Waikare Gorge Design

Noise and Vibration Assessment

Waka Kotahi NZ Transport Agency

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→ **The Power of Commitment**

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Executive summary

This report details the assessment of the anticipated noise and vibration effects arising from the proposed construction and operation of the realignment of State Highway 2 (SH2) as it passes through Waikare Gorge located midway between Wairoa and Napier. The proposed alignment and Protected Premises and Facilities (PPFs) are shown in Figure 2.1.

Construction noise and vibration

Noise emissions have been modelled for the different construction scenarios determined from the construction methodology provided. The noise emissions predicted are useful for establishing the potential for emissions to the surrounding environment and informing the potential extent of the effects envelope. They should not be considered to provide a definitive set of noise levels at any one receiver.

Compliance with the NZS 6803 construction noise assessment criteria during typical daytime working hours based on the indicative construction scenarios has been established. The nearby noise sensitive receivers are predicted to experience the highest noise levels during vegetation removal, haul road construction and earthworks. The highest construction noise levels will only be experienced for limited periods when construction works are located near each sensitive receiver. Noise levels will reduce as construction progresses along the road alignment.

There are no relevant provisions in either the Hastings nor Wairoa District Plan for construction vibration. Construction vibration levels are predicted to comply with all Waka Kotahi Construction Guide[1] Category A (daytime) requirements at all surrounding receivers. Whilst the potential still exists for low levels of vibration to be felt by the closest receivers, negligible effects upon receivers are anticipated.

Notwithstanding that unmitigated noise and vibration levels are predicted to be compliant at surrounding receivers, implementation of the Best Practicable Option (BPO) mitigation measures referenced within NZS 6803:1999 are still recommended to minimise construction noise effects upon neighbouring properties.

At this stage of development, it is commonplace for the end construction methodology to not yet be fully identified. The potential exists for works to be required during day-time hours shoulder periods and night-time hours. As such, the best way to ensure that construction noise (and vibration) levels are both minimised and effectively managed at all times is with the implementation of the BPO mitigation measures under a CNVMP, and SSNMPs/Schedules (as required). It is on this basis that the noise and vibration effects arising from construction of the proposal are considered to be acceptable.

Operational noise

Existing road traffic noise levels were measured at three locations and were used for noise model verification. The model is considered representative of the measured noise environment.

Operational road traffic noise levels were predicted for three scenarios: 'Existing', 'Do nothing' and 'Do minimum'. The predicted operational noise levels for the 'Do-minimum' scenario fall within Category A of the NZS 6806[2] noise criteria.

On the balance of the assessment of effects presented, taking into account the predicted change in noise levels resulting from operation of the Project, the impact of the type of noise upon the soundscape and the 'absolute' levels of noise in comparison to the WHO guidelines[3] the operational noise effects of the Project are considered acceptable without the need for noise mitigation above and beyond that already inherent to the proposed 'Do-minimum' design. Notwithstanding, it is still acknowledged that road traffic noise will become the dominant source of ambient noise at R007 and R009 which will change the nature of the soundscape and the increase in noise levels at R007 will be noticeable compared to the ambient noise level otherwise prevailing. It is therefore recommended to identify opportunities to minimise noise emissions to R007 and R009 that could be readily

[1] State Highway Construction and Maintenance Noise Vibration Guide (Waka Kotahi NZ Transport Agency, 2019 Version 1.1)
[2] NZS 6806:2010 Acoustics – Road-traffic noise – New and altered Roads
[3] Environmental Noise Guidelines for the European Region, 2018, World Health Organization Regional Office for Europe

incorporated within the design (e.g. use of excess fill material for bunds), in line with implementation of the Best Practicable Option.

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1. Introduction

1.1 The proposal

State Highway 2 (SH2) between Gisborne and Napier passes through both Hawke's Bay and Gisborne/Tairāwhiti regions. The route is recognised as a strategically important economic and social connection for the Gisborne/Tairāwhiti region.

The realignment, a length of 3.9 kilometres, which will bypass a 5.6 kilometre section of SH2 (RP 577/12.00 to RP 592/2.30), includes the northern and southern approaches and highway section that passes through Waikare Gorge, located midway between Wairoa and Napier.

The alignment site is predominantly moderate undulating agricultural farmland. Over the length of the alignment the site has a small holding of farm dwellings, ancillary farming and dairy sheds, storage buildings, stock fences and gates and stock accessways.

Broadly described the alignment, in a south to north direction diverges from SH2 south of Putorino Station Road, by approximately 300 metres, briefly runs parallel to the rail corridor (and on the existing Putorino Station Road alignment) and crosses Kings Creek. It then heads across moderately undulating farm and pasture land to traverse Waikare Gorge on a new proposed bridge approximately 160 m in length. From the northern side of the gorge it veers towards and crosses over the KiwiRail corridor to reconnect and tie into the existing SH2 after the McKenzie's Rail Overbridge.

A full description of the Project is available within the Assessment of Environmental Effects Report ('AEE'). The extent of the works is shown in the drawings that accompany the application.

1.1.1 Key alignment features

The key alignment features, running north to south, consist of the following:

1. Northern tie-in works to create a smooth transition between the existing SH2 corridor and the realignment.
2. Typical road cross-sections consisting of minimum 1.5m sealed shoulders, 3.5m traffic lanes and the installation of a physical wire rope median barrier coupled with a 2 – 3 metre wide median.
3. A rail overbridge crossing the Palmerston North to Gisborne railway will be constructed.
4. A large culvert to allow the alignment to cross the existing gully that bisects the Lee property will be installed.
5. Significant earthwork cutting of up to 15.5 metres high on the northern approach to the Waikare Gorge.
6. A 500m (approximately) northbound uphill slow vehicle bay commencing just after the northern abutment of the proposed gorge bridge will be provided.
7. A proposed 160m bridge (approximately) spanning the Waikare Gorge will be constructed.
8. A 700m (approximately) southbound passing lane commencing just after the southern abutment of the proposed gorge bridge will be provided.
9. Stock underpass structures are proposed along the length of the proposed alignment.
10. A bridge to allow the alignment to cross Kings Creek will be constructed.
11. Southern tie-in works to provide a uniform connection with this realignment and the previous section of highway will be completed.

1.2 Scope

This assessment has been prepared to predict the potential effects of noise and vibration emissions during construction and operation of the proposal.

The scope of this assessment includes:

– Identification of the surrounding Protected Premises and Facilities (PPFs) potentially impacted by construction and operational noise from the proposal

– Measurement of existing road traffic noise levels at three locations along the proposal alignment
– Prediction of the noise and vibration emissions arising from construction and operation
– An assessment of effects of the noise and vibration emissions
– Recommendation of mitigation measures where applicable
– Preparation of a report summarising the findings of the noise and vibration assessment.

1.3 Limitations

This report: has been prepared by GHD for Waka Kotahi NZ Transport Agency and may only be used and relied on by Waka Kotahi NZ Transport Agency for the purpose agreed between GHD and Waka Kotahi NZ Transport Agency as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Waka Kotahi NZ Transport Agency arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

2. Existing environment

2.1 Study area

The assessment study area has been selected in accordance with the guidance provided in NZS 6806:2010 *Acoustics – Road-traffic noise – New and altered roads*.

NZS 6806 states that road traffic noise from new or altered roads are recommended to be assessed at Protected Premises and Facilities (PPFs) and does not apply to "*PPFs located in rural areas and located more than 200 m from the edge of the closest traffic lane for the new or altered road"*.

The proposal traverses through a rural area therefore all buildings within 200 metres from the edge of the closest traffic lane have been included within this assessment for consistency with NZS 6806.

2.2 Protected Premises and Facilities

Section 1.4.1 of NZS 6806 outlines the PPFs that would be considered for assessment. These include:

– Buildings used for residential activities including:
  - Boarding establishments
  - Homes for elderly persons
  - Retirement villages
  - In-house aged-care facilities, and
  - Buildings used as temporary accommodation in residentially zoned areas, including hotels and motels, but excluding camping grounds.

– Marae

– Spaces within buildings used for overnight patient medical care

– Teaching areas and sleeping rooms in buildings used as educational facilities including tertiary institutions and schools, and premises licensed under the Education (Early Childhood Services) Regulations, and playgrounds which are part of such facilities and located within 20 m of buildings used for teaching purposes.

Buildings that are not considered as PPFs under NZS 6806 include:

– Residential accommodation in buildings which predominantly have other uses such as commercial or industrial premises

– Garages and ancillary buildings

– Premises and facilities which are not yet build, other than premises and facilities for which a building consent has been obtained which has not yet lapsed.

The identified PPFs are outlined in Table 2.1 and shown in Figure 2.1.

