Guide to assessing road-traffic noise

This guide describes the processes to be used on road improvement projects for assessing and, where required, determining appropriate mitigation for road-traffic noise. These processes include application of NZS 6806:2010. The guide also gives effect to the Waka Kotahi NZ Transport Agency's state highway project development and delivery standards, in particular Z19 Taumata Taiao - Environmental and sustainability standard.

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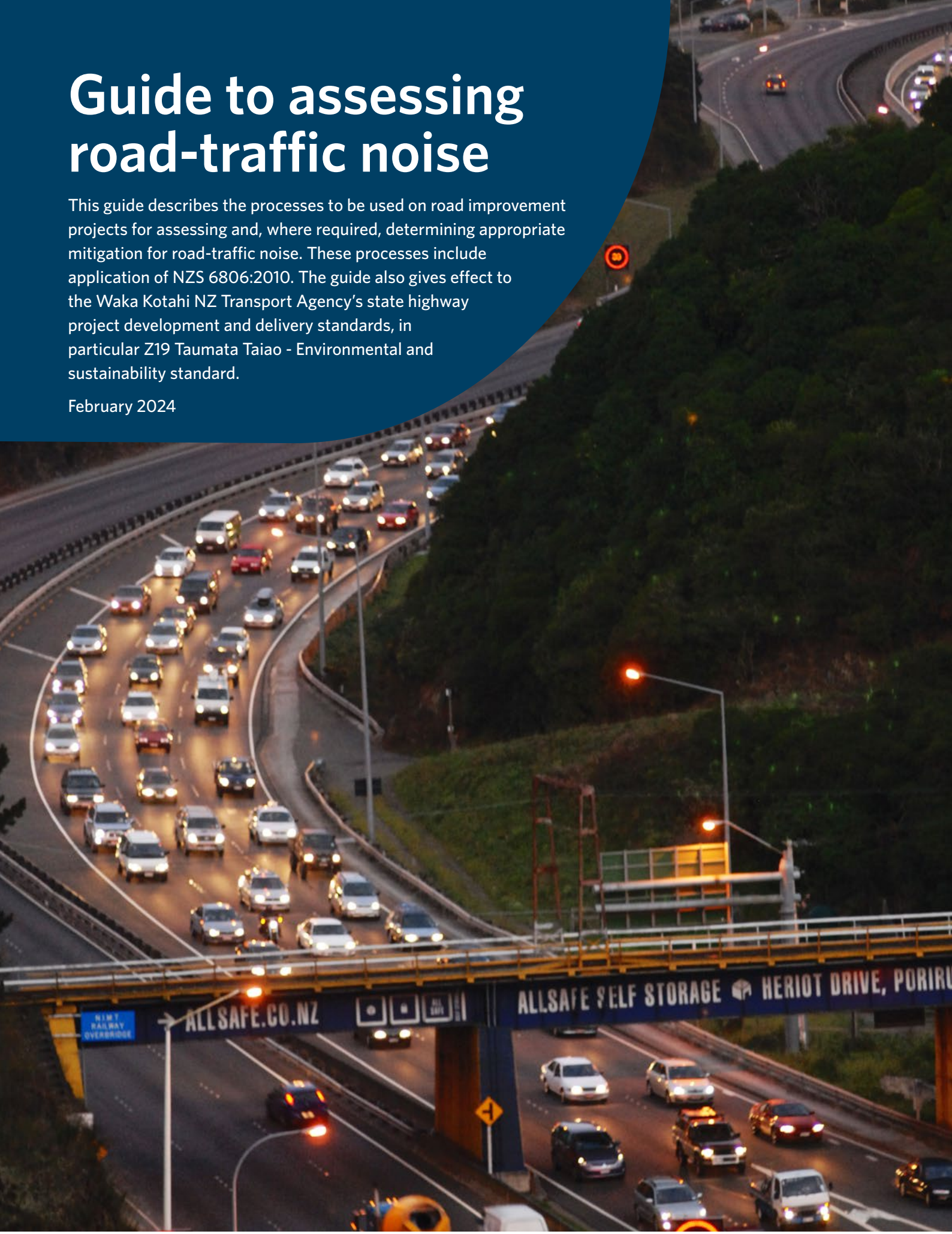

NZ TRANSPORT AGENCY
WAKA KOTAHI

Te Kāwanatanga o Aotearoa
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Contents

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Document management plan

Purpose

This management plan outlines the updating procedures and contact points for the document.

Document information

Document name	Guide to assessing road-traffic noise for road improvement projects
Document number	SP/M/023
Document availability	This document is located in electronic form on the Waka Kotahi website at **nzta.govt.nz**
Document owner	Principal Noise and Vibration Specialist
Document sponsor	Team Lead Environment and Sustainability

Amendments and review strategy

All corrective action/improvement requests (CAIRs) suggesting changes will be acknowledged by the document owner.

Activity	Comments	Frequency
Amendments (minor revisions)	Updates incorporated immediately when they occur.	As required
Review (major revisions)	Amendments fundamentally changing the content or structure of the document will be incorporated as soon as practicable. They may require coordinating with the review team timetable.	Five yearly
Notification	All users who have subscribed to Technical Advice Notes will be advised by email of amendments and updates.	Immediately

Record of amendment

Amendment number	Description of change	Effective date	Updated by
1.1	Address changes in Waka Kotahi processes and case studies	July 2016	Greg Haldane
2.0	Expanded assessment method to address matters outside the scope of NZS 6806. New surface corrections added in appendix.	February 2024	Richard Jackett

1 Introduction

Background

Transport noise and vibration can cause a range of impacts on people and communities including annoyance and interference with daytime activities such as work, study and domestic living. Other effects include potential sleep disturbance, and long-term health impacts such as increased risk of heart disease.

When a new or altered section of road is planned and built, the route selection, road design and noise reduction measures, can minimise these adverse effects for people nearby. While residual adverse effects remain unavoidable in most cases, the processes set out in this guide are designed to reduce potential noise effects of new and altered roads to at least an acceptable degree.

Purpose of this document

This guide assists in determining the level of assessment required during project development, and how noise mitigation evolves through delivery, construction, and operational phases.

Where noise mitigation is required, this guide describes the processes to be used, including tools and templates prepared by Waka Kotahi.

For road-traffic noise (not construction noise) this guide is aimed at:

- project managers who need to schedule and budget for the relevant processes
- acoustics specialists who need to perform and present assessments in a consistent manner
- planners who need to draft designation conditions that allow for detailed design of noise mitigation to occur at the appropriate time
- for each project, the person responsible for the final determination of noise mitigation.

Waka Kotahi has prepared other guides, which are also relevant, including:

- *State highway noise barrier design guide*[01]
- *State highway guide to acoustic treatment of buildings*[02]

Supporting tools and information are available on the Waka Kotahi website: **nzta.govt.nz/roads-and-rail/highways-information-portal/technical-disciplines/noise-and-vibration**

Specification P40

Waka Kotahi has a specification (P40) for noise mitigation, which covers the design, construction, documentation and post-construction review of state highway road-traffic noise mitigation[03].

