Transport Noise Management Code of Practice Volume 1 – Road Traffic Noise

November 2013

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Amendment Register

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2	-	Revised Edition	CE (E&T)	Oct 2013

Volume 1 – Road Traffic Noise

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1 Overview

1.1 Framework behind the Code of Practice

The Transportation Noise Management Code of Practice is structured into volumes. Initially there are two:

- Volume 1: Road Traffic Noise
- Volume 2: Construction Noise and Vibration.

All following references to the Code refer to Volume 1 only otherwise noted.

1.1.1 Aim of the Code of Practice

This Code of Practice (CoP) aims to demonstrate the compliance of the Queensland Department of Transport and Main Roads (the Department) with its General Environmental Duty as required by the *Environmental Protection Act (1994),* by assisting understanding of assessment and management of the impact of road traffic noise on the built environment. The Department's obligation to achieve good environmental management practices is reflected in key departmental policies and strategies, including:

- Roads Connecting Queenslanders
- Department of Transport and Main Roads Strategic Plan
- Environmental Management Policy and Strategy
- Roads Policy Manual
- Road System Manager.

1.1.2 Legislative framework

Where required by legislation, departmental road projects may be subject to external assessment processes. Legislation which has potential to affect the environmental assessment and approval processes for the Department from a road traffic noise perspective includes:

- *Transport Infrastructure Act 1994 (Qld)*
- *Australian Land Transport Development Act 1988 (Cwlth)*
- *Environmental Protection Act 1994 (Qld)*
- *Sustainable Planning Act 2009 (Qld)*
- *State Development and Public Works Organisation Act 1971 (Qld)*
- *Environmental Protection (Noise) Policy 2008 (Subordinate Legislation) (Qld)*
- *Professional Engineers Act 2002 (Qld).*

The *Transport Infrastructure Act (1994)* requires the construction, maintenance and operation of all government supported infrastructure to be carried out according to standards published by the Chief Executive. This CoP is one such standard and its implementation is a legislative requirement.

Transport infrastructure provides many benefits to the community, but its operation or use may have significant adverse environmental impacts. Consequently, the Act defines transport infrastructure as 'beneficial assets' necessary for the community's environmental, social and economic wellbeing.

It is intended any significantly adverse environmental impacts resulting from the construction, maintenance or use of transport infrastructure be progressively reduced where it is practicable to do so. This CoP helps in this process.

1.1.3 Purpose

The purpose of this CoP is to provide guidance and instruction for assessing and managing the impact of road traffic noise.

1.1.4 Specific objectives

Specific objectives of this CoP are to:

- establish consistent methodologies assessing the impact of road traffic noise
- establish road categories based on the type of road project/assessment
- establish criteria for road traffic noise for established road categories
- identify technical considerations in managing the impact of road traffic noise
- recommend good environmental management practices for reducing the impact of road traffic noise
- provide design guidelines including noise attenuation treatments into the road environment so that social, economic, visual, safety, community and environmental factors are not compromised
- provide guidance on prioritising road segments within the State-controlled road network for noise attenuation treatments.

1.1.5 Other relevant Departmental documents

This CoP is one of a series of manuals published by the Department. These manuals provide guidance on good environmental management practices for a wide range of issues associated with road infrastructure projects. Other manuals include the following:

- Environmental Processes
- Road Landscape
- Cultural Heritage
- Roads in the Wet Tropics
- Fauna Sensitive Road Design
- Environmental Legislation Register.

Some of the manuals should be used together with this CoP (particularly the *Environmental Processes Manual*, *Road Landscape Manual*, *Fauna Sensitive Road Design Manual* and *Environmental Legislation Register*).

1.1.6 Departmental management framework

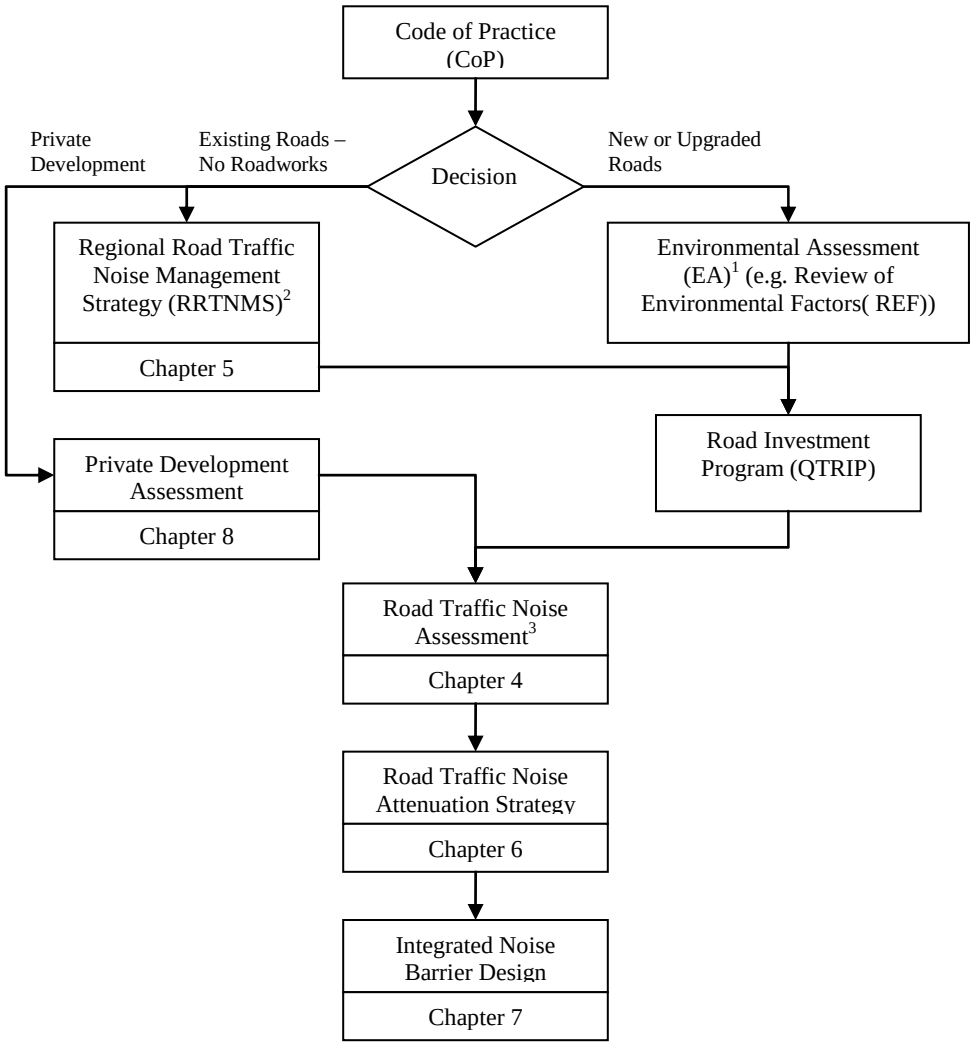
Community amenity may be improved through appropriate planning and management of new and existing State-controlled roads and land planning.

There are three approaches to managing the impact of road traffic noise:

- Regional Road Traffic Noise Management Strategy (RRTNMS) for existing roads – no roadworks
- Environmental Assessment for proposed new roads and upgrading existing roads
- Private Development Assessment.

The CoP provides guidelines for each of these approaches (refer to Figure 1.1.6).

Figure 1.1.6 - Approach to managing the impact of road traffic noise



Notes:

1. As detailed in the departmental Environmental Processes Manual. The report initially scopes relevant environmental issues for a project.
2. Element Management for Road Traffic Noise is primarily supported by RRTNMS.
3. Road Traffic Noise Assessment is carried out if road traffic noise is identified as an issue in a project's environmental assessment or a RRTNMS.

1.2 Structure of the CoP

The management of road traffic noise impact is outlined in this CoP within the following chapters.

Chapter 2 Description of road traffic noise defines road traffic noise and describes it in different ways. It details the factors contributing to the generation and propagation of road traffic noise. It highlights important factors referenced in this CoP and other related policies (for example, *Environmental Protection (Noise) Policy 2008*).

Chapter 3 Categories and criteria provides guidance on the categories and criteria for road traffic noise management. This is part of the Department's progressive achievement of the objectives of relevant environmental protection legislation. Chapter 3 focuses on noise from:

- New roads, busways and light rail
- Upgrading existing roads, busways and light rail
- Existing roads, busways and light rail with no roadworks.

Chapter 4 Road traffic noise assessment outlines the type and specific requirements of a road traffic noise assessment. Chapter 4 specifies:

- the assessment process, to ensure compliance with the noise criteria
- methods and treatments for road traffic noise attenuation
- road traffic noise assessment requirements.

Chapters 3 and 4 are written primarily for:

- departmental regional officers
- project managers
- road planners
- road designers
- acoustical consultants
- land developers.

Chapter 5 Road traffic noise management strategy provides guiding principles for the development of regional strategic road traffic noise management plans. Chapter 5 is written primarily for departmental purposes.

Chapter 6 Road traffic noise attenuation strategy outlines the preferred noise attenuation strategies applying to departmental projects and private developments, with detailed information on noise barriers and exceptional circumstance treatments. Chapter 6 is written for both departmental regional officers and land developers.

Chapter 7 Integrated noise barrier design provides guiding principles for:

- noise barrier locations and effectiveness
- safety requirements
- maintenance requirements
- public amenity
- fauna movements
- horizontal and vertical alignment

- visual amenity considerations
- community engagement
- detailed design issues
- drainage requirements.

These principles should be considered as part of a road traffic noise assessment.

Chapter 7 is written primarily for:

- road designers
- landscape architects
- land developers.

Chapter 8 Proposed noise sensitive development provides information to assist applicants in preparing development proposals. It provides guidance on how to assess road traffic noise impacts and propose road traffic noise attenuation strategies for developments near State-controlled roads. Chapter 8 is written primarily for land developers.

Chapter 9 Managing noise complaints provides guidance for managing public expectations regarding road traffic noise impacts and noise complaints. Reference is made to the Queensland Ombudsman's recommendations about road traffic noise on the concrete pavement sections of the Pacific Motorway. Chapter 9 is written primarily for departmental purposes.

Glossary provides definitions of important technical terms and abbreviations.

Appendices provide further information on road traffic noise issues including:

- agreements and forms
- letters
- template reports
- brochures
- technical references and notes.

Word versions of the Appendices including template forms and letters are available on the department's *Transport noise management: code of practice* webpage.