Table 2.1 Identified PPFs for the assessment

Receiver ID	Address	Titles	Approximate distance to project footprint, m
R001	5235 State Highway 2, Putorino	HBC4/1210	160
R002	5224 State Highway 2, Putorino	HBP4/388	70
R003	5294 State Highway 2, Putorino	HBP4/388	170
R004	5294 State Highway 2, Putorino	HBP4/388	170
R005	4 Putorino Station Road, Putorino	HBK3/588	80
R007	100 Putorino Station Road, Putorino	-	100
R009	146 Putorino Station Road, Putorino	-	170

Receiver ID	Address	Titles	Approximate distance to project footprint, m
R010	5556 State Highway 2, Putorino	HBG3/1433	130
R011	5550 State Highway 2, Putorino	HBF4/1448	150

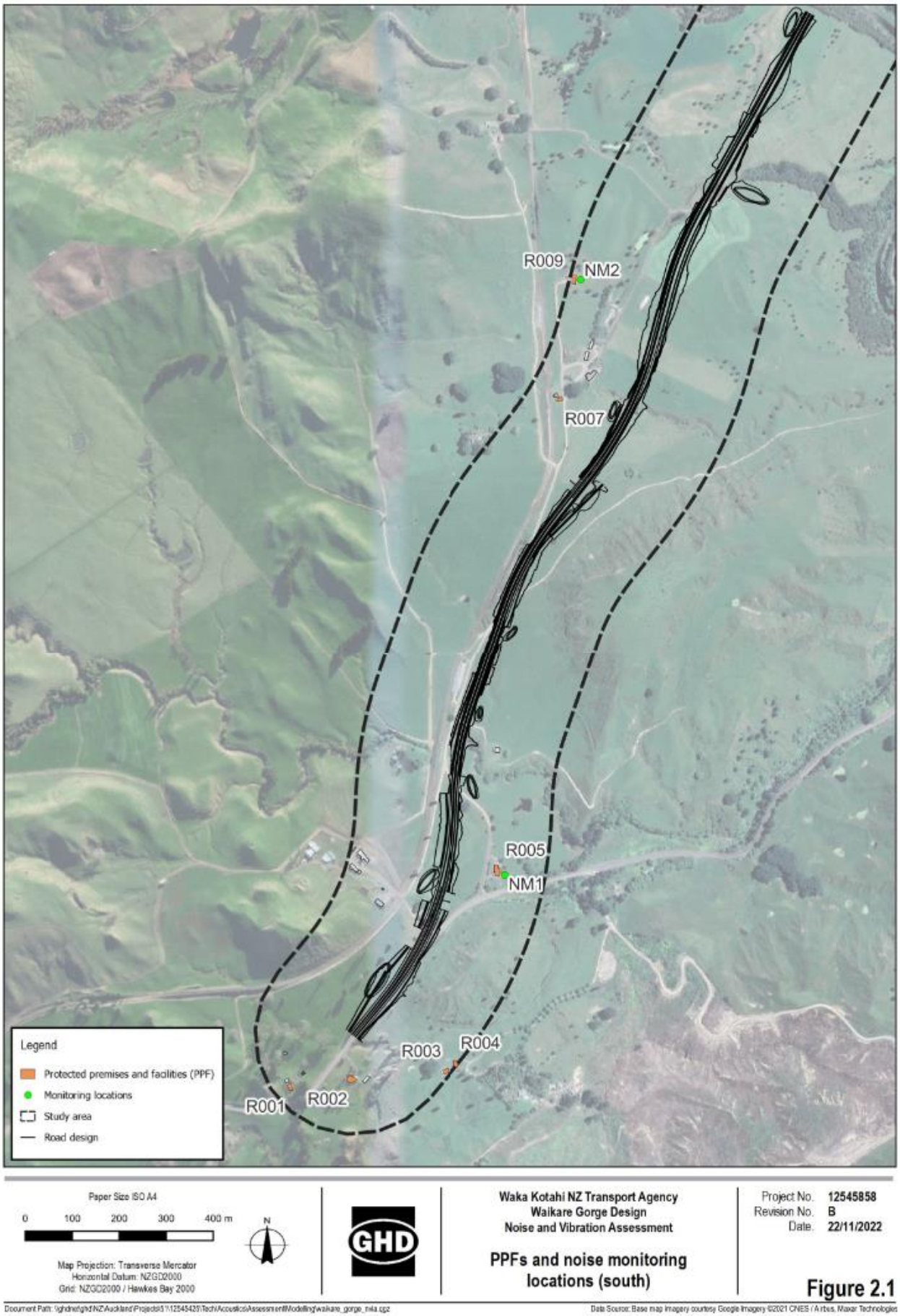


Figure 2.1 PPFs and noise monitoring locations (south)

Figure 2.2 PPFs and noise monitoring locations (north)

2.3 Noise monitoring

2.3.1 Methodology

Long-term unattended noise monitoring was completed at the following three locations and are shown in Figure 2.1.

– NM1 (4 Putorino Station Road)
– NM2 (146 Putorino Station Road)
– NM3 (5556 State Highway 2)

Ambient noise levels were monitored for eight days between 8 and 17 February 2022 using environmental noise loggers. Noise measurements were completed in general accordance with Waka Kotahi noise monitoring requirements[4] and NZS 6801:2008 *Acoustics – Measurement of environmental sound*. Survey details for each specific location are provided in Appendix A. These include photos of the site locations and measurement positions, graphic illustrations of the measured data, summaries of the noise levels measured, equipment and operator details as well as noise source observations during the surveys.

Meteorological data was obtained from the Wairoa Aerodrome located north-east of the proposal area. This data was used to determined periods of adverse weather conditions (such as high winds or rain). These periods were excluded from the measured data prior to processing.

Descriptions of the noise monitoring equipment at each noise monitoring location are provided in Table 2.2.

[4] NZTA Noise monitoring requirements V1.0

Table 2.2 Noise monitoring locations and equipment details

Item	NM1	NM2	NM3
Address	4 Putorino Station Road, Putorino	146 Putorino Station Road, Putorino	5556 State Highway 2, Putorino
Monitoring location	Free-field	Free-field	Free-field
Measurement start	9 February, 2022	9 February, 2022	9 February, 2022
Measurement end	16 February, 2022	16 February, 2022	16 February, 2022
Equipment details	Svan 977C, Type 1	Svan 979, Type 1	01 dB Cube, Type 1
Equipment serial number	92628	92066	14085
Equipment settings	A weighted, Fast time response, 15 minutes	A weighted, Fast time response, 15 minutes	A weighted, Fast time response, 15 minutes
Calibration drift	± 1 dB	± 1 dB	± 1 dB
Approximate distance to existing SH2	30 m	650 m	100 m
Site photo			

2.3.2 Existing ambient noise levels

The measured existing ambient noise levels and calculated average noise levels at each monitoring location are provided in Table 2.3. Dominant noise sources at each monitoring location were observed during equipment and are summarised below:

– **NM1:** dominated by road traffic noise along SH2. Peak noise levels were associated with aircraft and heavy vehicle pass-bys.

– **NM2:** distant road traffic noise along SH2 is audible. Peak noise levels were associated with aircraft noise and wildlife noise.

– **NM3:** dominated by road traffic noise along SH2.

Table 2.3 Noise monitoring results summary

Date	**Measured existing ambient noise level, dB $L_{Aeq(24\ hour)}$**		
	NM1 4 Putorino Station Road	**NM2 146 Putorino Station Road**	**NM3 5556 State Highway 2**
Wednesday, 9 February 2022	55	45	55
Thursday, 10 February 2022	55	46	54
Friday, 11 February 2022	55	47	54
Saturday, 12 February 2022	49	47	50
Sunday, 13 February 2022	48	45	47
Monday, 14 February 2022	56	44	54
Tuesday, 15 February 2022	55	45	54
Wednesday, 16 February 2022	56	45	55
Average noise level	**55**	**46**	**54**

3. Assessment criteria

3.1 Resource Management Act 1991

The overarching requirement for the control of noise is to comply with a reasonable level of noise in accordance with Section 16 (1) of the Act.

> **Section 16 (1)**
>
> Every occupier of land (including any premises and any coastal marine area), and every person carrying out an activity in, on, or under a water body or the costal marine area, shall adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level.

The Act defines noise as "includes vibration" and defines the Best Practicable Option (BPO) as:

> Best practicable option, in relation to a discharge of a contaminant or an emission of noise, means the best method for preventing or minimising the adverse effects on the environment having regard, among other things, to—
>
> a) the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and
>
> b) the financial implications, and the effects on the environment, of that option when compared with other options; and
>
> c) the current state of technical knowledge and the likelihood that the option can be successfully applied.

3.2 District Plans, Standards and Guidelines

The District Plan, Standards and Guidelines used to develop the assessment criteria are summarised in Table 3.1.

Table 3.1 Summary of District Plans, Standards and Guidelines

Aspect	Guideline / document
Construction noise	Hastings District Plan Rule 25.1.6I Wairoa District Plan Rule 24.1.4.i NZS 6803:1999 *Acoustics – Construction noise*
Construction vibration	State Highway Construction and Maintenance Noise Vibration Guide (Waka Kotahi NZ Transport Agency, 2019 Version 1.1) (Waka Kotahi Construction Guide)
Operational noise	Hastings District Plan Rule 25.1.7I Wairoa District Plan Rule 24.1.4.iii NZS 6806:2010 *Acoustics – Road-traffic noise – New and altered Roads* Guide to assessing road-traffic noise using NZS 6806 for state highway asset improvement projects (Waka Kotahi NZ Transport Agency, August 2016 Version 1.1)

The land use rules within the Hastings District Plan and the Wairoa District Plan do not apply to the State Highway designation, but are used as a reference.

