise management, and will be a key consideration in the preparation of ASCNMP.

There is no change in effects associated with the option of constructing the shafts in the one construction period rather than across two separate construction periods. As set out above, the construction methodology of the primary and secondary shafts will remain the same. The noise and vibration effects as already assessed will occur, albeit in a different and potentially more truncated

[6] Noise at 40 Tawariki Street is predicted to be less than at 36 and 38 Tawariki street as it is closer to screening, whereas 38 and 36 Tawariki Street are difficult to screen due to elevated noise source, so have higher predicted noise levels.

overall timeframe (due to the need to mobilise, establish and disestablish on site only once rather than twice).

Overall, we consider that the change in noise effects associated with the relocated shaft site and altered construction programme are consistent with those originally assessed.

4.4 Noise management and mitigation

Designation 9468 contains a number of conditions to manage construction noise effects, and these conditions will appropriately manage the effects of the construction of the secondary shaft on 42 (as opposed to 44) Tawariki Street. No additional conditions are considered necessary.

The MDA assessment recommended noise management and mitigation measures, which would be incorporated into a CNVMP. The measures are considered applicable to the current proposal, and should be incorporated into the CNVMP prepared in accordance with condition 3.4, such as noise barriers to screen neighbouring properties.

5 Change in vibration effects

The closest receiver to the proposed location for the secondary shaft is 40 Tawariki Street, at a distance of approximately 10 m. Vibration levels at 10 m have been predicted using the same methodology as the McMillen Jacobs assessment[7] and are shown in Table 5.1 below, with levels predicted at 15 m for comparison.

Table 5.1: Summary of predicted vibration levels

Equipment	Predicted vibration level mm/s PPV	
	15m from vibration source	10m from vibration source
120t crane	0.7	1.3
450t crane	0.8	1.5
320/330 excavator	0.5	0.9
Secant pile drill rig	0.4	0.7
Sheet piles vibratory hammer (20-50Hz)	6.0	10.9

As a result of the change in location of the shaft, the closest property will now be 40 Tawariki Street. Vibration levels from most equipment is predicted to be well below the guideline limits in DIN 4150-3 that are required to be met under the designation conditions. Whilst it is not yet known whether sheet piling will be required for the construction of the secondary shaft, we have conservatively assessed the potential effects if it were to occur. If required, the predicted vibration level from sheet piling at 10 m exceeds the DIN 4150-3 short-term limit at frequencies below 34 Hz. Vibration from sheet piling is predicted to comply with the DIN 4150-3 short-term limits at distances greater than 13 m (assuming operating frequency greater than 20 Hz).

Conditions 3.6 to 3.8 of the designation set out requirements for managing vibration. The conditions require preparation of a CNVMP to be prepared, setting out how the DIN 4150-3 standards will be met. Almost all construction activities proposed for the site will comply with DIN 4150-3, the only exception being sheet piling if it occurs within 13 m of 40 Tawariki St. If sheet piling is proposed within 13 m of 40 Tawariki St, the conditions will require Watercare to consult with the building owner, and subject to their agreement, undertake a building condition survey to determine the sensitivity of the building to construction vibration.

Condition 3.6(f) requires the CNVMP to detail methods for monitoring of construction vibration. We recommend that the CNVMP includes vibration monitoring when sheet piling occurs within 13 m of 40 Tawariki Street.

We note that Condition 3.6(b) allows for a condition survey of 42 Tawariki Street. Given the change in location for the secondary shaft, we suggest that this condition is updated to refer to 40 Tawariki Street instead. 33 Tawariki Street should also be provided with a building condition report if identified as an “at risk” building.

Overall, we consider that the change in vibration effects associated with the relocated shaft site are consistent with those originally assessed, with the key difference being the closest affected property will now be 40 Tawariki Street. Almost all construction activities proposed for the site will comply with DIN 4150-3, with the only exception being sheet piling if it occurs within 13 m of 40 Tawariki St.

[7] United States Federal Transit Administration (FTA). 2006. Transit Noise and Vibration Impact Assessment; FTA-VA-90-1003-06.

We consider that the conditions of the designation will appropriately manage the vibration effects of the project.

6 Summary

This report assesses the change in effects from noise and vibration due to the proposed concurrent construction of the primary and secondary shaft at the Tawariki Street shaft site, and the relocation of the secondary shaft to 42 Tawariki Street.

The construction methodology is not proposed to change. The same equipment and activities are expected to occur for the construction of the secondary shaft as detailed in the original AEE and MDA assessment. This report determines that much of the construction activity proposed for 42 Tawariki St will comply with the noise levels set by the designation.

It is important to note that this assessment represents a conservative approach in that it is based on noise from sheet piling. It is not yet known if sheet piling will be required for the construction of the secondary shaft within 42 Tawariki St. If sheet piling is required, noise levels are predicted to be higher for several receivers compared to the assessment in the original NOR due to sheet piling occurring closer to those properties. However these receivers were already expected to receive noise levels that exceeded the designation noise limits, and the changes in noise level do not materially change the nature of the construction noise effects for the project. It was always anticipated that sheet piling would result in exceedances of the noise limits set in condition 3.2, and consequently, the designation conditions provide for an ASCNMP (condition 3.5). Consultation with residents around timing and duration of sheet piling (if required) will be an important aspect of noise management, and will be a key consideration in the preparation of ASCNMP.

No additional measures beyond those already required by the existing conditions of the designation are considered necessary to appropriately manage the noise effects resulting from the change in shaft location and construction programme.

Vibration levels have been predicted from construction activities at 10 m, representative of 40 Tawariki Street (the closest receiver). Vibration levels from most equipment is predicted to be well below the guideline limits in DIN 4150-3 that are required to be met under the designation conditions. Whilst it is not yet known whether sheet piling will be required for the construction of the secondary shaft, we have conservatively assessed the potential effects if it were to occur. Vibration from sheet piling is predicted to exceed DIN 4150-3 limits when this is undertaken closer than 13 m (assuming operating frequency greater than 20 Hz).

Vibration monitoring is recommended when sheet piling is closer than 13 m from 40 Tawariki Street. Where vibrations are predicted to exceed DIN 4150-3, Watercare will be required to demonstrate that they have consulted with neighbouring properties and that the buildings and structures will withstand higher levels of vibration. The vibration mitigation and management measures in the designation conditions are considered appropriate to manage vibration effects from construction works.

7 Applicability

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

We understand and agree that our client will submit this report as part of an alteration to designation and that the consenting authority will use this report for the purpose of assessing that application

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

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