2 Description of road traffic noise

2.1 Definition of noise

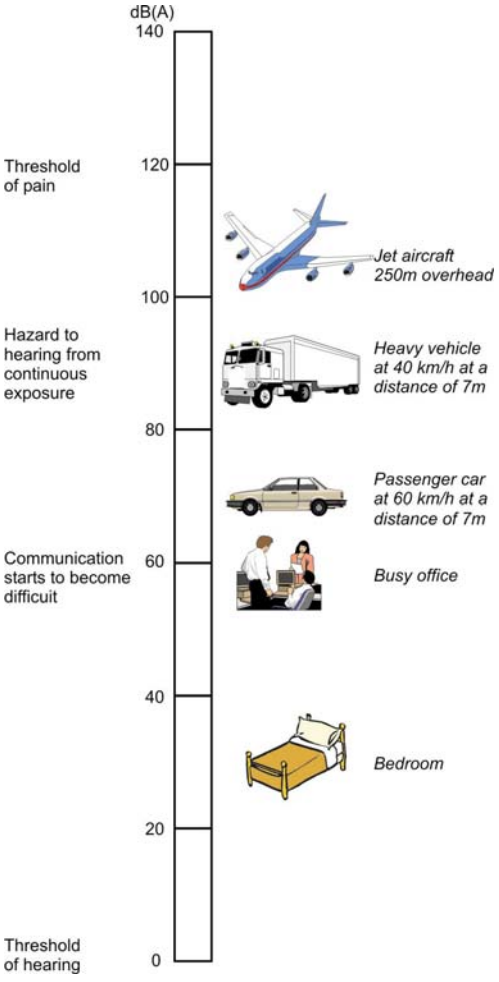
Noise is defined as unwanted sound transmitted through air or another medium. Sound is defined as any pressure variation (in air, water or some other medium) that human ears can detect. Noise is complex and it is difficult to determine its impact. Human response to noise, as with any human response to environmental factors, is highly variable. For this reason, it is difficult to predict the response of any individual. A person's perception of noise is subjective not objective. Quite legitimately, a person's perception can be psychologically affected. At high noise exposures, there may be individuals who are not annoyed. Alternatively, at low noise exposures, there may be some individuals who are highly annoyed.

It is intended that the criterion levels contained within this CoP provide a compromise between the ranges of sensitivities to road traffic noise. In addition, this CoP also takes into account:

- the cost implication for the Department
- technical feasibility of achieving the criterion levels
- the reasoning behind a decision.

To ensure measured levels approximate human response, a weighting scale known as the 'A' scale is used. The 'A' weighting scale interprets sounds in a similar manner to human ears.

Figure 2.1 - The level of common sounds on the dB(A) scale



All reference to the noise levels in this CoP is in dB(A). Some examples of typical sound levels in 'A' weighted decibels (dB(A)) are shown in Figure 2.1. They are an indication of the short term measured levels in the environments indicated. These levels do not relate to the L_{A10} (18 h) descriptor. The time scale for transport noise criteria reflects the period being considered (e.g. 1 hour, 18 hours) and cannot be related to shorter term measurements.

2.2 Factors influencing road traffic noise generation and propagation

Sound generation is the creation of sound energy from a source. Road traffic noise is the aggregation of the noise from individual vehicles in the traffic stream. It is considered to be from a line source if the density of the traffic is high enough as distinct from a point source (e.g. a noisy machine observed from a distance).

There are seven principal factors upon which the generation of road traffic noise depends:

- traffic volume (usually described as Annual Average Daily Traffic (AADT) or Average Daily Traffic (ADT))
- average traffic speed (usually represented by the posted speed limit)
- traffic composition (the percentage of heavy vehicles)
- road gradient (the longitudinal slope of the road)
- road pavement surface type and texture
- driving conditions (free-flowing)
- individual vehicle noise.

Individual vehicle noise is a combination of noise produced by the:

- engine
- exhaust
- transmission
- braking system
- interaction of tyres and road pavement surface
- body, tray and load rattles
- movement of air around the vehicle.

Sound propagation is a process whereby sound energy is transferred. There are many factors influencing the propagation of road traffic noise:

- road corridor cross-section (whether the road layout is at grade, depressed or elevated)
- distance between the source and reception point
- type of intervening ground cover between source and reception point (e.g. grass, water or concrete)
- natural or artificial obstructions
- meteorological conditions.

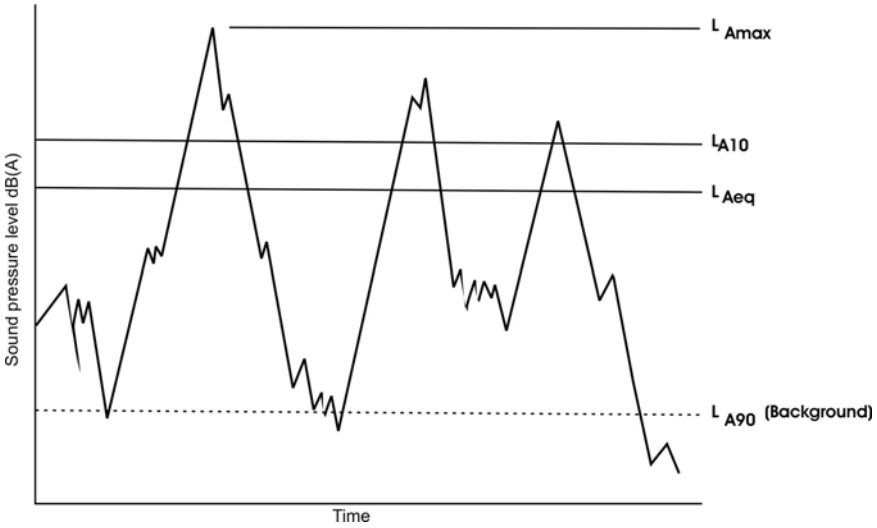
2.3 Environmental noise indices and noise descriptors for road traffic noise

Four environmental noise indices have been traditionally used for assessing road traffic noise:

- L_{A10} level. This is the level of noise exceeded for 10% of any period. The typical period is 60 minutes. The hourly L_{A10} (1h) level is therefore the road traffic noise level exceeded for 6 minutes in every hour. The L_{A10} (18h) level is the arithmetic average of 18 hourly L_{A10} (1h) levels over consecutive hours between 6 am and 12 midnight. Similarly, the L_{A10} (12h) level is the arithmetic average of the L_{A10} levels over consecutive hours between 6 am and 6 pm.
- L_{Aeq} level. This is the equivalent energy level. It is the constant level that, over a period of time, contains the same amount of sound energy as the varying levels of the road traffic noise.
- L_{A90} level. This is the noise level exceeded for 90% of a period. The level is normally regarded as being representative of the background noise level.
- L_{Amax} level. This is the maximum level generated from a single noise event.

In this CoP, the principal noise descriptor used is the L_{A10} (18h) and L_{A10} (1h) levels. Traditionally, these descriptors have been considered to best represent typical road traffic noise exposure. These descriptors are also easy and reliable to predict through the use of the United Kingdom, Department of Transport (1988) procedure, Calculation of Road Traffic Noise (CoRTN 88). Figure 2.3 illustrates the relationship between the indices that describe noise.

Figure 2.3 - Relationship between noise indices



2.4 Facts about road traffic noise

The following facts are generally true for road traffic noise:

- A 3 dB(A) change in noise level is equivalent to halving or doubling the traffic volumes.
- A 10 dB(A) change in noise level is equivalent to halving or doubling the subjective or perceived loudness or a tenfold increase or decrease in traffic volume.
- A 10 km/h increase in speed will increase the noise level by approximately 1 dB(A).
- A 3.5% compound annual growth rate in traffic will increase the noise level by approximately 1.5 dB(A) over a 10 year horizon.

- An 8% compound annual growth rate in traffic will increase the noise level by approximately 3.0 dB(A) over a 10 year horizon.

While the information presented in Table 2.4 is not precisely verifiable for road traffic noise, it is useful in understanding the significance of change in environmental noise exposure.

Table 2.4 - Significance of environmental noise exposure changes

Increase over existing noise level dB(A)	Change in subjective loudness	Significance of change
<3	Nil	Insignificant
3-5	Noticeable	Marginal
10	About Double	Significant
15 or more	At Least Triple	Very Significant

A change in noise level of 1 to 2 dB(A) is difficult for most people to detect. A 3 to 5 dB(A) change corresponds to a small but noticeable change in loudness when noise samples are presented without a significant time break between them.

2.5 Limitations of the adopted noise descriptor

There is some evidence to show that there is a correlation between the L_{A10} (18h) noise descriptor and community annoyance.

The L_{A10} (18h) noise descriptor does not adequately assess the impact of road traffic noise due to isolated noisy events (e.g. heavy vehicles). Night time annoyance and sleep disturbance are related to the number and magnitude of isolated noisy events. The Department is unable to provide strategies to reduce these events. Providing noise attenuation treatments (other than at the source) is not technically feasible, reasonable or cost effective. The noise cannot be reduced to an acceptable level, as these events are usually due to driver behaviour and vehicle maintenance. Very high noise barriers would be required, and the resulting visual pollution is generally unacceptable. Consequently, the Department does not use L_{Amax} or L_{eq} (1h) in defining noise criteria for roads in Chapter 3.

The Department provides input to the management of road traffic noise impact as per this CoP. Regions should manage complaints from the general public regarding individual noisy vehicles according to Chapter 9.

3 Categories and criteria

3.1 Introduction

This Chapter specifies road traffic noise criteria of the Department of Transport and Main Roads (the Department). It applies to existing noise sensitive land uses only. Criteria for new noise sensitive development near State-controlled roads can be found in Chapter 8.

When considering noise attenuation treatments for road projects, the actual measured, calculated and/or predicted levels shall be assessed against the criteria specified in this Chapter. The assessment process shall follow Chapter 4.

Criteria can be advisory, flexible or fixed as defined in Table 3.1 which compares the advantages and disadvantages of these three approaches.

Table 3.1 - Comparison of approaches to setting criteria

Approach	Comment	Disadvantages	Advantages
Advisory	Exceeding the criteria is tolerated on a case-by-case basis whenever compliance is undesirable, impractical, not feasible or not cost effective	• relatively ineffective • low level of control by relevant authorities.	• no need to check compliance, as exceeding the criteria is tolerated • low impact on infrastructure budgets when policy implemented • low management costs, as exceeding the criteria is tolerated.
Flexible	Criteria are set relatively low, but can be adjusted upwards on a case-by case basis if compliance with base criteria is undesirable or impractical.	• relatively complex to implement and manage policy.	• ensures that noise control must be considered in all situations involving significant noise impact • allows costs to be managed • allows negative impacts of noise control measures to be managed.
Fixed	Criteria must be complied with wherever possible.	• pressure to set high criteria • may lead to high costs • may lead to excessively high noise barriers with associated negative visual and overshadowing impacts	• relatively simple to monitor compliance • maintains consistency of standards • establishes criteria up front in order to manage expectations.

The Department uses fixed criteria when considering implementing noise attenuation treatments. It acknowledges that it may not always be possible to achieve the criteria in all circumstances.

The criteria represent a compromise between the need to improve acoustic amenity, visual amenity and the technical/cost constraints in providing treatments for noise attenuation. The Department generally considers noise attenuation treatments within transport corridors and these include noise barriers and using quiet road surface pavements. The Department may also consider Exceptional Circumstances Treatments (ECT) outside transport corridors if:

- the noise level exceeds the criterion level, and
- the receptors do not have direct access to the state controlled roads, and
- a noise barrier is not technically feasible, reasonable and cost-effective.

The Department will determine work schedules for installing noise attenuation treatments depending on budget, total roadwork programs and other considerations. The Regional Road Traffic Noise Management Strategy (RRTNMS) is also an important reference document in this process specifically for the 'Existing Road - No Roadworks' category. Chapter 5 outlines the methodology behind a RRTNMS.