This guide should be read in conjunction with P40, as understanding how mitigation will be implemented in practice is essential for an accurate assessment of effects, and an efficient design process.

New Zealand Standard NZS 6806

New Zealand Standard NZS 6806:2010[04] sets out criteria for noise from new and altered roads and a process to determine practicable noise mitigation measures. There is not a fixed noise limit but if reasonable external noise levels cannot be achieved then buildings are treated, if required, to achieve reasonable internal noise levels. Application of NZS 6806 is part of the assessment process required by this guide. It is used within a broader framework that also assesses potential noise effects that may occur (even when there is compliance with the NZS 6806 criteria).

NZS 6806 does not apply to existing roads that are not being altered.

01 Waka Kotahi NZ Transport Agency (2010) *State highway noise barrier design guide* **nzta.govt.nz**

02 Waka Kotahi NZ Transport Agency (2015) *State highway guide to acoustic treatment of buildings.* **nzta.govt.nz**

03 Waka Kotahi NZ Transport Agency (2024) *P40 - Specification for road-traffic noise mitigation* **nzta.govt.nz**

04 Standards New Zealand (2010) NZS 6806:2010 *Acoustics – road-traffic noise – new and altered roads* **standards.govt.nz**

2 Terminology

Terminology used in this document

Term	Definition
AADT	Annual Average Daily Traffic - the vehicle count for an entire year in both directions past a point on the road, divided by the number of days in the year.
Acoustics specialist	A person with the qualifications, experience and professional accreditation in acoustics.
Altered road	An existing road that is subject to a change in the horizontal or vertical alignment that without specific noise mitigation would cause an increase in road-traffic noise above thresholds defined in NZS 6806. NZS 6806 applies to new and altered roads. It does not apply to existing roads that are not being 'altered'. An online screening tool to help determine whether or not NZS 6806 applies to a particular project is provided on the Waka Kotahi website: **nzta.govt.nz.** Maintenance works such as resurfacing are not classified as an altered road project.
Audio tactile pavement markings (ATPM)	ATPM (e.g. rumble strip) is most commonly a series of raised painted road markings at an edge of a traffic lane, which induce a sound inside (and outside) a vehicle as its tyres pass over them, to warn the driver of the lane departure.
Build now designation	A designation that is obtained with the intention of commencing construction in the immediate future.
Building-modification mitigation	Measures to reduce the effects of internal traffic noise levels in buildings include: • mechanical ventilation/cooling (to provide thermal comfort so windows can be kept closed to reduce road-traffic noise) • acoustic insulation • voice amplification systems (eg in schools) • building relocation.
Decibels (dB $L_{Aeq(24h)}$)	Road-traffic noise under NZS 6806 is measured in decibels (dB) as the A-frequency-weighted, time-average level over 24 hours ($L_{Aeq(24h)}$).
Design year	10 to 20 years after the opening of a new or altered road.
Do-nothing	The scenario of no change to the existing road, but with traffic growth that would have occurred at the design year.
Do-minimum	The scenario at the design year of a new or altered road having been constructed, but with no specific traffic mitigation measures implemented. (traffic modellers and transport planners often use the terms do-nothing and do-minimum with different definitions; care should be taken to apply the correct definitions under NZS 6806).
Free-field	Under NZS 6806 road-traffic noise is assessed at the position of the building facade excluding noise reflected from the building, as if it wasn't there.
Multi-criteria analysis (MCA)	A tool for assessing multiple quantitative and qualitative criteria to refine both longlists and shortlists of options.
Protected premises and facilities (PPFs)	Spaces in buildings used for: • residential activities • marae • overnight medical care • teaching (and sleeping) in educational facilities • playgrounds that are part of educational facilities and are within 20 m of buildings used for teaching purposes. PPFs are the locations where road-traffic noise is assessed and for which noise mitigation measures may be required. NZS 6806 does not apply to PPFs in urban areas that are located more than 100 m from the edge of the closest traffic lane for the new or altered road, or PPFs in rural areas located more than 200 m from the edge of the closest traffic lane.
Route protection designation	A designation obtained where there is not an immediate need for a new road however land is to be set aside for future needs.
Structural mitigation	Measures to reduce noise such as: • low-noise road surface materials • noise barriers (including walls, fences and bunds).
Urban/rural	The definition of urban and rural areas specified in NZS 6806 is no longer used by Stats NZ and cannot be applied. For noise assessments under this guide, the definition of urban and rural areas is to be as shown on the current "Urban Rural (generalised)" map published by Stats NZ. This results in smaller urban areas than the NZS 6806 definition. The larger Stats NZ Functional Urban Area definition is not to be used.

3 Assessment process

Introduction

Actions are required throughout the lifecycle of a road to consider and address road-traffic noise effects. Different project stages are defined and included in the Z19 Taumata Taiao - Environmental and sustainability standard, which are shown in figure 2.

There are three major processes, although each is split into smaller segments.

- Project development, where a need is established and the preferred option is confirmed.
- Project delivery, where statutory approvals are obtained, detailed design performed, and a contractor engaged to construct the project.
- Maintenance and operation, which is once the road is open. Maintenance contracts will be in place and will include noise barrier and road surface requirements.

This guide is particularly relevant to the development phase and the consenting component of the delivery phase. Specification P40 should be referenced for the delivery and maintenance phases.

Project development

In the business case approach, the transportation need is assessed before undertaking detailed analysis of environmental effects such as noise.

This means noise assessments in the early phases are limited to identifying whether noise is a significant issue, and the likely scale of mitigation required. Where different route options are being investigated, noise will be one of many factors to be considered and may form part of a multi-criteria analysis.

The consenting strategy will be confirmed during the detailed business case, however the technical assessments required to secure the consents will often not be performed until a decision to construct the project has been made and funding allocated.

Consenting

A robust technical assessment is required for obtaining the statutory approvals, however the level of detail will vary depending on the project. The noise mitigation design process detailed in NZS 6806 requires significant effort, and for many routine projects, noise mitigation is not warranted and neither is a full assessment.

Critical to getting the right noise outcome, is obtaining the necessary approvals with appropriate conditions. This is discussed further in section 6.

Project delivery

For 'build now' designations, which applies to most projects, the delivery phase will include designing the details of noise mitigation with the form and general extents identified in the consenting stage.

The form and general extent of noise mitigation, and noise levels at individual properties should not be revisited, unless any alterations to the designation are required.

In the case of a 'route protection' designation, a detailed noise assessment might not be performed until the project delivery design stage. If noise mitigation options are considered then a detailed evaluation following this guide is required.

Figure 1: Waka Kotahi state highway noise guides

Noise assessment tiers

Noise tiers have been developed to allow consistent noise assessments, but as the tiers are not bound to specific business case phases, the assessments may be performed earlier or later, depending on the size and complexity of the project.

The appropriate tier of noise assessment varies for each stage, depending on the risk associated with the project.