3.3 Construction noise

3.3.1 District Plan Rules

The project area traverses two District Councils as the Waikari River forms the geographical boundary between the Hastings District to the south and the Wairoa District to the north.

3.3.1.1 Hastings District Plan

Rule 25.1.6I of the Hasting District Plan states the following:

> **Construction Noise**
>
> Higher levels of noise over Controlled durations will be accepted for construction purposes.
>
> (a) Any noise arising from construction, maintenance and demolition work in any Zone shall comply with NZS 6803:1999 Acoustics – Construction Noise.
>
> (b) Construction noise shall be measured and assessed in accordance with NZS 6803:1999 Acoustics – Construction Noise.
>
> (c) To avoid doubt, Standards 25.1.6C to 25.1.6H above shall not apply to construction noise.

3.3.1.2 Wairoa District Plan

Rule 21.1.4 of the Wairoa District Plan states the following:

> The noise limits stated in the Zone rules shall not apply in the following circumstances:
>
> i) all construction (including hydrocarbon exploration of less than 90 days duration), demolition and maintenance work shall be designed and conducted to comply with the requirements of NZS 6803:1999 Acoustics – Construction Noise.

3.3.2 NZS 6803 Construction noise limits

Recommended upper limits for construction noise are provided in NZS 6803 for residential, commercial and industrial areas. Limits are provided to assess average (L_{Aeq}) and maximum (L_{AFmax}) construction noise levels. The construction noise limits are assessed externally at a distance of 1 metre from the façade and between 1.2 to 1.5 metres high above the floor level of interest of any building that is normally occupied at the time of construction.

The following section summarises the construction noise limits that apply to construction noise sensitive receivers (i.e. a building that is normally occupied at the time of construction, including PPFs) identified within the proposal study area.

Residential construction noise limits

The recommended upper limits for construction noise received in residential zones and dwellings in rural areas are shown in Table 3.2. These limits depend on the following factors

– The time of week during which construction occurs
– The time period during which construction noise is received
– The overall duration required for construction works.

- **Short-term duration:** construction works at any one location for up to 14 calendar days;
- **Typical duration**: construction works at any one location for more than 14 calendar days but less than 20 weeks; and
- **Long-term duration:** construction works at any one location with a duration exceeding 20 weeks.

The indicative construction programme is expected to take approximately 30 months to complete. The construction noise limits for long-term duration have been adopted as construction works would occur over a period exceeding 20 weeks, e.g. 70 dB L_{Aeq} and 85 dB L_{Amax} between 7.30am to 6pm Monday to Saturday. The relevant noise limits are highlighted in Table 3.2 and Table 3.3.

With reference to Section 6.2 of NZS 6803, the construction noise limits are referenced to a representative assessment duration of between 15 and 60 minutes.

Table 3.2 Recommended upper limits for residential premises

Time of week	Time period	Recommended upper limit for construction noise, dB					
Duration of construction works		Typical		Short-term		Long-term	
Noise descriptor		L_{Aeq}	L_{Afmax}	L_{Aeq}	L_{Afmax}	L_{Aeq}	L_{Afmax}
Weekdays	6:30 am – 7:30 am	60	75	65	75	55	75
	7:30 am – 6:00 pm	75	90	80	95	70	85
	6:00 pm – 8:00 pm	70	85	75	90	65	80
	8:00 pm – 6:30 am	45	75	45	75	45	75
Saturdays	6:30 am – 7:30 am	45	75	45	75	45	75
	7:30 am – 6:00 pm	75	90	80	95	70	85
	6:00 pm – 8:00 pm	45	75	45	75	45	75
	8:00 pm – 6:30 am	45	75	45	75	45	75
Sundays and public holidays	6:30 am – 7:30 am	45	75	45	75	45	75
	7:30 am – 6:00 pm	55	85	55	85	55	85
	6:00 pm – 8:00 pm	45	75	45	75	45	75
	8:00 pm – 6:30 am	45	75	45	75	45	75

Commercial and industrial noise limits

The recommended upper limits for construction noise received in commercial and industrial areas are outlined in Table 3.3. These upper limits apply on all days.

Table 3.3 Recommended upper limits for construction noise received in industrial or commercial areas for all days of the year

Time of week	Time period	Recommended upper limit for construction noise, dBA		
Duration of construction works		Typical	Short-term	Long-term
Noise descriptor		L_{Aeq}	L_{Aeq}	L_{Aeq}
All days	7:30 am – 6:00 pm	60	65	55
	6:00 pm – 7:30 am	75	80	70

3.4 Construction vibration

There are no relevant provisions in either the Hastings or Wairoa District Plan for construction vibration. The Waka Kotahi Construction Guide provides construction vibration criteria based on standards from other countries (i.e. the UK's BS 5228-2 and Germany Industrial Standard DIN 4150-3 (1999): Structural vibration – Part 3 Effects of vibration on structures ("DIN 4150-3")).

On this basis, the recommended construction vibration criteria in the Waka Kotahi Construction Guide are adopted in this assessment. These criteria consider both human and structural response to vibration. The construction vibration criteria are presented in terms of peak particle velocity (ppv), in units of millimetres per second (mm/s).

The construction vibration criteria are presented in Table 3.4 and Table 3.5. Application of the Category A and Category B criteria are outlined in the Waka Kotahi Construction Guide which states:

> *"If measured or predicted vibration levels exceed the Category A criteria then a suitably qualified expert should be engaged to assess and manage construction vibration to comply with the Category A criteria as far as practicable. If the construction vibration exceeds the Category B criteria then construction activity shall only proceed if there is appropriate monitoring of vibration levels and effects on those buildings at risk of exceeding the Category B criteria, by suitably qualified experts."*

Table 3.4 Waka Kotahi construction vibration criteria

Receiver	Location	Details	Category A	Category B
Occupied PPFs	Inside the building	Night-time 2000h – 0630h	0.3 mm/s ppv	1 mm/s ppv
		Daytime 0630h – 2000h	1 mm/s ppv	5 mm/s ppv
Other occupied buildings	Inside the building	Daytime 0630h – 2000h	2 mm/s ppv	5 mm/s ppv
All other buildings (i.e. Unoccupied buildings)	Building foundation	Vibration – transient	5 mm/s ppv	BS 5228-2 Table B.2
		Vibration – continuous		BS 5228-2 50% of Table B.2 values

Table 3.5 Transient vibration guide values for cosmetic damage (Table B.2 from BS 5228-2)

Type of building	Peak component velocity in frequency range of predominant pulse	
	4 to 15 Hz	15 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s	50 mm/s
Unreinforced or light framed structures Residential or light commercial buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

3.5 Operational noise

3.5.1 District Plan Rules

3.5.1.1 Hastings District Plan

Rule 25.1.7I of the Hastings District Plan states the following:

> **Noise from new or altered roads**
>
> (a) New or alterations to existing roads outside the roading designation or corridor shall be designed to meet the criteria set out within New Zealand Standard NZS 6806:2010 'Acoustics – Road Traffic Noise – New and Altered Roads'.

3.5.1.2 Wairoa District Plan

Rule 21.1.4 of the Wairoa District Plan states the following:

> The noise limits stated in the Zone rules shall not apply in the following circumstances:
>
> iii) noise generated by traffic on public roads.

3.5.2 NZS 6806

The Waka Kotahi Guide[5] provides direction on the assessment of road-traffic noise. Changes in road traffic noise from new and altered State Highway asset improvement projects are required to be assessed in accordance with NZS 6806:2010 Acoustics – Road traffic noise – New and altered roads (NZS 6806).

NZS 6806 outlines the methodology for the assessment of road traffic noise from public roads on the surrounding environment. This methodology is outlined in the following section.

[5] Guide to assessing road-traffic noise using NZS 6806 for state highway asset improvement projects v1.1, August 2016, Waka Kotahi NZ Transport Agency

The operational road traffic noise criteria applied depends on the type of road project and whether noise is from an altered road or a new road.

The proposal contains noise contributions from both new and altered roads. The road is considered an altered road near the tie-ins to the existing road. This is a special case which is defined in section 6.2.1 of NZS 6806.

The other part of the proposal is considered a new road as it is to be constructed where no previously formed legal road existed.

3.5.3 Assessment scenarios

Section 7.2.5 of NZS 6806 outlines the road traffic noise assessment scenarios that are to be considered. These scenarios are provided in Table 3.6.

Table 3.6 Assessment timeframes

Scenario	Description	Adopted year for assessment
Existing	The current year at the date of assessment	2020[1]
Do-nothing	The existing road, 20 years after the 2026 year of opening	2046
Do-minimum	The proposed road (no mitigation), 20 years after the 2026 year of opening	2046

1. Traffic volumes for 2020 are available for the assessment. Adopting 2020 traffic volumes for the existing scenario represents a conservative assessment approach.

3.5.4 Assessment criteria

The assessment criteria provided in NZS 6806 are summarised in Table 3.7 for the following road projects:

– Altered roads
– New roads with a predicted traffic volume of 2,000 to 75,000 AADT at the design year.

Three categories are provided which specify the target noise levels that should be achieved dependent on whether the best practicable option for road-traffic noise mitigation can be implemented. The order of priority of applying the road traffic noise criteria is Category A, Category B then Category C. Category C is an internal noise criteria.