3.2 Categories and criteria

The categories and criteria are summarised in Table 3.2 (a) and Table 3.2 (b). The categories and criteria cover the transport modes of roads, busway / light rail and multi-modal corridors. The categories are defined in the Glossary and are primarily based on:

- New Road – Access Controlled
- Upgrading Existing Road
- Existing Road – No Roadworks
- Exposure of Second Row of Buildings.

The same categorisation method applies to a busway / light rail:

- New Busway / Light Rail – Access Controlled
- Upgrading Existing Busway / Light Rail
- Existing Busway / Light Rail – No Roadworks
- Exposure of Second Row of Buildings.

If a busway or light rail runs side by side with a State-controlled road, the transport corridor is identified as a Type 1 Multi-modal Corridor.

Noise criteria are defined for the following noise sensitive land uses:

- Existing Residences
- Educational, Community and Health Buildings
- Outdoor Educational and Passive Recreational Areas (including Parks).

A complete list of noise sensitive land uses can be found from the definition of Noise Sensitive in the Glossary.

If the noise criterion levels are predicted to be exceeded, the Department will consider noise attenuation treatments within the road corridor with the aim to reduce the noise levels to the criteria or below.

Table 3.2 (a) - Categories and criteria for roads (including Type 1 Multi-modal Corridor)

<table>
<tr><th rowspan="2">Categories</th><th colspan="3">Criteria</th></tr>
<tr><th>Existing Residences (façade corrected)</th><th>Educational, Community and Health Buildings (façade corrected)</th><th>Outdoor Educational and Passive Recreational Areas (including Parks) (free field)</th></tr>
<tr><td>New Road – Access Controlled</td><td>63 L_{A10} (18h), existing level > 55 L_{A10} (18h)
60 L_{A10} (18h), existing level ≤55 L_{A10} (18h)</td><td>58 L_{A10} (1h)</td><td rowspan="2">63 L_{A10} (12h)</td></tr>
<tr><td>Upgrading Existing Road</td><td rowspan="2">68 L_{A10} (18h)</td><td rowspan="2">65 L_{A10} (1h)</td></tr>
<tr><td>Existing Road – No Roadworks</td><td rowspan="2">N/A</td></tr>
<tr><td>Exposure of Second Row of Buildings</td><td>65 L_{A10} (18h)</td><td>60 L_{A10} (1h)</td></tr>
</table>

Table 3.2 (b) - Categories and criteria for busway / light rail

<table>
<tr><th rowspan="2">Categories</th><th colspan="3">Criteria</th></tr>
<tr><th>Existing Residences (façade corrected)</th><th>Educational, Community and Health Buildings (façade corrected)</th><th>Outdoor Educational and Passive Recreational Areas (including Parks) (free field)</th></tr>
<tr><td>New Busway / Light Rail</td><td>55 L_{Aeq} (1h) day&evening
50 L_{Aeq} (1h) night
64 L_{Amax} night</td><td>55 L_{Aeq} (1h) operation hours
64 L_{Amax} night</td><td rowspan="2">57 L_{Aeq} (1h) day
66 L_{Amax} day</td></tr>
<tr><td>Upgrading Existing Busway / Light Rail</td><td rowspan="2">60 L_{Aeq} (1h) day&evening
55 L_{Aeq} (1h) night
64 to 69 L_{Amax} night
69 L_{Amax} night</td><td rowspan="2">60 L_{Aeq} (1h) operation hours
69 L_{Amax} night</td></tr>
<tr><td>Upgrading Existing Busway / Light Rail – No Roadworks</td><td rowspan="2">N/A</td></tr>
<tr><td>Exposure of Second Row of Buildings</td><td>57 L_{Aeq} (1h) day&evening
52 L_{Aeq} (1h) night
66 L_{Amax} night</td><td>57 L_{Aeq} (1h) operation hours
66 L_{Amax} night</td></tr>
</table>

Notes for Categories and Criteria:

1. The criterion levels are defined in units of dB(A). They represent noise levels for a 10 year prediction horizon following completion date of construction / upgrading / assessment where applicable.

2. The criteria levels are façade corrected for building facades, and free field for outdoor open areas.

3. The noise measurement / calculation / prediction height shall be 1.5 m above Finished Floor Level (FFL) or mid window height, whichever is the higher, for each storey of the building (1.0 m in front of most exposed façade). Otherwise, the receptor heights shall be assumed at 1.8 m and 4.6 m above the building platform level for the ground and first floors respectively. A height of 0.5 m below the eaves height is also acceptable. For free fields, the noise measurement / calculation / prediction height shall be 1.5 m above the ground level.

4. The time periods of noise descriptors are defined in Table 3.2 (c).

Table 3.2 (c) - Time periods of noise descriptors

<table>
<tr><th rowspan="2">Periods</th><th colspan="3">L_{A10}</th><th colspan="2">L_{A90}</th><th>L_{Aeq}</th><th rowspan="2">L_{Amax}</th></tr>
<tr><th>18h</th><th>12h</th><th>1h</th><th>18h</th><th>8h</th><th>1h</th></tr>
<tr><td>Day</td><td rowspan="2">6am – 10pm</td><td>6am – 6pm</td><td rowspan="3">Operation hours</td><td rowspan="2">6am – 12pm</td><td></td><td rowspan="3">Operation hours</td><td rowspan="3">Passby</td></tr>
<tr><td>Evening</td><td></td><td></td></tr>
<tr><td>Night</td><td></td><td></td><td></td><td>10pm – 6am</td></tr>
</table>

Determination of criteria for New Road (including New Busway / Light Rail) takes account of existing pre-construction noise levels. They apply to new access controlled roads in:

- proposed or existing unused corridors near existing residences
- proposed corridors where formal approval for nearby land development by a local government or other statutory authority is current at the date of compulsory land acquisition by the Department. This applies even if the development does not yet exist.

The criteria for New Road (including New Busway / Light Rail) are lower than those for an existing road for the following reasons:

- a new road creates a new road traffic noise impact on nearby existing or approved proposed development
- existing development near an existing road is already exposed to road traffic noise impact.

For Existing Roads – No Roadworks, priority may be given to treatment in cases where there is a:

- sudden increase in traffic volumes (at least double), or
- high percentage of heavy vehicles (greater than 20%), particularly at night.

The criteria for Exposure of Second Row of Buildings apply where the first row of buildings is removed as part of an upgrade of roads, resulting the second row having direct exposure to transport noise.

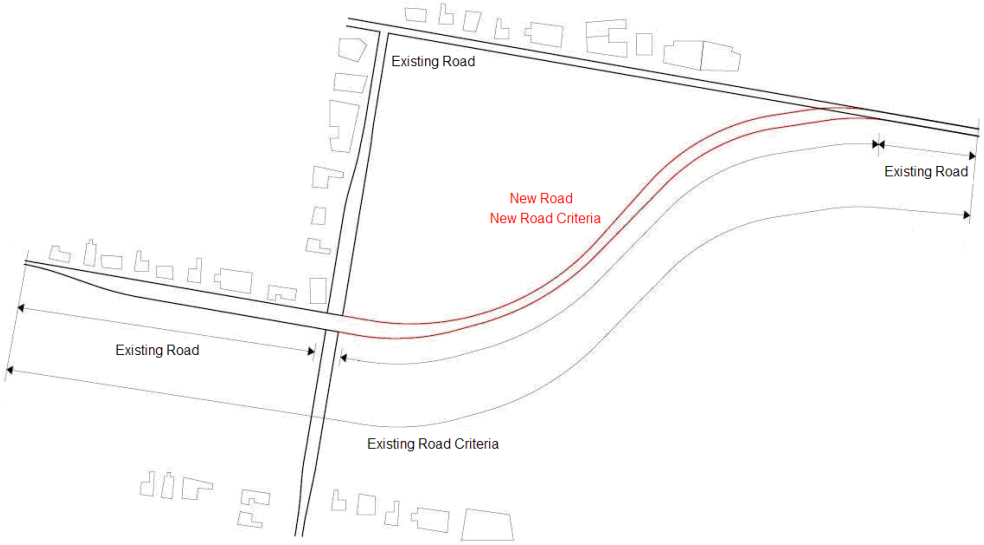
For Type 1 Multi-modal Corridors, road traffic will always be the dominant noise source. The relevant criteria are in accordance with those for roads. For acoustical assessment:

- the percentage of commercial vehicles shall include the number of commercial road vehicles and the number of bus / light rail movements
- L_{A10} (1h) and L_{Amax} shall be assessed.

Situations can arise where the alignment of proposed roadworks means using both existing and new road criteria. Determining appropriate criteria is performed by reviewing the definitions of New Road and Existing Road – No Roadworks in the Glossary. Acoustical assessment shall consider:

- For noise sensitive land uses adjacent to the new road section, determine the impact from only the new road section using the New Road criteria, and
- For noise sensitive land uses in the whole affected area, determine the impact from the whole project length including the new road section using the Existing Road – No Roadworks criteria (refer to Figure 3.2 for an example).

Figure 3.2 - Application of both new road and existing road criteria



3.3 Criteria for Exceptional Circumstances Treatments

In exceptional circumstances, the Department may consider noise attenuation treatments outside the transport corridor for individual noise sensitive buildings. This is at the discretion of the Regional Director. The criteria for Exceptional Circumstances Treatments (ECT) are defined in Table 3.3 and apply to each category of road / busway / light rail defined in this Chapter.

Table 3.3 - Criteria for Exceptional Circumstances Treatments

Predicted Level (Rounded)	Treatments
Do not exceed criterion level	• no treatment required.
Exceed criterion level by less than 3 dB(A)	• mechanical ventilation • windows can remain closed or partly closed to reduce noise entering habitable rooms.
Exceed criterion level by 3 dB(A) to 9 dB(A)	• air-conditioning and mechanical ventilation • windows can remain closed to reduce noise entering habitable rooms.
Exceed criterion level by 10 dB(A) or greater	• air-conditioning, mechanical ventilation and any necessary architectural upgrade treatments • windows can remain closed to reduce noise entering habitable rooms. • to ensure internal noise level is at least 10 dB(A) below the external noise criterion level.

Note: Predicted levels are rounded to the nearest integer, e.g. 68.4 is rounded to 68 and 68.5 is rounded to 69.

The range of possible building treatments is determined by considering:

- predicted noise levels outside the façade(s) of habitable room(s) (including those for educational, community and health buildings) within a 10 year horizon

- sustainable development principles such as equity, energy efficiency and economics.

The applicability and limitations of ECT are detailed in Chapter 6.

3.4 Rationale for outdoor educational and passive recreational areas

The criteria for outdoor educational and passive recreational areas (including parks) apply to the following two categories:

- New Road / Busway / Light Rail
- Upgrading Existing Road / Busway / Light Rail

For areas greater than 2000 square metres, the criterion level is to be achieved for a minimum 2000 square metres. For areas less than 2000 square metres, the criterion level shall be achieved in the whole area. The noise measurement / calculation / prediction height for outdoor areas shall be 1.5 m above ground level in the free field.

All available relevant information about the provision and future use of the outdoor educational or passive recreational areas should be considered. All cases shall be determined on a case-by-case basis.

For example, in large areas of open spaces, only a small percentage may be affected by the impact of transport noise. There is often scope to locate activities away from the influence of transport noise without the requirement of noise barriers. This may be of benefit from a security perspective and also break the visual monotony for the road user of long sections of continuous noise barriers within the road corridor. The Department recognises that, in some situations, it will be desirable to provide some protection for these areas. This should be resolved by consultation with local government and community groups.