For many projects the tier 1 assessments can be conducted by project staff without the need for acoustics specialists. Tier 2 assessments might require acoustics specialist input.

Tier 3 assessments are not required on all projects, but do require acoustics specialists.

Generally, for larger higher-risk projects, the more detailed tier 2 and 3 assessments will be required in earlier stages. The 'noise risk' associated with the project is determined from the tier 1 assessment. The tier 1 and 2 noise assessments are conducted separately for each project option.

The tier 3 noise assessment is only conducted for the preferred project option determined in the detailed business case.

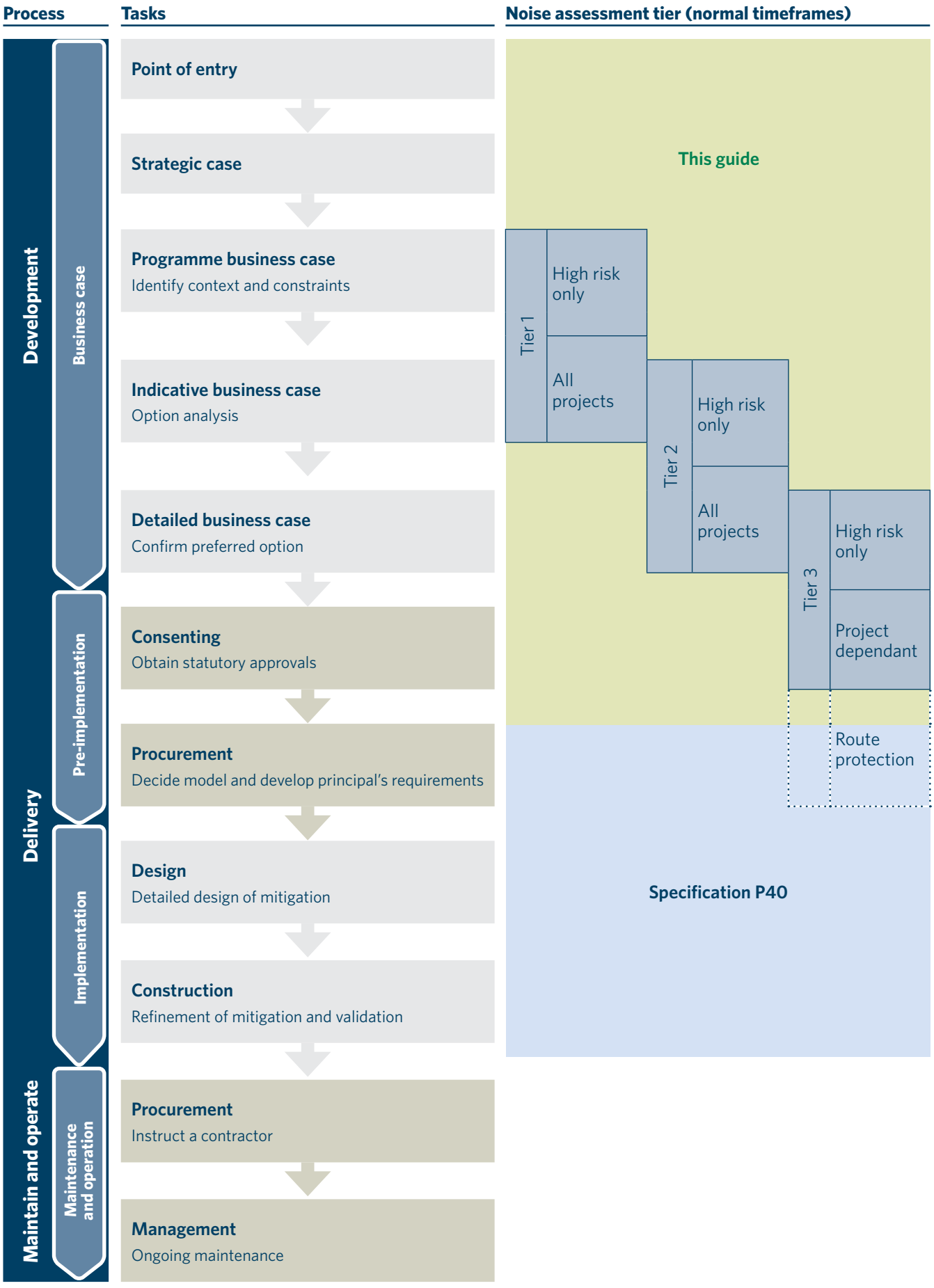
The purpose and output of each tier are summarised in table 1. Figure 2 shows the normal timeframes for the assessment tiers.

There are often variations to these timeframes.

Table 1: Noise assessment tiers

	Purpose	Output
Tier 1	Identify issues / fatal flaws for single or multiple options	Environmental Screen / rating for multi-criteria analysis
Tier 2	Confirm whether NZS 6806 applies	Preliminary Technical Assessment Report
	Scale of mitigation and indicative cost	
Tier 3	Determine appropriate noise mitigation after robust evaluation process based on NZS 6806	Technical Assessment Report
	Assessment of effects for RMA approvals	

Figure 2: Assessment process



Tier 1 – Noise risk assessment

The aim of tier 1 assessments is to inform decision making during business case development. The assessments are generally done at a high level on a desk-top basis, to identify issues and to broadly consider potential impacts of a project or project option. Tier 1 assessments can take different forms depending on the nature of each project and can be conducted multiple times for some projects.

As part of a tier 1 assessment, noise levels might be estimated or calculated at PPFs to allow for estimation of the numbers of PPFs within bands of noise exposure. However, tier 1 assessments do not include quantification or evaluation of noise effects at individual PPFs, or detailed analysis of noise mitigation options.

For all projects, a tier 1 noise assessment is made as part of the Environmental Screen, by completing the relevant questions relating to Human Health. These are explained within the Environmental Screen.

If potential noise issues are identified, such as from an initial Environmental Screen, multiple tier 1 noise assessments might then be made for individual project options to inform ratings in a multi-criteria analysis (MCA). Tier 1 assessments for each MCA option should identify parameters such as:

- numbers of PPFs in bands of noise exposure
- typical changes in noise exposure at PPFs
- proximity of PPFs to road features that might give rise to noise characteristics (eg PPFs within 200 m of an intersection, road gradient above 3%, on/off ramp, raised safety platform, bridge, lane merge, speed change)

The parameters can vary between projects, but should remain at a broad level commensurate with the purpose of informing business case decision making. MCA ratings for operational road-traffic noise should not be bundled with other aspects of noise and vibration. Regardless, it is unnecessary to include road-traffic vibration and construction noise/vibration in most MCA assessments.

Tier 2 – Preliminary technical assessment

NZS 6806 only requires mitigation to be considered in clearly defined circumstances. The purpose of the tier 2 assessment is to screen out those project options where mitigation is definitely not required.

Examples of such projects/options include:

- Widening of existing roads with no additional traffic.
- Minor roads with significant setbacks to the nearest PPFs.