The assessment criteria are applied at the façades of all PPFs located within the study area at a height of 1.2 to 1.5 m above the floor level of interest.

Table 3.7 NZS 6806 relevant road noise criteria

Category	Category description	Altered road $L_{Aeq(24\ hour)}$	New roads $L_{Aeq(24\ hour)}$
A	Primary external noise criterion	64	57
B	Secondary external noise criterion	67	64
C	Internal noise criterion	40	40

4. Construction noise and vibration assessment

4.1 Construction noise

4.1.1 Construction period

The assumed mid-2023 construction commencement date has been used as the ‘baseline date’ to inform technical reports for the potential commencement of the works.

The indicative construction programme is expected to take approximately 30 months to complete. This proposed construction timeframe will be subject to, amongst other things, availability of material, plant and contractors.

Due to no confirmed funding from Waka Kotahi, at the time of lodgement, and subject to final design considerations of the alignment, no confirmed construction start date is able to be provided at this time.

4.1.2 Construction methodology

4.1.2.1 Construction staging

The construction methodology has been reviewed to identify the construction scenarios that have been used to assess the potential for noise emissions. These scenarios are outlined in Table 4.1. It is important to note that the construction scenarios envisaged should only be treated as indicative, as the final construction methodology is subject to change. Nonetheless, the noise emissions predicted are useful for establishing the potential for emissions to the surrounding environment and informing the potential extent of the effects envelope; as opposed to providing a definitive set of noise levels at any one receiver.

Table 4.1 Construction Scenarios

Scenario ID	Description
CS01	Site establishment
CS02	Vegetation clearing
CS03	Haul road construction
CS04	Cross culverts
CS05	Earthworks
CS06	Bridge construction
CS07	Bridge construction (piling)
CS08	Drainage infrastructure
CS09	Pavement and surfacing, road tie-ins
CS10	Furniture installations and line marking
CS11	Landscaping works

Whilst the proposed construction hours are unknown at the time of writing, this assessment assumes that the hours will typically fall between Monday to Saturday 7.30am – 6.00pm.

4.1.2.2 Equipment sound levels

The proposed equipment that is expected to generate the highest noise levels during each works phase and their associated scenario sound power levels are provided in Table 4.2. Reference noise levels for equipment have been obtained from BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise (‘BS5228-1‘), AS 2436-2010 Guide to noise and vibration control on construction,

demolition and maintenance sites ('AS 2436'), Construction Noise and Vibration Strategy Transport for NSW[6] (CNVS TfNSW) and Roads and Maritime Services Construction Noise and Vibration Guideline[7] (RMS CNVG).

Construction scenarios have been created based on the equipment likely to be operating simultaneously at any given time, based upon the location creating the highest received noise levels, to provide a conservative approach. The modelling assumes the 'worst-case' scenario to identify where noise levels could be of concern and require mitigation.

Whilst other equipment may be used it is anticipated that they would produce similar net noise emissions compared with the equipment listed in Table 4.2. The scenario sound power levels are based on the two loudest items of equipment operating simultaneously.

The scenario sound power levels assume that equipment will operate at full power for the full duration of the assessment period, e.g. 15 minutes to 1 hour. In reality, the equipment is more likely to move around the construction footprint which will change the level of noise emissions as construction progresses.

[6] Construction Noise and Vibration Strategy, Transport for NSW, April 2018
[7] Construction Noise and Vibration Guideline, Roads and Maritime Services, August 2016

Table 4.2 Construction equipment and scenario sound power levels

Equipment	Sound power level, dBA	Construction scenario										
		CS01	CS02	CS03	CS04	CS05	CS06	CS07	CS08	CS09	CS10	CS11
Scenario sound power level		**109**	**116**	**116**	**112**	**116**	**116**	**113**	**114**	**113**	**109**	**114**
Asphalt truck and sprayer	103									X		
Backhoe	111								X			
Chainsaw – petrol	114		X									
Compactor	106				X	X						
Compressor	109							X				
Concrete pump	109				X			X	X	X		
Crane – Mobile (600T plus)	113						X					
Dozer (20T-28T)	109		X			X						
Excavator – 10 tonne	100		X	X	X	X			X			X
Excavator – 20 tonne	105		X	X	X	X			X			X
Excavator – 30 tonne	110					X			X			
Franna crane	98	X				X	X		X		X	
Front end loader	112		X	X		X						X
Generator (silenced)	92						X	X				
Grader	113			X		X						
Grinder	105		X									
Hand tools (electric)	102	X			X						X	X
Jackhammer	113						X					
Light vehicles	88	X	X	X	X						X	X
Lighting – daymaker	98	X										
Line marking truck	108										X	
Pavement profiler/ Road planner	110									X		

Equipment	Sound power level, dBA	Construction scenario										
		CS01	CS02	CS03	CS04	CS05	CS06	CS07	CS08	CS09	CS10	CS11
Crane mounted auger (rotatory bored piling)–	107							X				
Roller – smooth drum	107				X	X			X	X		
Roller – Vibratory	109					X			X	X		
Scissor lift	98										X	
Truck – concrete	109				X			X	X	X		
Truck – dump	110		X			X		X		X		X
Truck – medium rigid	103	X		X							X	X
Truck – road truck	108	X	X	X		X		X	X	X		X
Poker vibrator	106				X							
Water cart	107			X		X	X					

4.1.3 Construction noise modelling

Noise modelling was completed using SoundPLAN 8.2. SoundPLAN is a computer program for the calculation, assessment, and prognosis of noise exposure. SoundPLAN calculates environmental noise propagation according to *ISO 9613-2 'Acoustics – Attenuation of sound during propagation outdoors'*.

The following noise modelling assumptions were made:

- surrounding land was modelled with a ground absorption coefficient of 0.75 assuming a mix of 75 per cent soft and 25 per cent hard ground
- atmospheric absorption was based on an average temperature of 10°C and an average humidity of 70 per cent
- atmospheric propagation conditions were modelled with noise enhancing wind conditions for noise propagation (downwind conditions) or an equivalently well-developed moderate ground-based temperature inversions
- modelled scenarios take into account the shielding effect from surrounding buildings and structures on and adjacent to the site
- noise modelling assesses the noise source at multiple locations and takes the highest L_{Aeq} noise level at the receiver.

4.1.4 Predicted construction noise levels

Predicted noise levels, for all modelled scenarios, at the noise sensitive receivers (i.e. PPFs) identified are provided in Table 4.3.

The predicted levels are based on construction works occurring at the worst-case location relative to each receiver. The actual noise levels received at sensitive receivers during construction will generally be lower as construction works progress along the road alignment and the highest noise level emissions will only be experienced for limited periods where equipment is operating at their maximum capacity. For most of the time, construction equipment would produce lower noise levels than those considered in this assessment.

The highest noise levels are predicted during CS02 (vegetation clearing), CS03 (haul road construction) and CS05 (earthworks). Construction noise levels up to 70 dBA are predicted when the works are located closest to the nearest receivers. The primary contributors to the noise levels are due to operation of a front-end loader, grader or chainsaw.

The predicted construction noise levels comply with the criteria of 70 dB L_{Aeq} and 85 dB L_{Amax} between 7.30am to 6.00pm Monday to Saturday at all surrounding receivers. Should works be required to run during daytime-hours shoulder periods (i.e. 6.30-7.30am, 6.00-8.00pm) mitigation methods will need to be investigated on a case-by-case basis to enable compliance with the more stringent noise limits to be achieved and minimising effects on nearby noise sensitive receivers.

Table 4.3 Predicted construction noise levels, dB L_{Aeq} dBA

Receiver ID	Address	CS01	CS02	CS03	CS04	CS05	CS06	CS07	CS08	CS09	CS10	CS11
R001	5235 State Highway 2, Putorino	55	62	62	59	61	30	26	60	60	55	60
R002	5224 State Highway 2, Putorino	62	70	69	66	69	30	26	67	66	62	68
R003	5294 State Highway 2, Putorino	56	63	62	59	62	27	22	60	60	56	61
R004	5294 State Highway 2, Putorino	55	61	61	58	60	25	21	59	59	54	59
R005	4 Putorino Station Road, Putorino	62	69	68	65	68	33	29	66	65	61	67
R007	100 Putorino Station Road, Putorino	59	66	65	62	65	41	37	64	62	59	64
R009	146 Putorino Station Road, Putorino	55	62	61	58	61	44	40	60	59	55	60
R010	5556 State Highway 2, Putorino	57	63	63	60	62	42	38	61	61	56	61
R011	5550 State Highway 2, Putorino	57	64	63	60	63	39	34	62	61	57	62

4.1.5 Night-time works

Generally, construction activities will be completed during daytime hours. There is potential for some of the construction works (e.g. existing State Highway tie-in works, over-sized bridge components requiring delivery at night, 24-hour concrete pours) will be carried out during night-time hours (i.e. 8:00pm – 6:30am) for safety reasons and to reduce the impact to traffic during daytime hours.

Night-time works completed in proximity to noise sensitive receivers are likely to exceed the night-time construction noise limits. The extent to which this occurs will depend upon the construction works to be completed, as well as the proximity of noise sensitive receivers.