3.5 Applicability of criteria

The Department acknowledges its obligations regarding the General Environmental Duty from a road traffic noise perspective. However the ability or need to control road traffic noise may sometimes be limited, including:

Technical constraints

- Noise attenuation treatments using noise barriers are only possible for access controlled roads. Noise barriers will not be provided for any non-access State-controlled road situations.
- Noise attenuation using quiet road surface treatments is generally only effective for roads with speed limits at least 60 km/h.
- Noise attenuation treatments outside the road corridor are not preferred unless in cases of exceptional circumstances or compulsory land acquisition (resumption). In cases of compulsory land acquisition, each noise sensitive site needs to be considered on an individual basis. Treatments for noise attenuation may form part of the compensation package (any compensation of this nature would then be according to the *Acquisition of Land Act 1967*).

Funding limitations

Noise attenuation treatments are subject to the funding levels of Regions and their works programs. The Department cannot commit to any noise attenuation strategy that it cannot deliver. It must comply with the contents of this CoP.

Reasonableness

Reasonableness implies common sense and good judgement to arrive at a decision. When identifying and implementing noise attenuation treatments, reasonableness can be assessed based on:

- absolute noise level
- change in noise level
- cost effectiveness of attenuation treatments
- noise attenuation benefits
- life cycle of attenuation treatments
- environmental impacts of noise attenuation treatments
- opinions of affected residents (community engagement)
- input from local and public agencies
- social, economic, environmental, legal and technical factors
- scenic/visual amenity impacts
- streetscape and built environmental issues.

10 Year Horizon

The Department generally only considers the impact of road traffic noise upon an 'existing development'. A new noise sensitive development under the IDAS framework becomes an 'existing development' 10 years after the final sign off by the assessment manager following the development's completion.

Any complaint regarding road traffic noise from anyone who lives in or owns a noise sensitive dwelling for less than 10 years will not be considered by the Department unless road traffic noise level has increased by at least 3 dB(A) since they purchased or moved into the dwelling (a 3 dB(A) increase generally equates to the traffic doubling in volume).

In some cases where a road traffic noise impact assessment is required, e.g. building a new road near existing residences, a private development may have been constructed beside the proposed new road within 10 years prior to the assessment. The Department will consider the impact on this development if the impact had not previously been assessed under planning legislation (e.g. IDAS).

It is assumed that appropriate noise attenuation strategies would have been put in place as part of the development/building application process for the following scenarios:

- a condition of development for a residential subdivision required a registrable covenant on the land title. The outcome of this condition was that a building envelope of a floor of a detached dwelling be designed according to AS 3671 (1989) to achieve the indoor noise criteria stated in AS 2107 (2000). In addition, ventilation requirements of the Building Code of Australia /comfort requirements (e.g. air conditioning) would have had to be achieved.

- a condition of development for an attached housing development (duplex, town house, unit), educational, community or health building required a building envelope of a floor to be designed according to AS 3671 (1989), to achieve the indoor noise criteria stated in AS 2107 (2000). In addition, ventilation requirements of the Building Code of Australia / comfort requirements (e.g. air conditioning) would have had to be achieved.
- the requirements of the *Queensland Development Code MP4.4* were applied to Class 1 to 4 buildings as part of the building application.

The Department will not consider the impact of road traffic noise for the internal building areas on these developments where these conditions or requirements have been imposed, even if they were not fully implemented.

4 Road traffic noise assessment

4.1 Introduction

To ensure a consistent and comprehensive approach when addressing road traffic noise, the following should read this Chapter:

- project managers
- road designers
- land developers
- acoustical consultants.

4.1.1 Aim of road traffic noise assessment

The aims of a road traffic noise assessment are twofold:

- to determine the nature and extent of any road traffic noise impacts
- to propose appropriate road traffic noise attenuation treatments, including guidance on the integration of noise attenuation treatments into the road environment.

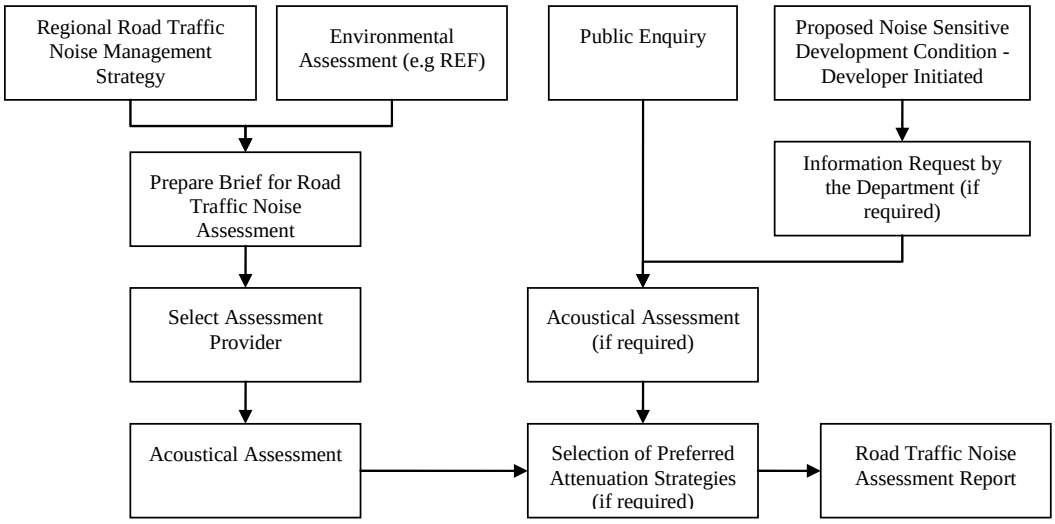
4.1.2 Assessment triggers

A road traffic noise assessment can be triggered in the following situations:

- recommendations from either the undertaking of a project's environmental assessment for a new or upgraded road proposal
- results from Regional Road Traffic Noise Management Strategy (RRTNMS)
- response to public enquiry from an affected property owner
- requirements of proposed developments.

Figure 4.1.2 outlines the processes for assessing road traffic noise impacts.

Figure 4.1.2 - Road traffic noise assessment process



Note: The brief for a Road Traffic Noise Assessment shall state that the assessment shall be conducted in accordance with this CoP.

4.2 Data requirements

Assessment area

The assessment is conducted over an area of noise sensitive receptors near the subject road segment.

This area must be carefully specified, but doing so can often become complex. In a new road proposal, for example, the assessment area might be constrained to the road corridor plus, say, two or three rows of houses either side of the corridor. When considering potential future community complaints, often a wider area may be required to determine the existing noise climate. If the new road may alter traffic patterns on nearby existing roads, it might be appropriate to extend the assessment area to include residences on or around these existing roads.

Consideration must also be given to:

- other relevant conditions (e.g. terrain)
- other noise sources that might interact with the road traffic noise being assessed.

All potentially affected or benefited noise sensitive receptor locations within the assessment area must be identified. It may be unnecessary to conduct noise measurements, calculations or predictions at every receptor location. The principal requirement is to ensure the noise exposure of all receptors is determined fairly, accurately and representatively.

Road and traffic data

For each receptor location, all the relevant road and traffic data must be acquired for:

- the road under investigation
- any other nearby roads that may contribute to the total noise level exposure at the receptor location.

Data may be obtained by direct measurements and observations or from the relevant Authority. The relevant Region should be contacted to confirm available data before requesting additional survey/measurement.

The required data includes:

- traffic volumes (hourly and daily)
- traffic compositions (usually expressed as the percentage of heavy vehicles in the traffic)
- controlled traffic speeds due to roadworks if applicable
- sign posted speed limits
- traffic growth rates and/or traffic modelling forecasts
- road pavement surface type.

Both existing and proposed road pavement surface types shall be identified. The appropriate pavement surface correction factors for the noise effects of these pavement surfaces shall be adopted in all calculations and predictions (refer to Table 4.3.4.1 for pavement surface correction factors).

Predicted (future) road traffic noise levels shall be based on a 10 year horizon after a new road or new development is expected to be opened. This 10 year horizon shall also apply:

- after the upgrade of an existing road is completed
- after the implementation of noise attenuation treatments to an existing road where no road works are involved.

Electronic road design, feature and terrain data

Road design, feature and terrain data is required as the basis for road traffic noise calculation and prediction modelling.

As a minimum, a 3D digital feature and terrain model of the study area is required when conducting road traffic noise modelling for an existing road segment, or along a new road corridor. The data shall be available as dxf files at commencement of the assessment. The required dxf files shall include:

- existing digital terrain model (within and outside the road corridor to the extent of the study area)
- digitised building envelopes
- cadastral boundaries (extracted from the DCDB - Digital Cadastral Database)
- digitised feature data detailing
  - lane line markings, edge of pavement surface and kerb lines for the subject road segment as well as for service roads, on and off-ramps, and local roads that may contribute to the road traffic noise environment in the study area
  - top and bottom edge of existing safety barriers, retaining walls and noise barriers.

For a new road or upgrade of an existing road, separate 3D dxf files shall also be provided detailing the new road alignments. The required dxf files shall include:

- a composite 3D digital road design model (within and outside the road reserve to the extents of the study area) created from the road design model and cut into the existing terrain
- the boundary of the digital road design model and the existing feature/terrain model
- a composite digital terrain model of the final design and existing terrain contours at suitable intervals.

Irrelevant/unnecessary data, including block and external references, shall be removed from all digital information. This can help:

- minimise the work required to create the road traffic noise model
- limit potential for errors in interpretation of the data.

Generally, the digital information shall be provided in the following format:

- 3D polylines only or 3D lines (i.e. splines are incompatible)
- all layers and models shall be labelled appropriately to reflect the corresponding road element
- all existing digital terrain model layers shall be merged as one layer
- coordinates with z values = -999 shall be removed
- the terrain elevation accuracy generally shall be no less than 0.25 metre intervals.

4.3 Acoustical assessment

When conducting a road traffic noise assessment, several key elements should be addressed which include:

- Measurement
- Calculation and prediction
- Criteria assessment
- Impact management.

4.3.1 Measurement

4.3.1.1 Purpose of measurements

Measurement of road traffic noise levels or of pre-construction noise levels are required to be undertaken for a number of reasons, depending on the project type. Table 4.3.1.1 presents the scenarios under which noise measurements may be undertaken, and the purposes for conducting the measurements at varying stages of a project.

Table 4.3.1.1 - Reasons for conducting noise measurements

Scenarios	Purposes
Before construction	• establish noise climate of pre-construction noise levels • provide baseline data for comparative assessment of pre and post construction noise levels • determine the relevant assessment criteria based on pre-construction noise levels • verify the noise model by comparing measured and calculated noise levels.
During construction	• manage compliance • monitor spot levels on larger scale projects.
After construction	• confirm compliance with criteria or project goals • collect data for comparative assessment of pre and post construction noise levels • quality control/assurance regarding attenuation treatments • continual improvement.
Ongoing	• quality control/assurance • complaint management • ongoing review of compliance • ongoing review of community exposure, by building a database to track noise level exposures.