For simple projects, a screening tool is available on the Waka Kotahi website, which can assist in determining whether the works fall within the scope of NZS 6806.

The assessment is made on the basis of future noise levels with and without the project, which can be estimated in a separate tool using traffic data (traffic, speed and road surface) and the relationship to the nearest PPF. For each project option, the one-page results sheet from the NZS 6806 screening tool should be appended to the Environmental Screen.

For projects with complex topography, a computer noise model may need to be developed by an acoustics specialist to confirm whether NZS 6806 applies, and whether noise mitigation options are required to be considered.

The output of the tier 2 assessment is a preliminary technical assessment report. The audience of the report is project staff and decision makers. The report should be concise and should not include explanation of criteria or a full assessment of effects.

For a project where no mitigation is required then for statutory approvals a road-traffic noise assessment report should be prepared setting out the details of this screening process and making a qualitative assessment of any potential noise effects beyond the scope of this consideration under NZS 6806.

Tier 3 – Technical assessment

A tier 3 assessment determines the recommended noise mitigation and assesses the effects of the project. This requires an acoustics specialist.

Key parts of the assessment are:

- Noise modelling.
- Mitigation design.
- An assessment of effects.
- Preparation of a report, which can be used to support a Notice of Requirement.

A tier 3 assessment is not required for all projects. As discussed above, in some instances a tier 2 assessment may be sufficient.

Noise modelling

A detailed computer noise model is used for the assessment and mitigation design. The New Zealand road surface noise corrections in the appendix should be used.

No corrections or 'calibration' based on site measurements should be performed. If appropriate, additional details should be added to the computer model, such as screening by boundary fences. Reasons for any residual discrepancies from measurements should be set out in the report.

Noise modelling for the design year (10 to 20 years after opening) should be based on an upper/high estimate of the future traffic volumes forecast by the transportation specialist. Expected diurnal variations in traffic volumes should be reviewed to confirm there will be a typical reduction in noise levels at night. If this is not the case, account should be taken of potential sleep disturbance effects occurring at lower average noise levels when evaluating mitigation options.

Mitigation design

The noise mitigation design process is discussed in detail in section 5. It is important that this process is well documented to enable the consent authority to verify that a thorough assessment by the appropriate specialists has occurred. Typically this would mean the assessment matrices and workshop discussion summaries are appended to the technical assessment report.

Evaluation of mitigation options should consider all road-traffic noise exposure in the project area, including existing exposure prior to the project.

Assessment of effects

All road projects requiring approvals under the Resource Management Act require an assessment of environmental effects. While closely related, this assessment is independent of the mitigation selection process and criteria from NZS 6806.

A clear assessment of the residual noise effects after mitigation is required. An evaluation of these impacts on indoor/outdoor amenity and health effects should be presented. While the NZS 6806 process should result in appropriate noise levels, this consideration may require additional actions to ensure amenity is preserved to an acceptable level.

Regardless of mitigation, noise effects associated with a new road are usually adverse and are often significant for residents experiencing a major change in their environment, even when the resulting noise levels comply with guideline criteria. The assessment should not attempt to combine positive and negative noise effects in different locations or balance adverse noise effects with potential transportation, economic, connectivity or safety benefits.

If a project causes material changes in traffic on the broader road network outside the project area, the positive and negative noise effects of such changes outside the project area should generally be assessed on a qualitative basis.

Reporting

Technical assessment reports should effectively present the factors that are considered in relation to the selection of the noise mitigation design. The influence of non-acoustical factors should be discussed (e.g. reduced perception of noise due to visual screening by trees).

The existing noise environment needs to be evaluated, although extensive ambient noise monitoring is generally not warranted as modelling can be used.

All PPFs need to be clearly identified on a set of plans. A table of predicted road-traffic noise levels should be included in the technical assessment report showing the existing (where road-traffic is over 50 dB $L_{Aeq(24h)}$), do-nothing, do-minimum and selected options for each PPF.

The assessment of effects should consider certain public spaces that are not PPFs, for example public reserves. In addition, effects on receivers outside the 100/200 m buffers may need to be qualitatively assessed.

Noise effects should be transparently presented in non-technical terms so they can be easily understood by RMA decision makers and the affected community. In particular, adverse noise effects associated with a changing environment should be clearly acknowledged, even when criteria for noise levels are achieved. Temporary noise effects should be described, such as may occur when a chipseal surface is used for the first year before an asphalt surface is laid.

Reports should include peer review statements.

Peer review

A tier 3 assessment should be peer reviewed unless the project is of a smaller scale, in which case documented quality assurance checks should be made by an internal reviewer.

Peer reviews should be conducted by a suitably qualified and experienced professional also meeting the requirements for independent peer reviews set out in Z19 Taumata Taiao – Environmental and Sustainability Standard.

4 Noise mitigation

Road-traffic noise

Road-traffic noise is the combination of all sources of noise from vehicles including:

- Propulsion noise is generated by the engine, exhaust, intake, and other power-train components.
- Tyre/road noise or road surface noise is generated as the tyre rolls along the road surface.
- Aerodynamic noise is caused by turbulence around a vehicle as it passes through the air.
- Mechanical noise such as truck 'body slap' is often induced when vehicles pass over uneven surfaces.
- Supplementary braking systems, such as engine brakes, can also be a source of noise, particularly on downhill sections of road.

Propulsion noise will normally dominate the total road-traffic noise at low speeds. As speed increases, a crossover speed is reached at which the tyre/road noise becomes an equal source of noise, then at higher speeds it becomes the dominant source.

Where vehicles brake and accelerate, such as when approaching intersections or at speed limit changes, there can be an increase in propulsion noise relative to other components. Likewise, if there are features on the road such as bridge joints, APTM, or transverse surface joints, a different nature of road/surface noise is generated, and mechanical noise can be induced in vehicles. This noise often has more prominent characteristics than other sources.