Mitigation is to be provided in the form of community consultation, scheduling of particularly noisy works for when they are least likely to cause disturbance (if at all practicable) and the offer of temporary relocation should the situation warrant such consideration.

4.2 Construction vibration

4.2.1 Overview

A list of key construction activities is provided in Table 4.2 above. Among these activities, the typical vibration generating activities are vibratory compaction during earth works (CS05) and road surfacing (CS09) which requires the use of a vibratory roller.

The vibration sensitive receiver located closest to the construction footprint is as follows:

– PPF R002 (5224 State Highway 2): 70 metres.

Other unoccupied buildings are located further away from the construction footprint.

4.2.2 Predicted construction vibration levels

Whilst dependent upon the prevailing frequency in Hertz (Hz) of the vibration transmission, and the characteristics of the receiving building structure, it is worth noting that a vibration level of 5 mm/s often represents the threshold for the potential reduction in the serviceability of the building receiving vibration (e.g. cracking of plasterwork), below which no cosmetic damage is generally anticipated. This type of damage can be repaired and is considered to be minimal. Vibration levels that have the potential to lead to structural damage are typically significantly higher than those that cause cosmetic building damage e.g. 10 mm/sec at 10 Hz in dwellings and buildings of similar design and/or occupancy.

Construction vibration levels at receivers are dependent not only upon the equipment used, but also the localised ground conditions onsite. Typically, variability in localised ground conditions leads to a significant level of uncertainty when predicting levels of vibration transmission. Whilst accurate prediction of vibration levels at this stage of a project is unreliable, set-back distances to determine the extent of the potential for construction vibration effects have been identified based on empirical data provided in Appendix E of BS 5228-2. Assessment results are shown in Table 4.4 below.

Table 4.4 Typical set back distance for typical construction vibration generating activities

Activity	Typical minimum setback distances in metres		
	Category A (unoccupied buildings) **Category B (occupied PPFs/ other occupied buildings – daytime)** **(5 mm/s PPV)**	**Category A (Other occupied buildings)** **(2 mm/s PPV)**	**Category A (Occupied PPFs)** **(1 mm/s PPV)**
Vibratory fill compaction	15	35	60

As all of the surrounding vibration sensitive receivers/buildings are located at least 70 metres from the construction footprint, vibration levels are predicted to comply with Category A (daytime) requirements at all surrounding receivers.

4.3 Construction management

4.3.1 Construction Noise and Vibration Management Plan

Construction noise levels are inherently loud. Whilst unmitigated noise and vibration levels are predicted to comply with the day-time (Monday to Saturday 7.30am – 6pm) noise limits at surrounding receivers, implementation of the Best Practicable Option (BPO) mitigation measures referenced within NZS 6803:1999 are still generally recommended in order to minimise construction noise effects upon neighbouring properties. For example, the use of the smallest/quietest machinery practicable, minimisation of the number of items of equipment required on site and the idling of that equipment by planning and scheduling of works.

Additional mitigation measures may be required should works be required to run during daytime-hours shoulder periods (i.e. 6.30-7.30am, 6.00-8.00pm). These would need to be investigated on a case-by-case basis to enable compliance with the more stringent noise limits to be achieved.

Any works that cannot be carried out during the day, and therefore must be carried out during night-time hours, are likely to exceed night-time construction noise limits. These works will need careful management with a focus on community consultation including the potential for the offer of temporary relocation should the scale of the works and the potential for disturbance warrant such action after all other forms of mitigation have been considered. This is to be assessed on a case-by-case basis and informed and lead by the receiver's tolerance to potential noise disturbance.

The most effective way to ensure that the BPO mitigation measures are being followed and that noise and vibration emissions are minimised is by advising the contractor(s) how to manage levels and the effects upon neighbouring properties. This is best achieved under the framework of a Construction Noise and Vibration Management Plan (CNVMP). As a minimum, the CNVMP must address the relevant measures in Annex E of NZS 6803 and the Waka Kotahi Construction Guide.

4.3.2 Site Specific Noise Management Plans/Schedules

At this stage of development, it is commonplace for the end construction methodology to not yet be fully identified. As such, the best way to ensure that construction noise levels are both minimised and effectively managed at all times (but particularly during night-time hours) is to offer the provision of schedules to the CNVMP/Site Specific Noise Management Plan(s) (SSNMPs) in addition to the overall CNVMP. Ideally, an SSNMP / Schedule to the CNVMP is to be written when the noise levels for the specific activity are predicted to exceed the applicable noise limit with all practicable physical mitigation in place at any one receiver. This is intended as a fail-safe to enable construction noise levels to be minimised and effects managed where the end construction methodology has not yet been fully identified.

4.3.2.1 Temporary relocation

Given the scale of the works that the project would give rise to and the small number of proximate receivers the requirement for temporary relocation is expected to be minimal, if required at all. Temporary relocation should only be considered when the potential for all other forms of mitigation to reduce noise levels have been exhausted and an exceedance at a particular noise receiver will still occur i.e. it should only be offered if all other mechanisms of mitigation have been exhausted because relocation in and of itself has the potential for undesirable side-effects.

Any noise limit exceedance should not only be considered in terms of the dBA value as it is also a function of the duration, time of the activity, nature and type of the exceedance, sensitivity of the receiver, and feasibility of relocation.

5. Road traffic noise assessment

5.1 Noise modelling inputs

The noise model inputs and assumptions are presented in Table 5.1.

Table 5.1 Operational noise model inputs and assumptions

Input / assumption	Description
Software	SoundPLAN Version 8.2
Prediction algorithm	United Kingdom Department of Transport Calculation of Road Traffic Noise (CoRTN)
Model inputs	
Topography	Based on LiDAR data. The terrain resolution is generally < 5 m within the study area. Terrain data from LINZ with a terrain resolution of 20 m interval has been used to supplement the LiDAR data where LiDAR is not available. Analysis shown that the non-compliance with the terrain resolution specified in NZS 6806 is highly unlikely to have any material effect. This approach is supported by Waka Kotahi. It is also worth noting there is no PPFs have been identified within this area. The potential for different terrain resolution data to create an artificial ridge resulting in screening of the PPFs was checked and resolved in the topography modelling such that the model does not contain any artificial screening.
Road alignment and gradient	Considered based on the 3D road design and terrain contours for existing roads. The 3D road design includes the number of traffic lanes and edge of carriageway
Buildings	Building shape sourced from the LINZ data service
Receiver location	At the building façade
Receiver height	Ground floor 1.5 m above ground
Verification model receiver height	1.5 m above ground
Ground absorption	0.75
Input parameters	
Verification model road surface adjustment	Grade 3/5 two coat chipseal
Verification model traffic volumes	Based on measured traffic count data. Traffic count data was processed to obtain the light vehicle and heavy vehicle volumes for modelling. Measured volumes are provided in section 5.2.1
Verification model traffic speeds	Based on measured traffic count data. Measured speeds are provided in section 5.2.1
Existing and Do-nothing scenarios surface adjustments	Existing road: Grade 3/5 two-coat chipseal
Do-minimum scenario surface adjustments	Existing road: Grade 3/5 two-coat chipseal Proposed road: Grade 3/5 two-coat chipseal
Existing, Do-nothing and Do-minimum scenarios traffic volumes	Provided in section 5.2.2
Existing, Do-nothing and Do-minimum scenarios traffic speeds	Provided in section 5.2.2
Corrections	
CoRTN conversion factor	- 3 dB for conversion between $L_{A10(18\ hour)}$ levels and $L_{Aeq(24\ hour)}$ levels

5.2 Traffic data

5.2.1 Verification model

Traffic volumes were measured as part of the noise model verification process using automatic traffic counters (ATC) at one location on SH2 near 5556 State Highway 2 (i.e. NM3). The traffic count was completed simultaneously with monitoring of the existing ambient noise levels.

The data collected as part of the traffic counts included:

– Traffic volumes in each direction
– Vehicle speeds in each direction
– Classification of vehicle types (light vehicle and heavy vehicles).

Traffic volumes measured during existing ambient noise level monitoring are summarised in Table 5.2. The existing road surface is provided in Table 5.1.

Table 5.2 Existing road traffic volumes 2020

Road	Direction	Measured average daily traffic		
		Total traffic	% Heavy vehicles	Speed (85th percentile)
State Highway 2	Northbound	1057	29.7	98.1
	Southbound	1061	29.7	100.3

5.2.2 Existing, Do-nothing and Do-minimum scenarios

Traffic volumes for the existing year (2020/22) and the design year (2046) are provided in Table 5.3 for the following roads:

– Existing roads: the existing SH2
– Bypass: the proposed SH2
– Residual: the existing SH2 after construction of the proposed SH2. The residual road segment would allow for access to Putorino.

Traffic volumes between the do-nothing and do-minimum cases in the design year (2046) are not expected to change. The road surfaces used for the existing and proposed roads are provided in Table 5.1.