4.3.1.2 Measurement process

The process of measuring road traffic noise involves the following:

- setting objectives and identifying data requirements
- establishing sites and measurement locations
- recording all site details
- measuring noise levels for adopted descriptors

- monitoring traffic conditions during the measurement period such as traffic accidents and road maintenance activities
- monitoring and measuring weather conditions during the measurement period
- fully documenting all results.

All components of this process are significant in achieving reliable, suitable and accurate measurements. Time, resource and financial consequences may be expected if this process is not followed.

Further information on measurement of road traffic noise can be found in documents such as AS 2702 (1984) and Department of Environment and Heritage Protection *Noise Measurement Manual* (2013).

Objectives and data requirements

The objectives and purpose for undertaking the measurements should be clearly established. The extent and form in which the measurement data is to be used should be clearly identified.

Sites and measurement locations

Details such as where and when to undertake the measurements are to be determined once the objective and purpose of the monitoring are known. The selection of suitable sites and measurement locations can be a time consuming and unpredictable exercise. This is generally because of externalities such as animals, plant and other external features that have the potential to affect the measurements as demonstrated in the following example:

> Representative traffic noise data would be desirable at seven or eight residential facades that front onto a 3 km section of an urban motorway between two interchanges. An initial inspection of the section revealed that there are potentially 12 such residences, but five of them are near some light industrial sites. Since the industrial noise was clearly audible and was also detected by the measurement instrumentation at these five residences, it would interfere with the road traffic noise measurements. Therefore these five potential sites were eliminated. Of the other seven sites, one is almost inaccessible and a vicious, huge dog inhabits another. This leaves only five measurement sites that are suitable.

Recording all site details

This involves recording all relevant site data needed to identify the site and to conduct an accurate road traffic noise calculation/prediction. Site diagrams shall be prepared together with photographs taken for each site's identification. All data shall be recorded on the departmental standard measurement template (refer to Appendix 1) or in a similar format. The data shall include tabulated road traffic noise measurement results, time trace of the measurement, weather conditions and pavement surface types (photographs required) for each measurement location. This data collection process will ensure the measurement data can be confidently applied at any stage of a project.

Measuring noise levels

In order to use noise descriptors such as L_{A10} (18h), noise measurements shall be undertaken over a minimum of two days (i.e. 48 hours) with due consideration being given to the requirements for monitoring the traffic and weather conditions.

The noise measurement data shall be collected using appropriate instrumentation systems according to, for example, AS 2702 (1984). All instrumentation systems shall be suitably calibrated and have a current calibration certification. The instrumentation must be capable of measuring the required noise

descriptors, such as L_{A10} (1h) or L_{Aeq} (1h). The instrumentation shall be calibrated at the start and the finish of the measurement period.

Attended measurements (where a competent person(s) is present during part of the measurement period) are always preferred to unattended measurements. However the cost of time and labour for attended measurements may be prohibitive. For departmental projects such as road upgrades and complaint related investigations, an agreed attended measurement program shall be negotiated with the project manager at the outset of the project. For development applications, it is recommended that at least one attended measurement be conducted during each day. Attended measurement shall also be made at the start and the finish of the measurement period. Audio recording is also recommended for later review of potential extraneous noise.

During the time of attended monitoring, the competent person shall note any extraneous noise events, climatic conditions and any vandalism. The competent person shall also undertake a sampling of the descriptors for later correlation with the corresponding samples obtained during the long term measurement period, e.g. during one (or a quarter or half an hour as the case may be) of the hours of attendance. As a minimum, a quarter of an hour measurements shall be conducted using a sound level meter capable of measuring the noise indices, L_{Amax}, L_{A1}, L_{A10}, L_{A90}, L_{Amin} and L_{Aeq}.

Measurements shall not be conducted during periods of atypical traffic flows and patterns, unless it can be otherwise justified, such as when traffic data are measured simultaneously with the noise measurements. Periods of atypical traffic flows and patterns include weekends, school and public holidays. It should be noted that in some areas, such as popular holiday destinations, the use of measurement data for weekends, school and public holidays may be acceptable, based on the analysis of prior traffic data patterns in the area.

Furthermore, measurements shall not be conducted during periods of extraneous noise such as that from nearby construction activity. Noise events identified as extraneous shall be excluded from the noise calculation. Should extraneous noise sources be identified as interfering with the traffic noise data for more than two continuous hours or for more than three non-continuous hours during a 24 hour day, that day's data shall be discarded and an additional day's data shall be collected.

Where there are up to two continuous or three non-continuous hours during a 24 hour day affected by extraneous noise sources, the measured traffic noise data during these hours shall be discarded and replaced with values determined by simple linear interpolation of other data collected during that day.

When external noise levels are being measured in terms of one hour descriptors such as the highest L_{A10} (1h), attended measurements shall generally be conducted during the expected most noisy operation hours. The operation hours are the usual time of use or occupation of the noise sensitive place. For example, the noise measurement period shall be as follows:

- a school shall be 8 am to 4 pm on normal school days
- a child care centre shall be 6 am to 6 pm
- a church shall be during the time of services and similar activities
- a medical centre and library shall be during opening hours
- a community hall shall be during the typical hours of use.

Consultation with the owner(s) of the noise sensitive buildings will be necessary to determine the representative period for measurement.

Measurements are generally undertaken outside the building, without the influence of normal activities associated with the building. If it is difficult to measure during the usual time of use, it may be acceptable to measure outside normal times of use providing the relevant traffic data is available for the period of noise measurement.

Traffic conditions

Collection of traffic data during the time of the noise measurement is always preferable to traffic estimates such as the annual average daily traffic (AADT) or average daily traffic (ADT). However, such estimates can be used if the daily traffic conditions experienced during the measurement period is believed not to be varying significantly from the estimates that have been used. For large road upgrade projects, measured traffic data shall always be collected and traffic estimation shall only be used for comparative purposes, for example, for the upgrade of Gateway Motorway, Ipswich Motorway and Pacific Motorway.

The measurement of traffic data requires the collection of traffic volumes, speeds and compositions for each hour during the noise measurement period. Note that one hour of traffic data is required to calculate the L_{An} (1h) level (e.g. n = 10) for the relevant road traffic noise descriptors. Generally the nature and format of the traffic data should be aligned with the road traffic noise calculation model adopted. It must be recognised that events such as road works or traffic accidents may affect the traffic conditions and therefore influence the accuracy of the road traffic noise measurements. The competent person undertaking the noise measurement shall take all necessary steps to ensure that such events are monitored and adequately documented.

Weather conditions

Weather conditions shall be monitored and measured locally by means of a portable weather station at a height of approximately 1.8 to 2.0 m. in an open area not restricted by trees, buildings or other obstacles in conjunction with the road traffic noise measurements. All weather data shall be recorded on the departmental standard form template for road traffic noise measurements or in a similar format. Particular attention shall be given to wind speed and direction, rain periods and air temperature. Reliance on other sources of non local meteorological data such as from the Bureau of Meteorology is generally not permitted unless there is a failure of the portable weather station during the measurement period.

Weather conditions can substantially affect the quality and accuracy of road traffic noise measurements. The primary weather conditions that affect traffic noise measurements are wind and rain. For traffic noise measurements conducted over a 24 hour period, the maximum acceptable values of these conditions are as follows:

- average wind speed up to 3 m/s
- rainfall up to 0.3 mm/h.

Road traffic noise measurements conducted during a 24 hour period shall be discarded under the following weather conditions:

- when there are more than two consecutive hours of adverse weather conditions
- when there are more than three non-consecutive hours of adverse weather conditions.

When there are no more than two consecutive or three non-consecutive hours of adverse weather conditions during a 24 hour period, the measured road traffic noise data during these hours shall be

discarded and replaced with values determined by simple linear interpolation of the other data collected during that day.

In some cases, road traffic noise measurements can be conducted for periods shorter than a 24 hour or an 18 hour period. These cases would occur when the objectives of the measurements were to determine shorter time based noise descriptors. Under these situations, the number of hours during which adverse weather conditions of wind and rain is allowable would be proportionately less than those listed above. When noise levels are being measured in terms of one-hour descriptors such as the highest L_{A10} (1h), there shall be no rain during the relevant hour and the average wind speed during this hour shall not exceed 3 m/s.

In varying seasonal conditions, average wind speeds at some measurement sites may be consistently above the maximum acceptable value. In such cases it might be necessary to further analyse the noise measurement data and it may be necessary to relax this specification. There are some techniques available to assist in improving the reliability of the measured noise data and these include the following:

- calculate the wind speed vector perpendicular to the road in the direction of the measurement location. If the magnitude of this average wind speed vector does not exceed 3 m/s for more than two continuous or three non-continuous hours during the measurement period, then the m
- use measured noise data from days when the wind was blowing from the road to the measurement location about as much as it was blowing in the opposite direction.
- average the measured noise data at each site over a range of wind conditions, taking care to include as many days when the wind was blowing from the road measurement location as it was blowing in the opposite direction.

Documentation

All site, traffic, noise measurement and weather data, along with photographs and any other relevant information, shall be presented in a report document. All noise measurement data shall be reported to one decimal point.

4.3.1.3 Specific measurement requirements

In addition to the above general principles, there are several specific requirements set out below that must be addressed when road traffic noise measurements are being undertaken by, on behalf of or for review by the Department.

Site selection

When undertaking road traffic noise measurements along a particular road, it is firstly required that the sites of all potential noise sensitive receptors along the road be identified. These receptors shall include, but are not limited to, the following:

- all existing dwellings, approved future dwelling locations and proposed dwellings under a development application, particularly those where it is reasonable to expect that the relevant noise criteria might be exceeded
- all educational, community and health buildings
- all appropriate outdoor educational and passive recreational areas (including parks).

In most cases where road traffic noise measurements are being undertaken along a road, it is not economically justifiable to conduct noise measurements at the site of every potential noise sensitive building. Effectively, each noise measurement program represents a sample of the noise exposure of the population of potential noise sensitive buildings. Due consideration shall be given to the location of potential noise sensitive receptors, the surrounding terrain and geometry of the road. Two sampling approaches can be adopted:

- The first is that a cluster of buildings is considered, by desk top and/or site inspection, to have similar noise exposures. The measured level at one site within this cluster then represents all of the buildings.
- The other approach involves clustering buildings by desk top and/or site inspection so that all buildings in the cluster can by represented by one or more buildings that are considered to have higher noise exposures than the remainder in the cluster. Measurements are then conducted at the site of the one or more of the buildings predicted to experience the higher noise exposure.

Overall, the guiding principle of site selection is to ensure that there is full spatial coverage of all potential noise sensitive receptors along the road. To effect this principle, the spatial noise sampling should use the clustering-based site selection processes. In this way, measurements will be obtained at a representative number of sites along the road of interest. For example, it is quite likely that measurement locations will be in the front row to third row of buildings from the road.

For noise measurements conducted by or on behalf of the Department, advice to the owners/occupiers of selected noise measurement sites in the format of an information letter and 'Notice of Entry' Form (M727) (refer to Appendix 2) shall be prepared by a departmental representative and presented or delivered to the site owner/occupier on initial contact at each site.

Written approval by the site owner/occupier (i.e. a signed Form M727) shall be obtained prior to entering the site for noise measurement. Where written approval is not obtained after three days following receipt by the owner/occupier of Form M727, the departmental representative may elect to:

- proceed with entering the site without written approval
- investigate the availability of other potential noise measurement sites representative of that area
- eliminate the measurement site from the measurement program.