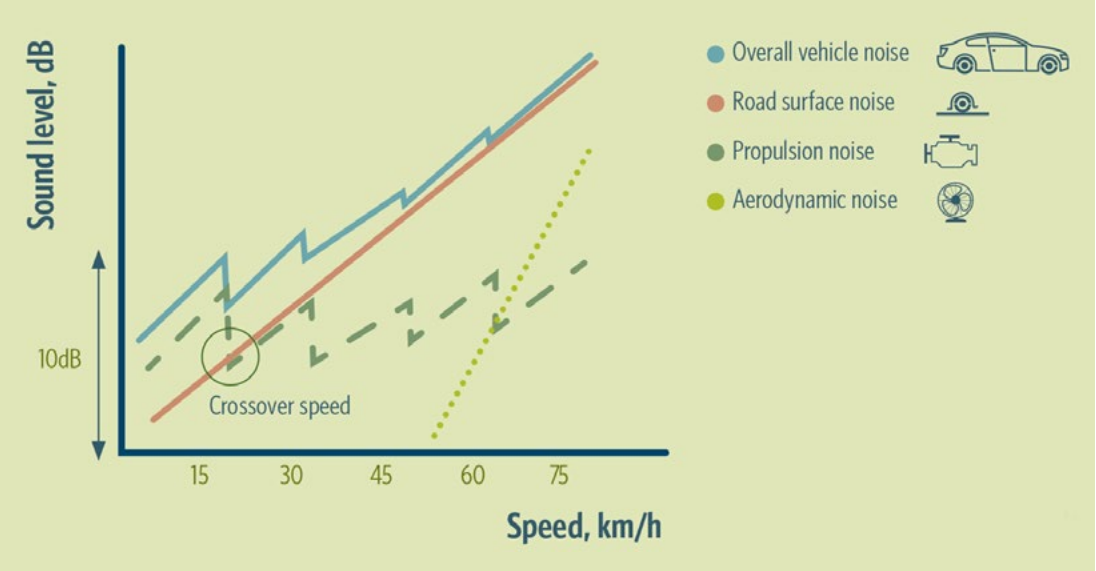
Different approaches to noise mitigation are required depending on the types of road-traffic noise in any particular location. Often multiple mitigation measures are needed in combination to address the mix of sources.

Low-noise road surfaces

As tyre/road noise is often dominant, reducing this component at source can be effective mitigation. Theoretically, both the tyres and road surface could be treated, but for road projects there is only scope to change the surface, and not the tyres of individual vehicles.

Consideration of low-noise road surfaces should be a central part of an options evaluation made in accordance with NZS 6806 (section 5). The quietest surfaces are generally asphalt mixes, which are more expensive than chipseals. When evaluating asphalt mix surfaces as noise mitigation options, in addition to noise level reductions at individual PPFs, consideration should be given to wider acoustic benefits. The main additional factor is that asphalt mix surfaces reduce the noise at source and therefore provide a benefit across the entire area and not just at specific PPFs. Also, asphalt mix surfaces can result in a noise character that most people find more acceptable than say chipseals, beyond just the benefit of the reduced level.

Figure 3: Road-traffic noise sources (Source: The little book of quieter pavements)



Noise barriers

A barrier can disrupt noise travelling between the road and neighbouring PPFs. Options and issues associated with noise barriers are set out in the *State highway noise barrier design guide*.

As a visually obvious form of mitigation, barriers are sometimes perceived as a necessity. However, they are often inefficient and ineffective, particularly in rural areas where long lengths of barrier may only provide small reductions in noise level at individual PPFs. In urban areas, barriers can be effective provided they are not overlooked by neighbouring PPFs and are not interrupted by driveways.

Noise barrier options should be assessed through the evaluation process in accordance with NZS 6806. The design of any noise barrier options should consider:

- whether a barrier option should be extended to a logical/rational end point beyond the project area (such as the next intersection) so that it also benefits adjacent PPFs, and
- how segments of barrier can be joined together to avoid gaps between them.

Concrete safety barriers can be effective noise barriers, particularly where roads are elevated. These usually range from 0.8 to 1.3 metres high depending on safety requirements. However, from a safety perspective, alternative safety barrier types are preferred instead of concrete barriers in many situations (alternative safety barrier types such as wire rope barriers do not provide noise reduction). Any sections of concrete safety barrier found to be required for noise mitigation through an options evaluation should be explicitly identified as such in the assessment report.

Visual screening

Trees do not materially reduce road-traffic noise, unless the planting is dense and deep (tens of metres). However, visual screening of road-traffic by trees can reduce the perception of noise. While not altering noise levels, this can help to mitigate road-traffic noise effects on people.

In addition to the quantitative assessment of noise levels and structural mitigation, opportunities should be considered for planting to visually screen road-traffic, particularly where there is a significant change in the noise environment due to a new road.

Building modification

NZS 6806 requires building modification mitigation (BMM) for PPFs with high noise exposure (category C) when structural mitigation such as low-noise surfaces and noise barriers are not practicable. This generally involves provision of mechanical ventilation so that windows of a PPF can be kept closed. In some cases glazing and other building elements also need to be upgraded. This is detailed in the *State highway guide to acoustic treatment of buildings*.

NZS 6806 includes a secondary threshold of 45 dB $L_{Aeq(24h)}$ below which BMM is not implemented to achieve the 40 dB $L_{Aeq(24h)}$ internal criterion. However, application of this threshold could result in unmitigated noise effects. Therefore, BMM should be offered for all category C PPFs as required to achieve 40 dB $L_{Aeq(24h)}$, regardless of the secondary threshold.

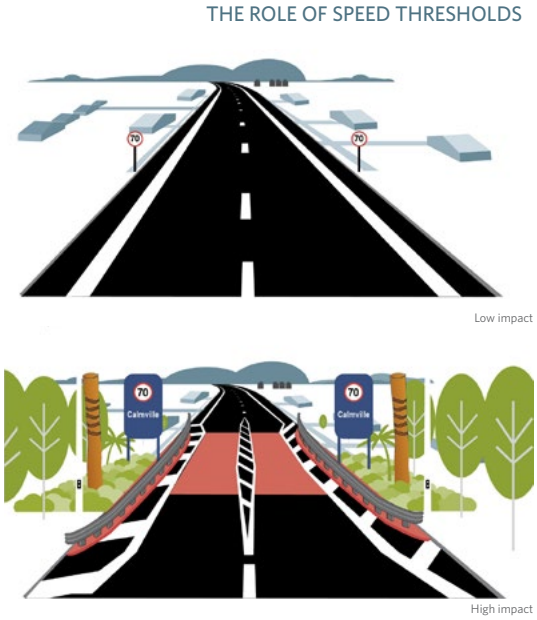
In addition to the minimum requirements of NZS 6806, provision of BMM should also be considered for PPFs with lesser noise exposure (category B), but that have experienced an increase in noise of 3 dB or more as a result of the project.

Acceleration and braking

Computer noise modelling and the NZS 6806 evaluation process primarily address average noise levels from free-flowing traffic. The noise level predictions are also valid for intersections where normal increases in vehicle acceleration and braking noise are generally offset by decreases in tyre-road noise. However, where intersections may regularly give rise to hard/aggressive braking and acceleration there may be additional adverse noise effects.

Where intersections or posted speed limit changes are proposed within 200 metres of a PPF, road environmental treatments should be considered to promote gradual acceleration and braking. A key aspect that should be considered is landscaping/ planting to clearly signal an upcoming change in the speed environment. An example of an untreated and treated speed threshold is shown in Figure 4. Additional methods that should be considered include signage, signals, road marking, lighting and road geometry. These treatments require input from the relevant specialists.

Figure 4: Landscape treatments signalling a change in speed environment (from Waka Kotahi Landscape guidelines)



Engine brakes

A small proportion of mainly older trucks use a supplementary braking system without appropriate silencers, giving rise to a distinctive and intrusive 'engine braking' noise. In addition to locations already discussed with respect to noise from acceleration and braking of general traffic, if PPFs are within 200 metres of a new or altered road with a downhill gradient exceeding 4%, consideration should be given to potential noise effects of truck engine braking. If the speed limit is below 70 km/h a bylaw could be made to prohibit engine braking. The adverse effects may require ongoing management through monitoring and enforcement with respect to individual trucks and their drivers.