Table 5.3 Design road traffic volumes

Road	Direction	Design road traffic volumes (hourly average)					
		2020 (Existing)			2046 (design year)		
		Light	Heavy	Speed	Light	Heavy	Speed
Existing roads	Both	1581	381	97	2494	601	97
Bypass	Both	-	-	-	2494	601	97
Residual	Both	-	-	-	350	84	97

5.3 Noise model verification

Noise model verification has been completed to demonstrate that the road traffic noise model produced for the existing situation is an accurate representation of the real world within the limitations of the algorithm. The noise model validation process determines the variation between the predicted road traffic noise levels (using measured traffic volumes) with the measured road traffic noise levels at each noise monitoring location.

A comparison of the measured and modelled road traffic noise levels is provided in Table 5.4. Noise monitoring location NM02 has been excluded from the noise model verification due to its distance from existing SH2 being over 600m.

Table 5.4 Noise model verification summary

Location	Address	Road traffic noise level dB $L_{Aeq(24\ hour)}$, dB		
		Measured	Modelled	Difference
NM01	4 Putorino Station Road	55	56	1
NM03	5556 State Highway 2	54	54	0

Predicted road traffic noise levels using the validation noise model are within ±2 dB $L_{Aeq(24\ hour)}$, of the measured noise levels at all locations.

5.4 Predicted operational noise levels

The predicted operational road traffic noise levels are provided in Table 5.5 for the scenarios outlined in Table 3.6. In addition to these scenarios, the project road contribution for the 'Do minimum' scenario has been included in order to determine whether the predicted noise levels are from an existing road or due to the project road upgrade.

The Category A criteria for each PPF has been identified in accordance with NZS 6806. The Project includes both 'altered roads' and 'new roads' with the sections of altered road located near the tie-ins to the existing SH2. The altered road criteria have been applied to all PPFs located within 200 metres of the existing SH2. This is consistent with 'Example 3 – Special Case' provided in Appendix A of NZS 6806. This example is similar to the Project being assessed as it considers the development of an intersection to connect a new road to an existing road in a rural environment.

As road traffic noise exposure on different sides of PPF R005 are different at different scenarios, the predicted noise levels at different façades of this PPF are provided.

Terrain data and vehicles running on roads (both existing and proposed) within approximately 300 m from the proposed SH2 were included within the road traffic noise model in accordance with NZS 6806. This means that noise modelling does not include for noise emissions from road traffic travelling along the section of the present alignment that will become the 'residual' alignment following construction of the bypass i.e. the closest parts of the existing SH2 to PPFs R007 and R009 are approximately 550 m away and not included within the road traffic noise model. On this basis, the predicted 'Existing' and 'Do-nothing' road traffic noise levels at R007 and R009 reported in Table 5.5 are lower than the actual road traffic noise levels in these locations. A high-level prediction based on CoRTN shows that the 'Existing' and 'Do-nothing' road traffic noise levels should be in the order of 40 dB $L_{Aeq(24h)}$ when noise from the existing SH2 alignment greater than 300m from the proposed SH2 is included in the noise model. This aligns better with onsite observations made when the noise level survey was undertaken.

Table 5.5 Predicted operational noise levels

PPF ID	Address	Category A Criteria	Predicted noise level, dB $L_{Aeq(24\ hr)}$			
			2020 Existing	2046 Do-nothing	Do minimum	
					Project + existing roads	Project road
R001	5235 State Highway 2, Putorino	64	60	62	62	47
R002	5224 State Highway 2, Putorino	64	56	58	58	52
R003	5294 State Highway 2, Putorino	64	45	47	47	45
R004	5294 State Highway 2, Putorino	64	45	47	47	44
R005a	4 Putorino Station Road, Putorino (Eastern and southern façades)	64	58	60	53	47
R005b	4 Putorino Station Road, Putorino (Western façade)	64	52	54	52	51
R005c	4 Putorino Station Road, Putorino (Northern façade)	64	40	42	49	49

PPF ID	Address	Category A Criteria	Predicted noise level, dB $L_{Aeq(24\ hr)}$			
			2020 Existing	2046 Do-nothing	Do minimum	
					Project + existing roads	Project road
R007	100 Putorino Station Road, Putorino	57	32[1]	34[1]	52	52
R009	146 Putorino Station Road, Putorino	57	31[1]	33[1]	48	48
R010	5556 State Highway 2, Putorino	64	52	54	50	50
R011	5550 State Highway 2, Putorino	57	48	50	51	50

1. A high-level prediction based on CoRTN shows that the 'Existing' and 'Do-nothing' road traffic noise levels should be in the order of 40 dB $L_{Aeq(24h)}$ when noise from the existing SH2 alignment >300m from the proposed SH2 is included in the noise model.

5.4.1 NZS 6806

In the 'Do-minimum' scenario, operational road traffic noise levels are predicted to range between 47 to 62 dB $L_{Aeq(24\ hour)}$ with the project road contribution ranging between 44 to 52 dB $L_{Aeq(24\ hour)}$. The PPFs with the highest predicted road traffic noise levels are due to traffic along existing roads (State Highway 2) and are not due to the project road upgrade. As all receivers are predicted to comply with the Category A criteria, no mitigation above and beyond that proposed under the 'Do-minimum' scenario, are required under NZS 6806.

6. Assessment of effects

This assessment has been prepared to predict the potential effects arising from the construction and operation of the proposal.

6.1 Construction noise and vibration

The noise emissions predicted are useful for establishing the potential for emissions to the surrounding environment and informing the potential extent of the effects envelope. They should not be considered to provide a definitive set of noise levels at any one receiver. It is on this basis that compliance with the NZS 6803 construction noise assessment criteria during typical daytime working hours has been established. The nearby noise sensitive receivers are predicted to experience the highest noise levels during vegetation removal, haul road construction and earthworks. The highest construction noise levels will only be experienced for limited periods when construction works are located near to each sensitive receiver. Noise levels will reduce as construction progresses along the road alignment.

Two indicative locations for site yards have been considered (one at the northern end and one at the southern end of the alignment). Both of these locations are separated from noise sensitive receivers by at least 130 metres. Site yards are typically used for the storage of materials and equipment. Given the minimal noise levels expected from the site yards (in comparison to the main construction works) and the separation distances between site yards and receivers, no further consideration of emissions is required.

Construction vibration levels are predicted to comply with Waka Kotahi Construction Guide Category A (daytime) requirements at all surrounding receivers. Whilst the potential still exists for low levels of vibration to be felt by the closest receivers, negligible effects upon receivers are anticipated.

Notwithstanding that unmitigated noise and vibration levels are predicted to be compliant at surrounding receivers during typical construction hours, the implementation of the Best Practicable Option (BPO) mitigation measures referenced within NZS 6803:1999 are still recommended to minimise construction noise effects upon neighbouring properties.

At this stage of development, it is commonplace for the end construction methodology to not yet be fully identified. The potential exists for works to be required during day-time hours shoulder periods and night-time hours. As such, the best way to ensure that construction noise (and vibration) levels are both minimised and effectively managed at all times is with the implementation of the BPO mitigation measures under a CNVMP, and SSNMPs/Schedules (as required). It is on this basis that the noise and vibration effects arising from construction of the proposal are considered to be acceptable.

6.2 Operational noise

Whilst different people react differently to changes in noise levels, guidance typically shows a general correlation between the change in noise level and subjective responses to ‘loudness’ in line with that shown in Table 6.1. This guidance should largely be thought of within the context of short-term changes rather than long term exposure, as receivers will generally become accustomed to the new noise levels. Although the complex subjective responses to changes cannot be accurately represented by the numerical change in noise levels, the table below provides an indicative guide to subjective responses and potential effects.

Table 6.1 Subjective perception of changes in noise level

Noise level change	General subjective perception
1 – 2 dBA	Negligible / insignificant change
3 – 4 dBA	Perceptible change
5 – 8 dBA	Noticeable change
9 – 11 dBA	Halving/double the loudness
> 11 dBA	More than halving/double the loudness

An assessment of the effects of the project has been undertaken by considering the change in noise level predicted between the 'Do-nothing' and 'Do-minimum' scenarios. Road traffic noise levels are predicted to:

– Remain unchanged at R001, R002, R003 and R004,
– Become 1 dBA higher at R0011 and 2dBA quieter at the western façade of 4 Putorino Station Road (R005b). These are considered negligible / insignificant changes.
– Become 4 dBA quieter at R010; considered a perceptible change in noise levels. This represents a positive effect of the project.
– Whilst no definitive quantitative assessment has been completed, the reduction in traffic vehicles numbers anticipated to travel along the existing SH2 alignment (i.e. Residual) with the introduction of the bypass is likely to lead to a 7 dBA decrease in noise levels at approximately 10 noise sensitive receivers along that alignment. This represents a noticeable, positive effect of the project.
– A reduction in noise from the existing SH2 alignment as it passes through Putorino will also generally benefit the surrounds of that area including receivers located further away from the alignment (approximately an additional 10).
– The new alignment will mean that noise levels on the eastern and southern facades of R005 (i.e. R005a) will be 7 dBA quieter, whilst on the northern façade noise levels (i.e. R005c) will be 7 dBA higher.
– Increases of 12 dBA at R007 and 8 dBA at R009 are considered to represent a noticeable negative effect and a substantial negative change in noise levels respectively.

Reductions in noise level are due to the project road moving traffic further away from the PPFs.