Combined, the information letter and 'Notice of Entry' Form (M727) shall outline:

- the purpose of the road traffic noise measurement
- the proposed duration of the road traffic noise measurement period
- the process of conducting the road traffic noise measurement
- household activities that should be avoided during the road traffic noise measurement (e.g. lawn mowing)
- contact details of the departmental representative and noise measurement officer
- whether sound recording will be undertaken.

Measurement locations

At each of the identified sites, road traffic noise measurement shall be undertaken at the appropriate location. For noise sensitive buildings, the measurement location shall be at the façade of the building most exposed to the road traffic noise. The measurement location shall be at the mid window height of the highest storey of the building, with the windows being closed. Otherwise it shall be at a minimum of 1.8m for a ground floor and 4.6 m for a first floor above the building pad level, which ever is higher. A height of 0.5 m below eaves height is also acceptable.

For existing buildings, the measurement location shall normally be at a distance of 1m from the building façade. The measurement location for proposed developments shall be at the set back distance complying with local government requirements wherever possible. When a noise measurement is made in the free field, it shall have a façade correction of 2.5 dB(A) added to the measurement to determine the façade corrected noise level. For schools and other similar noise sensitive receptors, if required, the measurement location inside the building shall be at the centre of the most exposed room and a height of 1.5 m above finished floor level.

For open spaces, for example, outdoor educational and passive recreational areas (including parks), measurements shall be at a minimum height of 1.5 m above ground level in the free-field and the location shall be determined on a case by case basis, taking into consideration the full circumstance surrounding the provision and future use of the open space (e.g. in large areas of open space, only a small percentage may be impacted by road traffic noise and there is often scope to locate activities away from the influence of road traffic noise).

For all measurements, it shall be clearly documented as to whether the measurement data is ‘free field’ or ‘façade corrected’.

Quality control

Road traffic noise measurements have to be conducted according to recognised standards such as AS 2702 (1984). Moreover the measurements must be conducted and interpreted by competent personnel. Particular care must be taken when using unmanned monitoring equipment where the potential for data contamination from extraneous sources not associated with road traffic may exist. Appropriate quality control procedures are required to ensure that the reported road traffic noise levels are, in fact, associated with the subject road source under consideration, and not with extraneous noise sources.

All road traffic noise assessment reports shall state that all measurements have been conducted by competent personnel to the appropriate standards.

Post construction measurements

Post construction noise measurements shall be conducted upon new road, upgraded road or existing road sections where noise attenuation treatments have recently been constructed. Preferably, post construction noise monitoring shall be undertaken within approximately 3-6 months of the opening/operation of the new/upgraded road or following completion of noise attenuation works along an existing road section. Post construction monitoring shall normally be carried out at the same representative measurement sites where preconstruction monitoring had been undertaken.

It is preferable for these measurements to be undertaken by the original acoustical consultant who undertook the acoustical assessment or by departmental resources in Engineering and Technology Branch of the Department.

Where feasible, post construction measurement should be accompanied by simultaneous measurements of the traffic volumes, compositions and speeds. In this way the resulting measured noise levels may be subsequently adjusted by a correction (usually upwards) to account for changes in traffic conditions that will occur between the time of the measurements and the 10 year horizon for which the assessment of the road traffic noise impact had been conducted. Note that in some cases, a program of installing roadside noise barriers occurs after the road has become operational. In these cases, post construction noise measurements at those locations where the traffic noise levels may change due to the installation of barriers, shall be delayed until these noise attenuation treatments are in place.

4.3.1.4 Relationship between road traffic noise descriptors

Generally road traffic noise is measured, calculated and predicted using noise descriptors such as the L_{A10} (18h), L_{A10} (1h) and L_{Aeq} (1h) descriptors, as discussed in Chapter 2.

In most cases, the relationship between noise descriptors for an existing road should be derived from actual measurement data recorded for the particular location.

However it has been regularly observed in Australian and international studies that there are readily determined correlations between the road traffic noise descriptors. These typically take the form of empirically determined relationships such as the one below (Samuels and Huybregts 1998):

$$L_{A10}\ (1h) = L_{Aeq}\ (1h) + 3.0 \qquad (4.3.1.4)$$

It should be noted that this relationship is generally only valid for traffic volumes in the range of 300 to 1100 vehicles per hour (Abbott and Harris 1999).

The relationship in Equation 4.3.1.4 can be most useful in screening measured data to ensure that only noise levels arising from road traffic are considered in the subsequent noise assessment process. It may be used as a data filter to remove measured data that have been contaminated by extraneous sources. The principle is to ensure that the measured L_{A10} (1h) and L_{Aeq} (1h) descriptors generally conform to the relationship.

It should also be noted that the constant in Equation 4.3.1.4 is an averaged value which was based on an extensive analysis of substantial data sets. The 95% confidence limits around this constant are close to ± 1 dB(A) and these limits should be taken into account when determining the conformity of measured data to the relationship of Equation 4.3.1.4. For example, the measured data in any given hour would generally be deemed to comply with this relationship if the difference between the measured L_{A10} (1h) and L_{Aeq} (1h) descriptors fell between 2.0 and 4.0 dB(A).

Another application of Equation 4.3.1.4 involves a further quality control check on measured L_{A10} (18h) traffic noise descriptors. Again this check is aimed at ensuring that the measured data are truly representative of road traffic noise at the site and have not been contaminated by extraneous noise or by adverse weather conditions.

Taking into account Equation 4.3.1.4 in the 18 sets of measured L_{A10} (1h) and L_{Aeq} (1h) descriptors over the course of an 18 hour period, measured data visually determined to be corrupted by spurious noise sources may be eliminated from future use. In this instance the overriding principles are that no more than three of the 18 hourly measurements may be discarded and that of these, no more than two can be from adjacent hours. If these principles are met, then the three discarded non-continuous or two discarded continuous hours of measurements may be substituted by simple linear interpolation of

the remaining data. Furthermore, if more than three non-continuous or two continuous hours data are discarded, then the entire day's data must also be eliminated from future use.

Low traffic flow conditions

The relationship of Equation 4.3.1.4 was determined from analyses of data collected at a variety of road types and generally where reasonable traffic volumes occurred.

The generation of road traffic noise is somewhat different under low traffic flow conditions compared to higher or 'normal' traffic flow conditions. In particular the L_{A10} (1h) and L_{Aeq} (1h) descriptors are most sensitive to variations in traffic flow at low traffic flow conditions according to CoRTN 1988. In this context, low traffic flow conditions are those where the traffic flow drops below around 300 vehicles per hour, below about 4000 vehicles per 18 hours (6am to 12pm) or below approximately 4500 vehicles per day (24 hours). Under these low traffic flow conditions, the rate at which road traffic noise varies with traffic flow is more rapid than under the nominal 'normal' conditions. In addition, the noise/traffic flow relationship also varies with the distance from the road, the measurement location and the average speed under low traffic flow conditions.

Therefore when road traffic noise measurements are made under low traffic flow conditions, it is even more important than previously discussed to ensure that extraneous noises do not affect the measured road traffic noise levels.

Consequently, under these conditions data screening then becomes a 'manual' type process which would include activities such as attended monitoring, listening to audio recordings or watching and listening to audio/visual recordings made during the data collection period.

4.3.2 Calculation and prediction

For the purposes of this CoP, the terms calculation and prediction of road traffic noise are defined as follows:

- calculation of road traffic noise involves the use of a road traffic noise model to estimate the existing noise levels at or near the subject road segment
- prediction of road traffic noise involves the use of a road traffic noise model to estimate the future noise levels at or near to the subject road segment.

Any given road traffic noise model usually involves a series of algorithms that describe and quantify the manner in which noise is generated, propagated and attenuated. There are many road traffic noise models and associated computer software packages available worldwide. Two road traffic noise models commonly used in Australia are the Calculation of Road Traffic Noise (CoRTN) from UK and the Traffic Noise Model (TNM) from American Federal Highway Administration. The use of other models such as Nordic models would not be appropriate until validated for local conditions.

Scientific studies of the CoRTN and TNM models have been conducted in Australia. The process of determining the performance of a model in the calculation of road traffic noise involves a series of scientifically based procedures known as evaluation, calibration and validation (Samuels 2005, Samuels Peters and Hall 2004, Samuels and Parnell 2002).

The receptor height for noise calculation and prediction is similar to noise measurement locations. That is, 1.5 m above finished floor level for all levels or 1.8 m for ground floor or 4.6 m for first floor above building pad whichever is higher. A height of 0.5 m below the eaves height is also acceptable.

4.3.2.1 Calculation of Road Traffic Noise

The CoRTN model originating in the UK has been widely used in Queensland by the Department and acoustical assessment providers. It was first released in 1975 and was subsequently updated in 1988. In 1983, a NAASRA (the predecessor of Austroads) Working Group comprehensively evaluated CoRTN under Australian conditions (Saunders et al 1983). CoRTN allows for calculations and predictions of either the L_{A10} (18h) or L_{A10} (1h) noise descriptors.

The stepped process documented in the CoRTN Manual does not intend to present a completely exhaustive explanation of the CoRTN model. Rather it sets out a typical, common and rather simple calculation process where the major aspects of the CoRTN procedures are covered. Reference should always be made to the CoRTN Manual for further information of how CoRTN addresses additional issues such as the following:

- calculation for low traffic flows
- calculation at the end of a section of upgraded road
- allowing for horizontal curvature in the road alignment
- screening and reflection effects from adjacent buildings and other nearby infrastructure including opposite facades
- multiple screening from more than one barrier
- contributions from segmental angles
- determination of the average height of propagation.

CoRTN also includes a procedure for the effect of pavement surface types being included in the calculated and predicted noise level based on texture depth measured by the sand-patch test. This particular procedure is not adopted in Queensland and other Australian States. In Queensland, the effects of pavement surface type are allowed for by application of the factors documented in Table 4.3.4.1 of this Chapter. Note that a similar procedure is also adopted in other Australian States. Similar factors (relative to DGA) shall be applied to other calculation and prediction methods such as TNM when these methods are used in Queensland.

The applicability of CoRTN for Queensland conditions has been statistically analysed by Saunders, Samuels, Hall and Leach (1983). The accuracy figures are presented in Table 4.3.2.1. Note that the 1983 factors apply generally across Queensland, with the exception for Pacific Motorway between Logan Motorway and Nerang. For this section of the Pacific Motorway, CoRTN has been comprehensively evaluated, calibrated and validated as part of the Pacific Motorway Noise Reassessment Project (2004). The accuracy figures and calibration factors resulting from this analysis are also presented in Table 4.3.2.1. The accuracy represents the 95% confidence limits.

The 1983 calibration factors shown in Table 4.3.2.1 shall be added to the calculated or predicted noise level using CoRTN in Queensland.

Appendix 3 gives the calibration factors for the Traffic Noise Model (TNM) under Qld conditions.