Surface features

Computer noise modelling does not account for sound characteristics and disturbance arising from road surface features. Noise from vehicles frequently passing over ATPM or traversing vertical deflection devices such as speed cushions and raised safety platforms has the potential to be unduly disturbing.

If ribbed ATPM or vertical deflection devices are proposed within 200 metres of a PFF, practicable alternative safety and noise treatment options should be evaluated by the relevant specialists.

Locating service and drainage covers within traffic lanes should be avoided.

Transverse surface joints should be located to maximise their separation from PPFs.

Mechanical joints within 200 metres of a PPF should be acoustically treated.

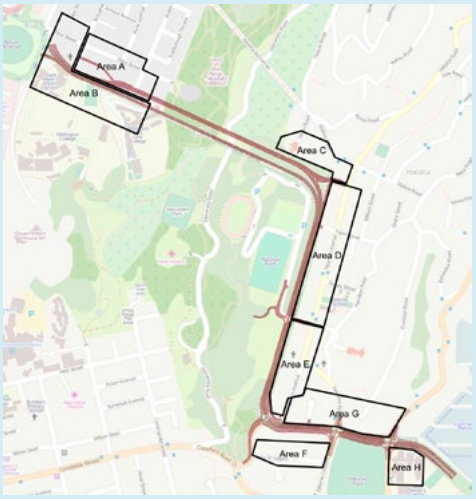
5 Options evaluation

The processes in NZS 6806 should be used to evaluate a number of mitigation options, dependent on the scale of the project. Key to the evaluation is the determination of the preferred noise mitigation taking into consideration noise levels and other inputs. In terms of noise levels, NZS 6806 gives categories (A, B and C) of noise criteria to assist in structuring the assessment. NZS 6806 refers to this process as determining the 'best practicable option'; however, this RMA term is best avoided as it is the consent authority's role to confirm what the best practicable option comprises.

In addition, the preferred mitigation design will change as the project is developed. There are two key stages of 'selected options' and 'detailed mitigation options' as described in section 7.

During statutory approvals, the selected options are essentially the Road Controlling Authority's recommendation for what constitutes the best practicable option, having considered all relevant factors.

1 The project should be split into discrete assessment areas. In urban environments, separate assessment areas should be used for each side of the road.



2 Detailed design of the mitigation is not required; however, general parameters such as height, extent and construction (eg noise bund vs noise wall) should be defined.

An A3 summary paper for each assessment area should be produced showing options for mitigation. Project examples are provided on the Waka Kotahi website. Any of the mitigation options developed could be used, but they will result in different proportions of PPFs in NZS 6806 categories A, B and C. Figure 3 shows an example of an A3 summary paper illustrating mitigation options.

Waterview Connection, Sector 1 North, Option 1

Waterview Connection, Sector 1 South, Option 1

Waterview Connection, Sector 1 North, Option 2

Waterview Connection, Sector 1 South, Option 2

KEY

Category A PPF | Category B PPF | Category C PPF | Barrier (with height in m)

Figure 5: Example of noise mitigation options summary paper

	Existing	Do-nothing	Do-minimum	Option 1	Option 2	Option 3	Option 4	Option 5
Category A	35	34	37	39	40	42	40	40
Category B	3	3	1	4	2	1	1	2
Category C	5	6	5	0	1	0	2	1
Total			43	43	43	43	43	43
Cost				$138,600	$181,800	$222,400	$192,000	$571,000
Benefit				$410,494	$371,834	$515,929	$335,166	$371,834
BCR				3.0	2.0	2.3	1.7	0.7
Structural				2.8 dB	2.5 dB	4.1 dB	2.4 dB	2.5 dB
NZS 6806 compliance				+	-	++	-	-
Structural mitigation				0	0	+	-	0
BCR				+ + +	+ + +	+ + +	+ + +	-

3 The project acoustics specialist should make or collate estimates of the cost of each noise mitigation option. If available, project-specific estimates from the project engineers / quantity surveyors should be used, but in most cases an approximation will be required based on indicative unit rates for noise mitigation. Allowance should be made for the substantial uncertainty associated with such cost estimates when evaluating options.

For each noise mitigation option, the acoustics specialist should also estimate the benefits arising from changes in noise exposure at PPFs. Benefits may be quantified in terms of the (non-monetised) health impacts predicted to be avoided by each option. Additionally or alternatively, benefits may be monetised using the method set out in NZS 6806, based on hedonic studies of property prices.

4 The project acoustics specialist should prepare an assessment matrix for each assessment area using the template on the Waka Kotahi website. The acoustics specialist should fill in the assessment for the acoustics criteria and then circulate the matrices with the options summary papers to the project team. For each option and assessment criterion the matrices should include both a rating and the reasoning. Although some of the inputs may be quantitative, the mitigation selection process in steps 6 to 9 is qualitative. The template allows the assessment criteria to be customised so that they are relevant to the specific project and location. As a minimum the criteria should cover the factors listed in section 6.3 of NZS 6806.

Assessor name	Discipline	Project		
An assessor	Visual and landscape	Example project		
Assessment area Assessment criteria	Issues / Risks	Option 1	Option 2	Option 3
The extent to which the mitigation option promotes integration and establishes visual coherence and continuity in form, scale and appearance of structures and landscape proposals along the route	· Visual clutter & lack of continuity of look, form & scale with crash barriers · Continuity with existing bunds e.g. ped/cycle link and HV roll over bund · Location of noise walls in proximity to road is a visual issue	- - Opportunity to replace 2m high noise wall with bund to tie in with cut face to south and batter slope to north Combine 2m high bund to north with existing ped/ cycle bund? Highlight HV roll over	o Maintains status quo with regard to safety barrier requirements Doesn't create an additional issues with regard to this criteria	- - 1.5m high noise wall that is ½ as long as Option 1 2m high noise wall only a minor improvement Opportunity to use bund in place of structural wall should be investigated
Road users' views to the surrounding landscape and key features/ locations in particular	· Views to the west (inland dune landscape and Kapiti Island) are key	o Proposed noise wall location doesn't affect any key views to the wider coastal dune landscape	o Proposed noise wall location doesn't affect any key views to the wider coastal dune landscape	o Proposed noise wall location doesn't affect any key views to the wider coastal dune landscape
Maintenance or enhancement of visual amenity for surrounding residents	· The height, location and material used for noise walls has a bearing on their visual prominence & resulting effects on both road users and residents · The form, scale and appearance of any barriers will need to be considered closely, as will their association with planting, to soften general appearance	- - A 2m high noise barrier located on the top of the fill slope will increase visual prominence from residential properties The proximity of the barrier to the road will have a direct bearing on the visual experience of road users	o Maintains status quo with regard to safety barrier requirements Doesn't create an additional issues with regard to this criteria	o 1.5m high noise wall that is ½ as long as Option 1 2m high noise wall only a minor improvement and will be barely discernable from vehicles or adjacent properties
Utilisation of materials that reflect the character of the location	· Large timber walls are inconsistent with materials/ structures in the existing landscape and road corridor in general · Large concrete walls could be faced using aggregate which reflects geology	- - The use of materials that reinforce the local vernacular are unlikely to mitigate the visual effects of a 2m high wall	o Maintains status quo with regard to safety barrier requirements Doesn't create an additional issues with regard to this criteria	- - The use of materials that reinforce the local vernacular are unlikely to mitigate the visual effects of a 1.5m high wall

5 All relevant project team members should complete the matrix. The key responses in addition to those from the acoustics specialists will often be from the safety, landscape/visual and urban design specialists.