R007 and R009 are located well away from the existing alignment of SH2. Therefore, the increase in noise levels is due to the proposed location of the bypass being much closer to these properties. The highest increase in road traffic noise level is predicted to be 12 dBA at 100 Putorino Station Road (R007). However, it is important to note that the measured existing ambient noise levels from NM2 at R009 (i.e. 146 Putorino Station Road) is 46 dB $L_{Aeq(24hr)}$. This level is considered representative of the existing ambient noise level at R007. The predicted road traffic noise levels of 'Do-minimum' scenario are up to 52 dB $L_{Aeq(24\ hr)}$ and therefore this indicates a 6 dBA increase compared to the existing ambient noise levels. This is considered a noticeable change in noise levels. It is also worthwhile considering that observations made during noise measurements noted that traffic noise from SH2 is already audible. As such, whilst noticeable – the proposal does not add a new type of noise to the soundscape. Notwithstanding, it must be noted that road traffic noise will become the dominant source of noise.

In addition to consideration of changes in noise level and character of the soundscape it is useful when assessing effects to consider the 'absolute' levels of noise being discussed and compare this to reference literature. The World Health Organization (WHO) Environmental Noise Guidelines for the European Region[8] recommends reducing noise levels produced by road traffic noise levels below 53 dBA L_{den}[9]. The predicted road traffic noise levels of up to 52 dB $L_{Aeq(24\ hr)}$ at 146 Putorino Station Road is equivalent to 57 dBA L_{den} for a strategic highway[10] which is approximately 4 dBA above the WHO recommendations.

On the balance of the assessment of effects presented, the operational noise effects of the Project are considered acceptable without the need for noise mitigation above and beyond that already inherent to the proposed 'Do-minimum' design.

Whilst no noise mitigation above and beyond that already inherent to the proposed 'Do-minimum' design is considered necessary to mitigate traffic noise levels at R007 and R009, it is still acknowledged that road traffic noise will become the dominant source of ambient noise which will change the nature of the soundscape and the increase in noise levels at R007 will be noticeable. It is therefore recommended to identify opportunities to minimise noise emissions to R007 and R009 that could be readily incorporated within the design (e.g. use of excess fill material for bunds), in line with implementation of the Best Practicable Option. For example, this could be incorporated within any property negotiations.

[8] Environmental Noise Guidelines for the European Region, 2018, World Health Organization Regional Office for Europe
[9] L_{den} indicator can be calculated as the A-weighted average sound pressure level, measured over a 24-hour period, with a 10 dB penalty added to the average level in the night (23:00–07:00 or 22:00–06:00), a 5 dB penalty added to the evening (19:00–23:00 or 18:00–22:00) and no penalty added to the daytime period (07:00–19:00 or 06:00–18:00).
[10] Calculated by Noise metrics tool published by Waka Kotahi NZTA (https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/technical-disciplines/environment-and-sustainability-in-our-operations/environmental-technical-areas/noise-and-vibration/noise-metrics-tool/)

7. References

New Zealand Standards (1999), *NZS 6803:1999 Acoustics – Construction noise*

New Zealand Standards (2010), *NZS 6806:2010 Acoustics – Road-traffic noise – New and altered Roads*

Waka Kotahi (2019), *State Highway Construction and Maintenance Noise Vibration Guide*

Waka Kotahi (2016), Guide to assessing road-traffic noise using NZS 6806 for state highway asset improvement projects

Environmental Noise Guidelines for the European Region, 2018, World Health Organization Regional Office for Europe

Appendix A

Existing ambient noise levels

NM1 – 4 Putorino Station Road, Putorino

Existing ambient noise level survey details

Parameter	Setting/source
Operator	CY Ho
Address	4 Putorino Station Road, Putorino
Equipment details	Type 1 Sound Level Meter Svan 977C Serial 92628, Acoustic Calibrator Svan SV36 Serial 10489
Measurement dates	Tuesday 8th to Thursday 17th February 2022
Observation	Traffic noise on Pacific Coast Highway (SH2) being dominant source of noise in the area. Peak noise levels were associated with aircraft and heavy vehicle pass-bys.

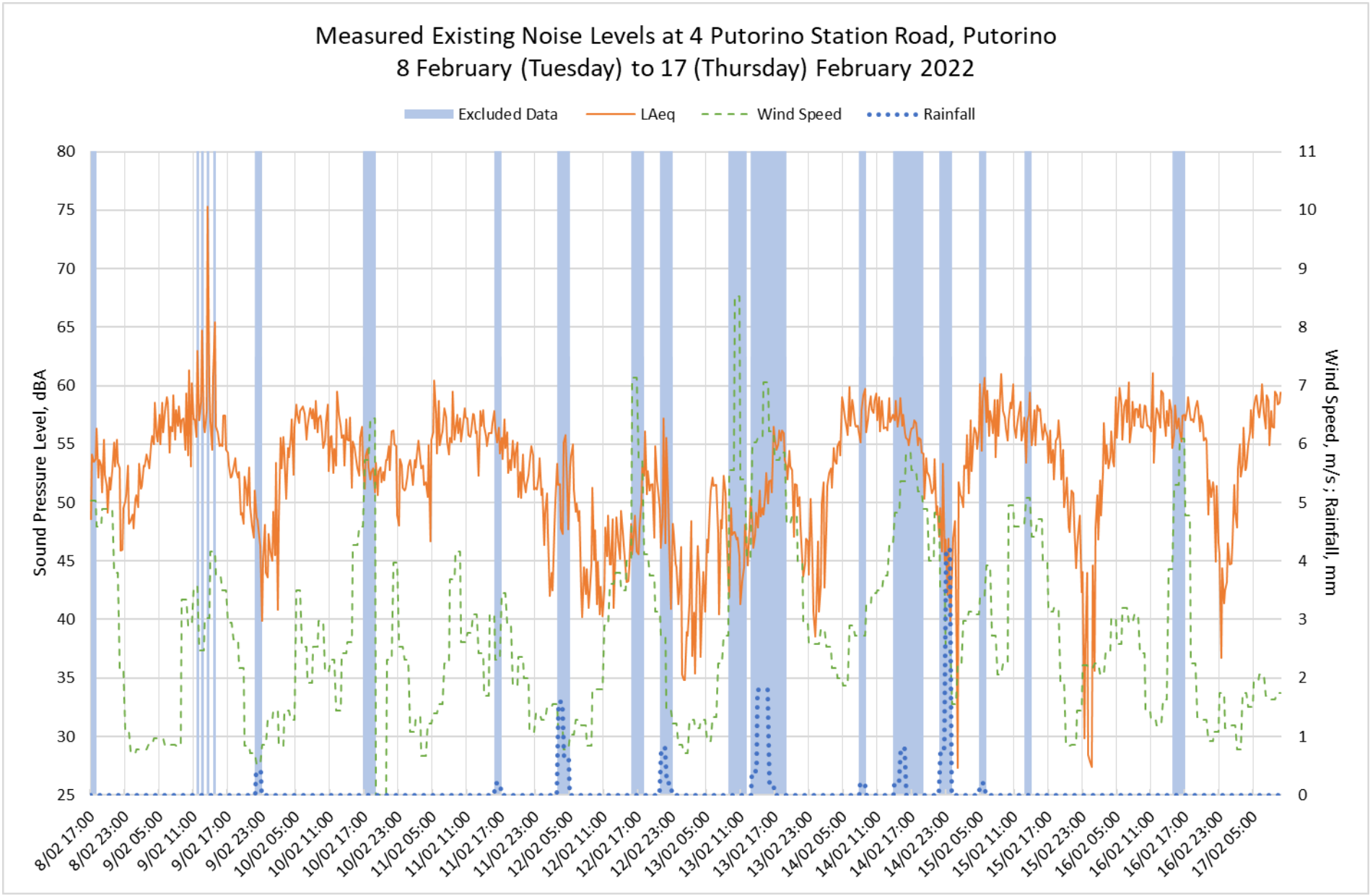
Summary of noise level survey results – $L_{Aeq(24h)}$

Date	$L_{Aeq(24h)}$, dB
Wednesday, 9 February, 2022	55
Thursday, 10 February, 2022	55
Friday, 11 February, 2022	55
Saturday, 12 February, 2022	49
Sunday, 13 February, 2022	48
Monday, 14 February, 2022	56
Tuesday, 15 February, 2022	55
Wednesday, 16 February, 2022	56
Average	55

Noise survey location


Measurement location
NM1

Photograph of noise measurement position



Note: Anomalous and weather affected measurement results have been excluded in the determination of the acoustic parameters