Table 4.3.2.1 - CoRTN calibration factors and accuracies for Queensland conditions

Road location	Receptor location	Calibration Factor (dB(A))	Accuracy of calibrated calculation or prediction (dB(A))
Across Queensland (Except Pacific Motorway, Logan Motorway to Nerang) (1983)	Free field	- 0.7 for all sites	± 3.6
	1 m in front of building facade	- 1.7 for all sites	± 5.0
Along the Pacific Motorway (Logan Motorway to Nerang) (2004)	Free field	- 9.7 at PCC sites - 6.0 at OGA sites	± 6.8 ± 5.2
	1 m in front of building facade	- 9.7 at PCC sites - 6.0 at OGA sites	± 6.8 ± 5.2
DGA: Dense Graded Asphalt. PCC: Portland Cement Concrete. OGA: Open Graded Asphalt.			

4.3.2.2 Calculations and predictions using computer software

When using CoRTN, it is possible to undertake calculations and predictions in a so called manual method by reading values off the various charts and tables in the CoRTN manual. This process can provide reasonably good calculations and predictions.

A preferred and detailed approach is to employ the algorithms provided in the CoRTN method to undertake the calculations or predictions. These algorithms form the basis of several commercially available computer versions of CoRTN such as SoundPLAN, PEN and TNoise. Several local consultants and other organisations have also developed their in-house spreadsheet programs for undertaking calculations or predictions with CoRTN.

Irrespective of whether a manual or software based approach is adopted, the most critical aspect of the entire calculations or prediction process is to determine the input parameters required and the values of each parameter.

4.3.3 Criteria assessment

Prior to undertaking any measurement, calculations and predictions, the relevant road traffic noise criteria pertaining to the site should have been established in accordance with Chapter 3. Once the measurements, calculations and predictions are completed, a comparison of the road traffic noise exposures with the established criteria can be conducted. The road traffic noise exposures should be specified in terms of the noise descriptors at all noise sensitive receptor locations.

Where the calculated or predicted exposures are greater than the relevant criteria, the acoustical assessment shall then give consideration to managing the road traffic noise impact at those areas exceeding the criteria.

4.3.4 Impact management

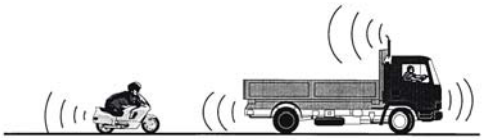
There are several ways in which the impact of road traffic noise can be reduced (refer to Figure 4.3.4):

- at the source (i.e. controlling the noise emitted by the vehicle)
- at the reception point (i.e. minimising noise transmission into the interior of a building by means of building location and design)

- along the propagation path (i.e. attenuating the noise as it travels between the source and reception point by means of noise barriers or buffer zones)

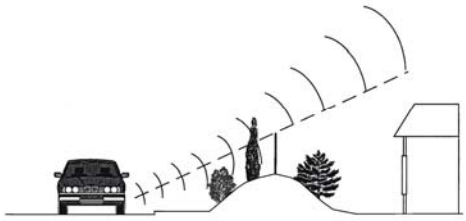
To achieve the departmental external criterion level, several noise attenuation strategies can be used. These include noise sensitive use exclusion zone, earth mound, noise fence, building design and pavement surface treatment. Details of the attenuation strategies are given in Chapter 6.

Figure 4.3.4 - Methods for the management of road traffic noise impact



Control at source

Control at reception point



Control along propagation path

4.3.4.1 Control at the source

Vehicle related noise sources and control

In the long term, the most equitable method of reducing road traffic noise is through control at the source. This is being constantly addressed in the Australian Design Rules (ADRs) by reducing maximum noise emission levels of new vehicles.

The Department has been involved in the formulation and administration of these rules and their enforcement is covered under the *Transport Operation (Road Use Management) Act 1995*. The Department encourages and supports related research and development for quieter vehicles.

Technically, road traffic noise may be regarded as the aggregation of the noise produced by individual vehicles in the traffic stream (Houghton 1994). For each vehicle, there are several noise sources including the engine, the exhaust system, tyre/road interaction, the air intake and the cooling fan. However, with the exception of motorcycles and the like, for just about all vehicles in a reasonable state of maintenance, tyre/road interaction represents the primary source of noise for all constant speeds in excess of around 40 to 50 km/h.

Pavement surface types

The magnitude of tyre/road noise levels generated on roads such as those within the jurisdiction of the Department depends largely on the pavement surface type. Consequently, one very effective means of controlling road traffic noise at the source is to vary the pavement surface type.

Since pavement surface type is such an important factor in the generation of road traffic noise, much research has been conducted in Australia and internationally on this topic (Samuels 1982, Samuels and Dash 1996, Samuels and Parnell 2002, Sandberg and Ejsmont 2002). The acoustic performances of various pavement surface types that have been scientifically investigated in Queensland are set out in great detail in *The QDMR Pavement Surface Noise Resource Manual* (Samuels 2008). This Manual primarily focuses on the following pavement surface types which are widely used throughout Queensland and indeed throughout Australia and internationally:

- Bituminous Seal (BS): a thin pavement surfacing comprising a layer of bitumen onto which cover aggregate has been placed and compacted by a rolling process.
- Portland Cement Concrete (PCC): a cement concrete pavement (reinforced or unreinforced) that may have various surface textures applied by tyning or other techniques.
- Asphalt: in general, comprised of mineral aggregate in a bituminous binder. Asphalt surfacings differ by the proportion of different size aggregate (crushed rock,) the amount of bitumen added and the presence of other additives and material.
- Dense Graded Asphalt (DGA): a smooth, uniform aggregate graded pavement surfacing. The depth depends on the purpose of the pavement surface layer (i.e. structural or surface layer).
- Stone Mastic Asphalt (SMA): an asphalt mix design typically that has a higher proportion of the larger stones and fine particles but relatively few stones of the intermediate size as opposed to the other asphalt mix designs.
- Open Graded Asphalt (OGA): comprised of a porous layer, usually a minimum of 25 to 45 mm thick, which is usually overlaid on DGA and provides a water drainage path within the porous layer. OGA has a higher proportion of the larger stones (compared with DGA) and a smaller percentage of small stones and fine particles. This type of pavement surface is also referred to as an Open Graded Friction Course in some references.

Acoustic attributes of Queensland pavement surface types

The acoustic attributes of Queensland pavement surface types are documented in Appendix 4. Methodologies from that Appendix should be used if further investigations of acoustic performance for individual pavement surface types are required.

It is recommended that the pavement surface correction factors (relative to DGA) given in Table 4.3.4.1 be adopted for the assessment of the impact of road traffic noise. These pavement surface correction factors are based on the recommendations of *The QDMR Pavement Surface Noise Resource Manual* (Samuels 2008).

Table 4.3.4.1 - Pavement surface correction factors

Pavement Surface Type	Change in Noise Level (dB(A))[3]
Portland Cement Concrete (PCC)	Increase by 5
16-20 mm Bituminous Seal (BS)[1]	Increase by 4-5
5-14 mm Bituminous Seal (BS) [1]	Increase by 1-3
Dense Graded Asphalt (DGA)	0
Stone Mastic Asphalt (SMA)	Decrease by 1
Low Noise Stone Mastic Asphalt (LNSMA)[2]	Decrease by 2
Open Graded Asphalt (OGA)[4]	Decrease by 2

Notes:

1. For a two coat BS, the size of the aggregate in the second coat shall be used to determine the pavement surface correction factor from this table.
2. Proprietary product not covered by the departmental specifications
3. These correction factors are nominally based relative to half the life of a DGA pavement surface type, for all speeds ≥ 60 km/h
4. The use of OGA as a pavement surface type also has the following construction limitations:
   - Free flowing drainage can be obstructed adjacent to kerbs/kerb and channels.
   - The pavement must be structurally sound.
   - Shorter pavement surface life and cannot be overlaid.

4.3.4.2 Control at the reception point

Effective land planning and design play an important role in abating road traffic noise exposure. The siting of less sensitive land uses in areas likely to be adversely affected can minimise noise impact.

It is desirable to examine noise issues at all phases of a proposed road project. Approved future land development should also be considered in all road traffic noise investigations. Proper planning and design at the land development approval stage should remove the need to attenuate impacts at a later date.

Where dwellings are built after construction of the road, appropriate architectural design and treatment at the reception point can limit the intrusion of road traffic noise. Measures such as acoustic seals, thickened glass, double glazing of windows and ceiling insulation can be effective means of treatment. These should be applied where effective indoor communication, sleeping and other noise-sensitive activities are required and where other alternatives are not appropriate.

To achieve the internal criterion levels specified in the departmental *Policy for Development on Land Affected by Environmental Emissions from Transport and Transport Infrastructure (Environmental Emissions Policy - the EEP)*, architectural treatment should be designed in accordance with AS 3671 (1989) (for new developments only).

4.3.4.3 Control along propagation path

The Department, local government and land developers have the greatest scope for control between the source and the reception point. The selection of alignment, grading, and provision of earth mounds and other noise barriers within or outside the road corridor, are some of the design issues requiring early consideration in the planning and preliminary design phases of a project. Chapter 7 provides guidance for road planners and designers on how to integrate such features into the road landscape.

4.4 Road traffic noise assessment report

4.4.1 Structure of a noise assessment report

The road traffic noise assessment report shall adequately document and present all the data inputs, assumptions, assessment results and noise attenuation strategies/options. The report shall contain the following as a minimum:

- Executive summary of the findings and recommendations of the assessment.
- Introduction and description of the road or development proposal.
- Assessment methodology (including the verification process and relevant assessment criteria).
- Summary of the road traffic noise measurement results including a layout plan depicting the site locations and positions of the noise measurements conducted for the assessment.
- Measurement data sheets and site attendance records/site notes taken by a competent person at each measurement site.
- Comparison of the logged noise levels and the attended noise levels.
- Documentation of all road traffic noise model input data and assessment criteria adopted.
- Verification results, comparing the measured and calculated road traffic noise levels for existing year (include for new road proposal only if an existing road network exists in the vicinity of the new road proposal). All results of measurements, calculations and predictions shall be presented in a tabular format such as that shown in Table 4.4.1. Note the calculated/predicted noise levels shall be rounded.
- Tabulation of calculated road traffic noise levels for all noise sensitive receptors in the study area for the assessment year (without noise attenuation treatments).
- Tabulation of predicted road traffic noise levels for all noise sensitive receptors in the study area for the year of road opening/completion and 10 year horizon following assessment year or road opening/completion (without noise attenuation treatments).
- Summary of noise sensitive receptors where the calculated and/or predicted road traffic noise levels exceed the relevant noise criterion levels (without noise attenuation treatments) for the assessment year, year of road opening/completion and 10 year horizon following assessment year or road opening/completion.
- Outline of the investigation process in determining the preferred road traffic noise attenuation strategies/options, if required.
- Tabulation of calculated and predicted road traffic noise levels for all noise sensitive receptors in the study area for assessment year, year of road opening/completion and 10 year horizon following assessment year or road opening/completion with suitable noise attenuation treatments/options.
- For departmental projects, the addresses of the noise sensitive receptors shall not be identified in publicly released reports due to privacy legislation. However, an additional table shall be provided with the street addresses identified for departmental use only.