It is important for all disciplines to complete the matrix, even if just to confirm neutral ratings. The network manager should contribute to the matrix to ensure operation and maintenance issues are adequately considered.

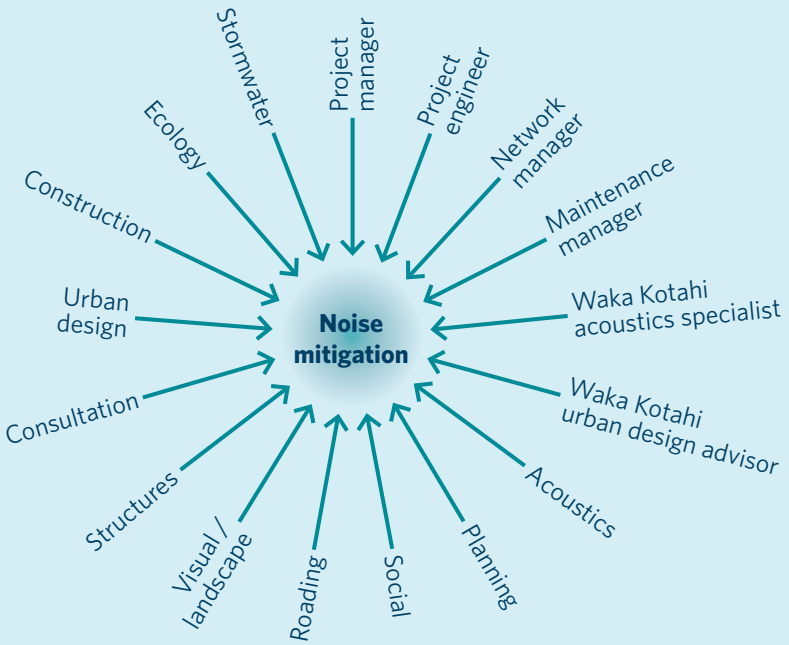
6 The responses to the matrices should be collated and reviewed by the project manager, planner and acoustics specialist. If the choice of noise mitigation options is clear-cut on the basis of the assessment matrices then these may be taken forwards as the selected options.

For simple projects it is envisaged that this will often be the case. For large, complex and high-risk projects it will usually be necessary to hold one or more noise mitigation workshops to review the matrices before determining the selected options.

7 If necessary, hold a noise mitigation workshop. Pre-circulate the completed assessment matrices to all attendees. Attendees may include:

- facilitator
- project staff
- consultant team: acoustics, planning, social, consultation, roading, structures, visual/landscape, urban design, construction, ecology, stormwater
- Waka Kotahi national office: acoustics, urban design (for state highway projects)
- network and maintenance managers (maintenance staff are critical contributors as the long-term performance of the mitigation depends on practicable maintenance)
- acoustics advisors from the council (observer only – as NZS 6806 is a process rather than performance based standard, it is beneficial for the regulatory authority's acoustics advisor to be able to witness the process so that they can verify it was correctly implemented).

Not all of these people will be needed for every noise mitigation workshop, and the appropriate attendees should be determined by the project manager.



8 Ideally the noise mitigation will be selected by consensus at the noise mitigation workshop. In many cases, minor variants to mitigation options will need to be remodelled following the workshop and reviewed by specific workshop participants.

If consensus cannot be achieved then a suitably qualified expert with a holistic view (such as a planner) is responsible for balancing the different considerations and selecting the preferred mitigation option.

Noise mitigation workshops

To give effect to the process detailed on the previous pages, a noise mitigation workshop needs to be well organised.

Prior to the workshop:

1. The acoustics specialist should complete the noise modelling and prepare a summary paper and draft assessment matrix for each area at least one month before the workshop.
2. All team members should complete their parts of the assessment matrices at least two weeks before the workshop. Prior briefing sessions should be arranged for any assessors unfamiliar with this process.
3. Complete assessment matrices with collated responses should be circulated at least one week before the workshop.

The workshop itself should be led by a facilitator/integrator with a holistic view, guided by the collated responses.

The selected options and rationale should be documented and circulated. Any subsequent alterations to the noise mitigation should be reviewed and confirmed by the relevant team members. The document describing the option selection process and outcome should be appended to the technical assessment report.

Stakeholder engagement

Stakeholder input is required in the noise mitigation assessment process, including from those people living adjacent to proposed barriers. Ideally, community opinions will be known when completing assessment matrices and prior to any noise mitigation workshop. Otherwise, the selected options should remain subject to confirmation, pending community consultation after the workshop.

It is important to note that significant design development will still occur after the consenting process has been completed. Therefore it is essential to establish the community desires and expectations, but not constrain engineering development.

Sensitivity analysis

Before confirming the selected options a sensitivity analysis of the noise modelling should be conducted. This should include consideration of potential changes in horizontal and vertical alignment of the road within the designation, and potential increases in future traffic volumes beyond the forecast. The roading engineer should advise on the scope for design changes in each area.

If changes in the noise model cause a change in the NZS 6806 categories of PPFs then enhanced mitigation should be considered.

Additional mitigation

Where practicable, all potential noise mitigation measures set out in section 4 should be considered in the options evaluation described above. However, in some cases potential noise effects and mitigation measures cannot be readily quantified and may require separate consideration (such as reductions in perceived noise from visual screening by planting). Therefore, once the preferred mitigation has been determined, the acoustics specialist should consider all residual noise effects and any other mitigation measures not able to be addressed through the evaluation process. Any additional measures found to be necessary should be included in the selected options.

6 Designation conditions

Figure 6 sets out the preferred structure and general content of designation conditions for noise mitigation. This structure and general content will provide certainty in the noise mitigation outcome to be provided, while allowing for mitigation details or alternatives to be developed (and approved if required) during normal detailed design processes.

It is not possible to prescribe a simplistic performance standard, such as a noise limit, to the NZS 6806 process or the results of the process. The noise mitigation design is determined by following the correct process and not by achieving an absolute limit.