NM2 –146 Putorino Station Road, Putorino

Existing noise level survey details

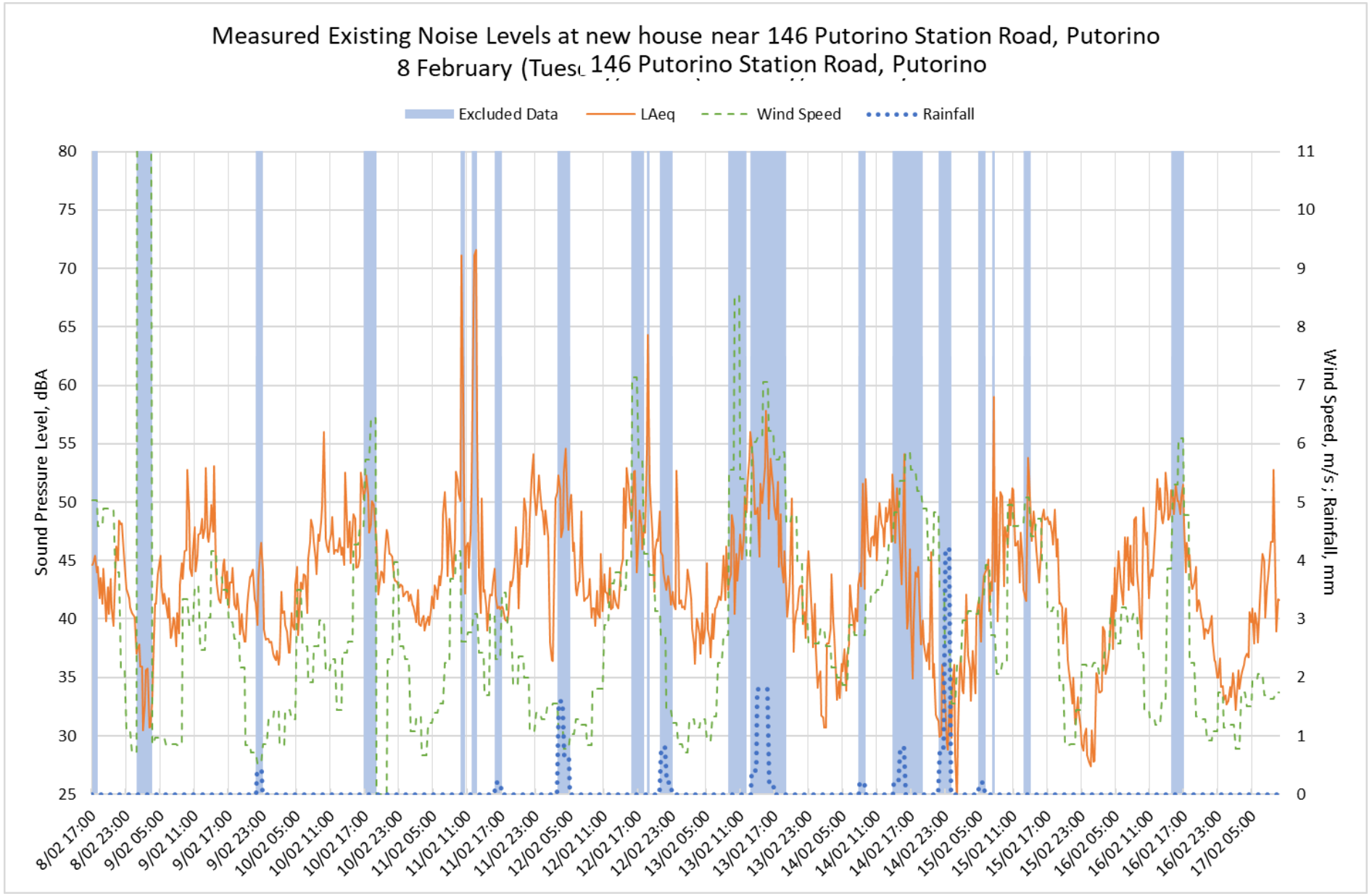
Parameter	Setting/source
Operator	CY Ho
Address	146 Putorino Station Road, Putorino
Equipment details	Type 1 Sound Level Meter Svan 979 Serial 92066 Acoustic Calibrator Svan SV36 Serial 10489
Measurement dates	8 Tuesday to 17 Thursday February 2022
Observation	Distance traffic noise on Pacific Coast Highway (SH2) are audible. Peak noise levels were associated with aircraft noise and wildlife noise.

Summary of noise levels survey results – $L_{Aeq(24h)}$

Date	$L_{Aeq(24h)}$, dB
Wednesday, 9 February, 2022	45
Thursday, 10 February, 2022	46
Friday, 11 February, 2022	47
Saturday, 12 February, 2022	47
Sunday, 13 February, 2022	45
Monday, 14 February, 2022	44
Tuesday, 15 February, 2022	45
Wednesday, 16 February, 2022	45
Average	46

Noise levels survey location

Photographs of noise levels survey position



Note: Anomalous and weather affected measurement results have been excluded in the determination of the acoustic parameters

NM3 - 5556 State Highway 2, Putorino

Existing noise level survey details

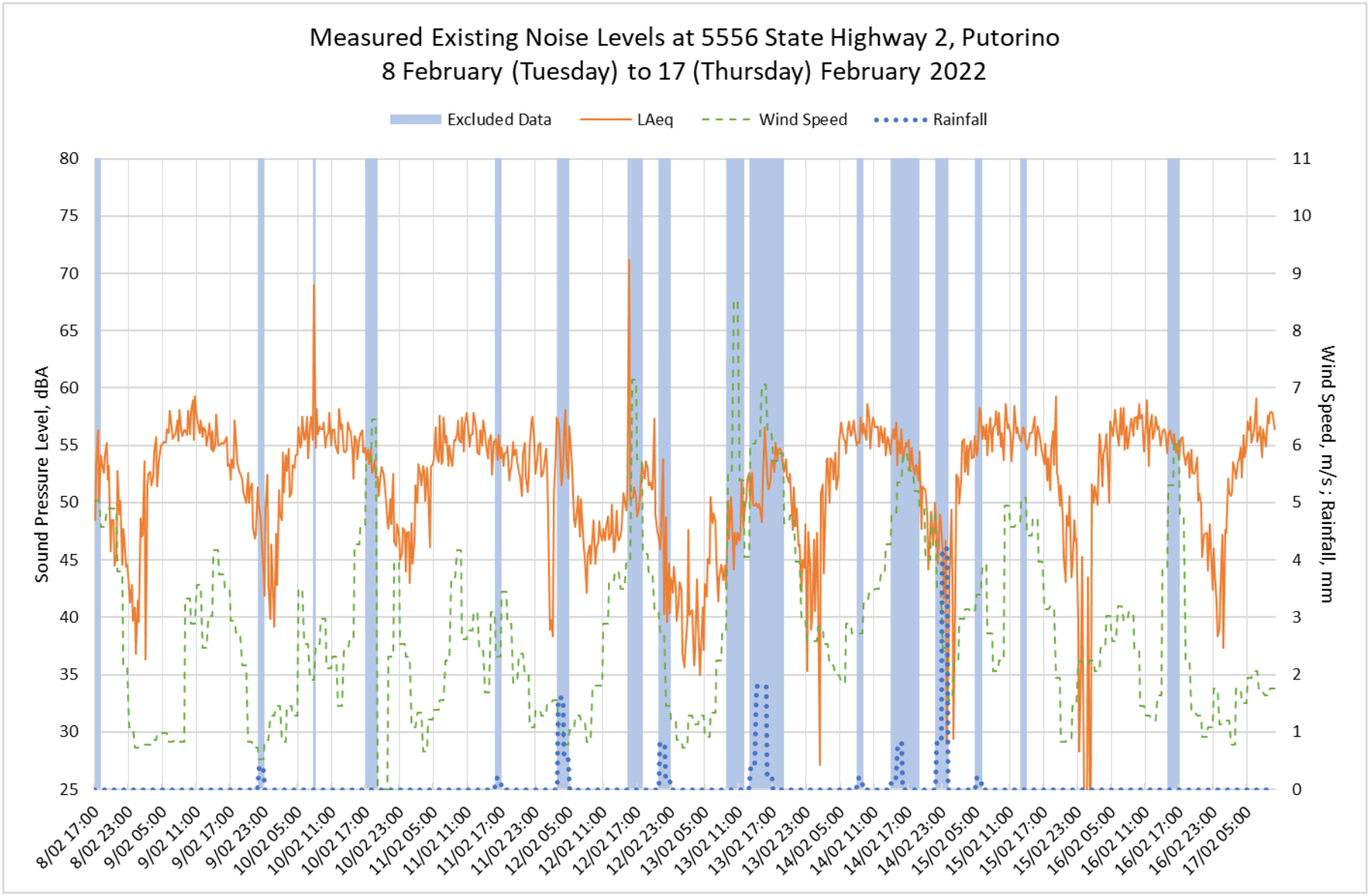
Parameter	Setting/source
Operator	CY Ho
Address	5556 State Highway 2, Putorino
Equipment details	Type 1 Sound Level Meter 01dB Cube Serial 14085 Acoustic Calibrator Svan SV36 Serial 10489
Measurement dates	8 Tuesday to 17 Thursday February 2022
Observation	Traffic noise on Pacific Coast Highway (SH2) being dominant source of noise in the area

Summary of noise levels survey results – $L_{Aeq(24h)}$

Date	$L_{Aeq(24h)}$, dB
Wednesday, 9 February, 2022	55
Thursday, 10 February, 2022	54
Friday, 11 February, 2022	54
Saturday, 12 February, 2022	50
Sunday, 13 February, 2022	47
Monday, 14 February, 2022	54
Tuesday, 15 February, 2022	54
Wednesday, 16 February, 2022	55
Average	54

Noise levels survey location

Photographs of noise levels survey position



Note: Anomalous and weather affected measurement results have been excluded in the determination of the acoustic parameters