Figure 6: Preferred structure and general content of noise mitigation designation conditions

Condition	Timeframe	Comments
Adopt selected options for noise mitigation from consenting phase.	Prior to construction	The form and extent of mitigation from the AEE design must be used as the starting point.
Adjust mitigation for updated alignment and earthworks design.	Prior to construction	Acoustics specialist will adjust the selected options as appropriate (eg barriers to stay on top of cuts).
Predict noise levels at PPFs at design year. Obtain approvals if noise categories or form of mitigation changes.	Prior to construction	If PPFs change from category A to B, a suitably qualified person (eg planner) must confirm that this change constitutes the best practicable option. If any PPFs change to category C, the council must confirm the change.
Prepare noise mitigation plan (NMP) detailing compliance with designation conditions and other contractual requirements.	Prior to construction	A template is available on the Waka Kotahi website.
Noise mitigation is to be constructed in accordance with NMP.	Prior to opening	
Perform post-construction review to confirm noise mitigation has been installed as designed.	Within 12 months of opening	A post-construction review report must be prepared and submitted to the council.
Maintain noise mitigation.	Ongoing	

7 Detailed mitigation options

Introduction

Project teams identify selected mitigation options (section 5), which are confirmed in the consenting phase. The selected options are then used as the starting point for the detailed mitigation options. Detailed mitigation options are developed through the fully detailed design, with all practical issues addressed. Detailed mitigation options identified can vary from the selected option and a process for determining the acceptability of changes, including with respect to designation conditions is necessary.

Project design development

While the overall layout of the construction design will remain broadly in accordance with the information presented in the Notices of Requirement, the vertical and horizontal alignments of traffic lanes will almost certainly move within the designation, as a result of design development and refinement.

Intersection forms are also likely to be developed, and it may be reversed which road passes over another or how they connect. This is particularly the case in design and construct tenders, where changes resulting in cost savings are encouraged.

Changes are also likely to noise barriers to accommodate stormwater design and other construction requirements.

Changes in form of mitigation

In some instances, the selected options may no longer be practicable to implement and an alternative may be developed. For example, where a noise bund was the selected option, but a noise wall is now required as the detailed mitigation option due to space constraints.

When evaluating the acceptability of alternate options, the reasons for selecting the original mitigation needs to be understood. For example, if an earth bund was selected in preference to a concrete or timber noise wall, this may have been because a noise wall would be out of character for the area and have unacceptable visual effects.

Where mitigation change is proposed, a suitably qualified expert (such as a planner) must reassess the selected option. This will require input from other specialists such as landscape/urban design. For this reason, the rationale behind the selected options must be clearly documented in the technical assessment report prepared during the previous stage, so it is available for reference.

Approvals

In addition to any designation condition requirements, the mitigation design must be certified by a qualified and experienced professional, with independent peer review for projects affecting more than 50 PPFs.

Waka Kotahi uses a national database (CSVue) which records all designation conditions and requires evidence to be submitted before each condition is marked as compliant.

Noise mitigation plan

The noise mitigation plan (NMP) is the design report prepared by the contractor that demonstrates compliance with designation conditions and other requirements.

The NMP is required to be prepared by an acoustics specialist and is required to address:

- Noise criteria.
- Noise modelling.
- Noise barriers.
- Low-noise road surfaces.
- Building modification.
- Road environment features for noise mitigation.
- Communication of noise effects.
- Post-construction review.

A NMP template is available on the Waka Kotahi website. The content of the NMP should be expanded to address any project specific requirements, such as may be required by designation conditions.

Appendix

Road surface corrections for noise modelling

Table A1 sets out corrections in decibels for New Zealand road surfaces that apply to noise predictions made using the CRTN algorithm[05]. Use of these corrections is mandatory when performing noise modelling of Waka Kotahi projects. These corrections and the manner in which they are applied replace all previously published New Zealand road surface corrections and methods of application.

Table A1 : Road surface noise corrections

Surface Category	Surface Type / Classification	Applies to	Surface Correction dB
Chipseal	Grade 2 or 3	Any chipseal that includes grade 2 or 3 chip, including single coat, two-coat, racked-in, etc. Any other unlisted surface type.	+6
	Grade 4	Single coat grade 4 chipseal. Two-coat grade 4/6 chipseal.	+5
	Grade 5 or 6	Single coat grade 5 or 6 chipseal.	+4
Asphalt (non-porous)	SMA14	SMA14 and any other unlisted SMA. Slurry seal.	+2
	SMA10	SMA7 and SMA10 Any AC and DG (ungrooved).	0
Porous Asphalt	PA	Any porous asphalt other than LN types. Includes PA & EPA, and HV & HS variants.	-1
	LN3	High-performance low-noise surface using an approved mix design and thickness controls.	-3
	LN5	High-performance low-noise surface using an approved mix design and thickness controls.	-5

Practitioners should note:

- The corrections apply directly to road segment noise levels predicted using the CRTN algorithm.
  - There is no longer a -2 dB "New Zealand calibration" as previously applied, although a separate -3 dB conversion from $L_{A10(18h)}$ to $L_{Aeq(24h)}$ is still required.
- The corrections apply to all traffic compositions and speeds.
  - Cars and trucks no longer have separate corrections and there is no longer a calculation to combine those based on traffic mix and speed.
- The new corrections include some allowance for surface variability.
  - On average, the new corrections are expected to contribute 1-2 dB in the direction of overprediction.

The studies to derive and verify these surface noise corrections are set out in research note *Road Surface Noise Corrections 2023*[06].

05 Calculation of Road Traffic Noise (1988) Department of Transport (United Kingdom), Welsh Office, HMSO

06 Waka Kotahi NZ Transport Agency (2023) Road surface noise corrections 2023. nzta.govt.nz

High-performance low-noise surfaces

High-performance low-noise surface classifications, LN3 and LN5, are defined generically to allow for flexibility in mix designs that provide equivalent noise performance.

If high-performance low-noise surfaces are considered as a noise mitigation option, they must be referenced only in terms of the generic classifications LN3 and LN5. Any designation conditions referencing high-performance low-noise surfaces should use these classifications and should not refer to specific mix designs. The noise performance is secured by reference to the classification.

Currently, there are only two mix designs that must be used to implement a LN3 or LN5 surface as set out in Table A2. The noise performance is critically dependent on the thickness of the surface, which is also specified in the table. All LN3 and LN5 surfaces must be subject to thickness measurement and quality controls as set out below Table A2.

Table A2: High-performance low-noise surface classifications

High-performance low-noise surface classification	Qualifying mix designs	Minimum thickness	Mandatory thickness measurements and quality controls
LN3	EPA7 (NZTA P11)[07] PA7 (NZTA P11)	40 mm	NZTA P11
LN5	EPA7 (NZTA P11)	50 mm	NZTA P11

07 Waka Kotahi NZ Transport Agency P11 – Specification for open graded porous asphalt. **nzta.govt.nz/resources/open-graded-porous-asphalt**

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If you have further queries, call our contact centre on 0800 699 000 or write to us:

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This publication is also available on our website at **www.nzta.govt.nz**

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