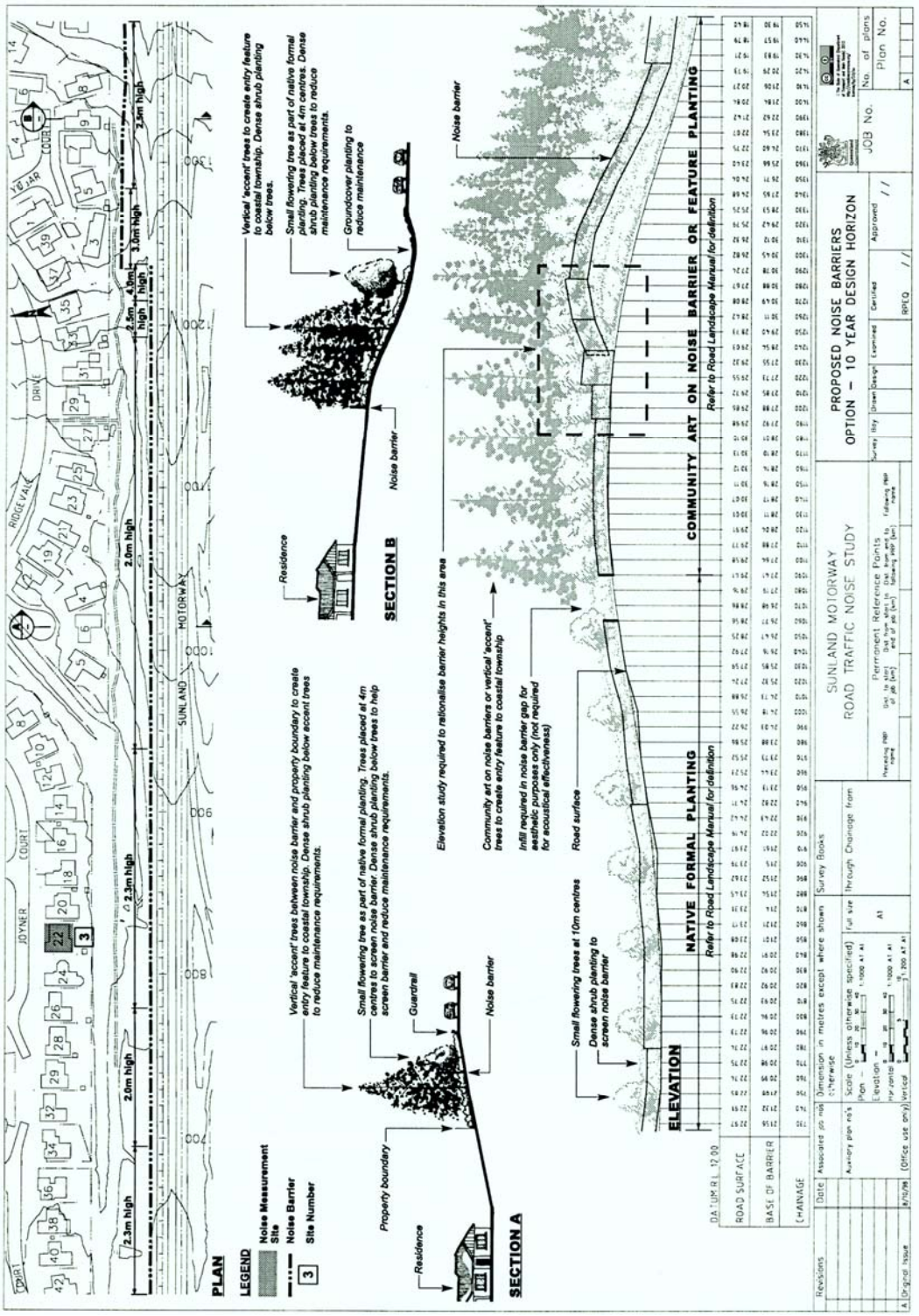
- Noise level contours for calculated and predicted noise levels for assessment year, year of road opening/completion and 10 year horizon following assessment year or road opening/completion with and without noise attenuation treatments (if required) for all scenarios. The noise contours shall be calculated / predicted as whole numbers without rounding.
- Road traffic noise level contours may be produced that cover very wide and extensive areas at or near the road. The road traffic noise level exposures can also be presented in a format depicting areas where the specified road traffic noise criteria is exceeded or where the road traffic noise levels of noise sensitive receptors fall within a certain noise level range. The format to adopt will depend on the number of factors/options/criteria considered in the road traffic noise assessment and the type of road or development proposal being assessed. Note that when presenting noise contours, the figure shall make clear whether the noise levels are façade corrected or free field and include the calculation/prediction year, the receptor height and pavement surface type assumed. Careful interrogation of noise level contours needs to be undertaken in conjunction with the tabulated noise levels in order to clearly identify any exceedences of the criterion level.
- Text descriptions and layout plan (where appropriate i.e. noise barrier option) of the length, height and location for all existing and recommended noise attenuation treatments/options.
- An example of a plan layout prepared for a road traffic noise assessment report is shown in Figure 4.4.1. This example provides details such as the receptor locations, measurement locations and proposed noise barrier treatment with respect to the vertical and horizontal alignment of the proposed road and adjacent land use / terrain.
- Recommendations and conclusions.
- Relevant attachments/references.
- Any other explanatory and general notes.
- All input and output data including modelling data files and noise barrier option coordinates shall be made available, if requested, in an electronic format.

Table 4.4.1 - Summary of acoustical assessment results

Site No.	Site Address	Measured	Calculated	Difference	Calculated (rounded)	Predicted (10 years)
1		-	69.1	-	69	71
2		-	69.7	-	70	72
3		69.2	69.6	0.4	70	72
4		-	68.8	-	69	71

Note: the noise levels are in terms of L_{A10} (18h) dB(A).

Figure 4.4.1 - Example plan layout for road traffic noise assessment



4.4.2 Issues to be addressed

Minimum requirements that need to be addressed when conducting a road traffic noise assessment include:

- The road traffic noise assessment shall be conducted according to this CoP and specific project brief. Functional Specification Proformas are provided in Appendix 5 for new roads / upgrade of existing roads projects and Appendix 6 for existing roads projects.

- Noise sensitive buildings shall be identified and the development conditions shall be taken into account if the development was constructed within 10 years prior to assessment.
- All noise measurements shall be undertaken according to guidelines set out in Section 4.3.1
- All hourly results of noise levels and meteorological conditions (particularly wind speed and direction) shall form an attachment to the Road Traffic Noise Assessment Report.
- The number of 24 hour measurements depends on the site-specific characteristics on a typical weekday or representative period. A minimum of at least one measurement site is required for each side of a road section. A road section is defined as the distance between two intersections or interchanges. The number of full 24 hour measurement sites needed depends upon the outcomes of the site selection process.
- External noise descriptors shall be measured, calculated or predicted, with either the microphone or the calculation/prediction position located as specified in Section 4.3.1 and Section 4.3.2.
- Calculations and predictions of road traffic noise shall be conducted using either CoRTN or TNM, depending on the relevant noise descriptor. CoRTN is the preferred calculation and prediction method.
- For existing roads, verifying a noise calculation model shall be undertaken by comparing measured and calculated noise descriptors determined simultaneously at a number of sites. The model may be deemed to be verified if the average difference between the measured and calculated values of the descriptors is no more than ± 2.0 dB(A). The relevant pavement surface correction factor from Table 4.3.4.1 and the respective Queensland calibration factors from Table 4.3.2.1 shall be applied to the calculations before verifying the model against the measured noise levels. Subsequently, the relevant correction and calibration factors are to be applied to the noise level calculations and predictions before assessing against the criteria.
- If verification fails, undertake the evaluation / validation / calibration process when a sufficient sample size is available.
- A common type of road traffic noise assessment involves calculating existing noise descriptor values, and then predicting the future values. At noise sensitive receptors along any particular road section:
  - if the average difference between existing measured and calculated noise descriptors values is positive (i.e. average measured values exceed the calculated values), then the calculated values shall be adjusted upwards by this average difference before determining the predicted values.
  - if the average difference between existing measured and calculated noise descriptors values is negative (i.e. average calculated values exceed the measured values), then no adjustment shall be made to the calculated values before determining the predicted values.
- It is not possible to calculate or measure the existing road traffic noise descriptors for a new road. In some cases, there may be an appropriate existing road within the area of the new road project. This existing road could be used for the assessment. For a new road project the assessment can only be based on the calculated and predicted values of the noise descriptors. Background noise levels are required to be measured at representative sites

along the proposed new road corridor to determine the existing noise climate and relevant criterion level to be applied.

- For land acquisition or new noise sensitive developments, Australian Standards such as AS 3671 (1989) may be used to determine noise values inside the noise sensitive receptor(s) if necessary.
- All measured, calculated and predicted road traffic noise descriptors shall be presented in tabular format together with noise contours and maps where appropriate. Clearly identify whether noise level data are façade corrected or free field. Noise measurements shall be rounded to one decimal place. Calculated and predicted levels shall be rounded to the nearest whole number (0.4 down, 0.5 up).
- Noise assessment must consider wether noise sensitive receptors are eligible for noise attenuation treatments and the forms and effectiveness of the treatments shall be clearly identified.
- All output data shall be supplied in electronic format for inclusion in an AutoCAD drawing file format.
- A post construction road traffic noise assessment shall be conducted after implementing noise attenuation treatments and completing roadworks and construction activities. The assessment shall collect noise measurement data according to Section 4.3.1. This ensures that road traffic noise descriptor values occurring in practice comply with the assessment values. Further assessment and remedial treatments may be considered for non-compliance. This requirement also applies before the Assessment Manager issues a certificate of compliance for the new development if required by development conditions. This shall be the developer's responsibility.
- Acoustic assessment for departmental projects shall be undertaken by pre-qualified consultants. Applicants for pre-qualification for this purpose are assessed by the Department and placed on a register at a level appropriate to their capability and experience.
- The acoustical assessments, whether they are for a departmental project or for a proposed development near a State-controlled road and subject to IDAS procedures, shall be certified by a Registered Professional Engineer of Queensland (RPEQ) in accordance with the *Professional Engineers Act of Queensland*, as they are deemed to be a professional engineering service.

5 Road traffic noise management strategy

5.1 Introduction

Queensland is experiencing an increase in population and development. This has caused an increase in traffic volumes and a subsequent increase in road traffic noise.

Road traffic noise generated by traffic on State-controlled roads under the jurisdiction of the Department is a major source of noise in urban as well as some rural areas.

A Regional Road Traffic Noise Management Strategy (RRTNMS) will align with the requirements outlined in Roads Connecting Queenslanders (2002) by helping realise the Department's vision for a road system that enhances the social, cultural, economic and environmental well being of Queensland communities.

A RRTNMS may be prepared for all State-controlled roads or for a selective number within a region. The study area for such a RRTNMS will be at the discretion of the Regional Director and dependent on the land use types considered in the strategy.

The Department needs to quantify the current and future road traffic noise levels at noise sensitive land uses adjacent to State-controlled roads within a region by applying a suitable noise calculation and prediction methodology. The current and predicted road traffic noise levels are to be representative of current and forecasted future traffic volumes on these roads and are to be expressed in terms of the relevant noise criteria described in Chapter 3 for Existing Roads – No Roadworks.

The principal outcome of the strategy is to identify and prioritise areas / road segments that are predicted to exceed the relevant noise level criteria within a 10 year horizon. The implementation of these priorities may be subject to social, technical, works priority and cost considerations including funding limitations. Noise barrier works may be integrated into the Department's *Queensland Transport and Roads Investment Program* (QTRIP).

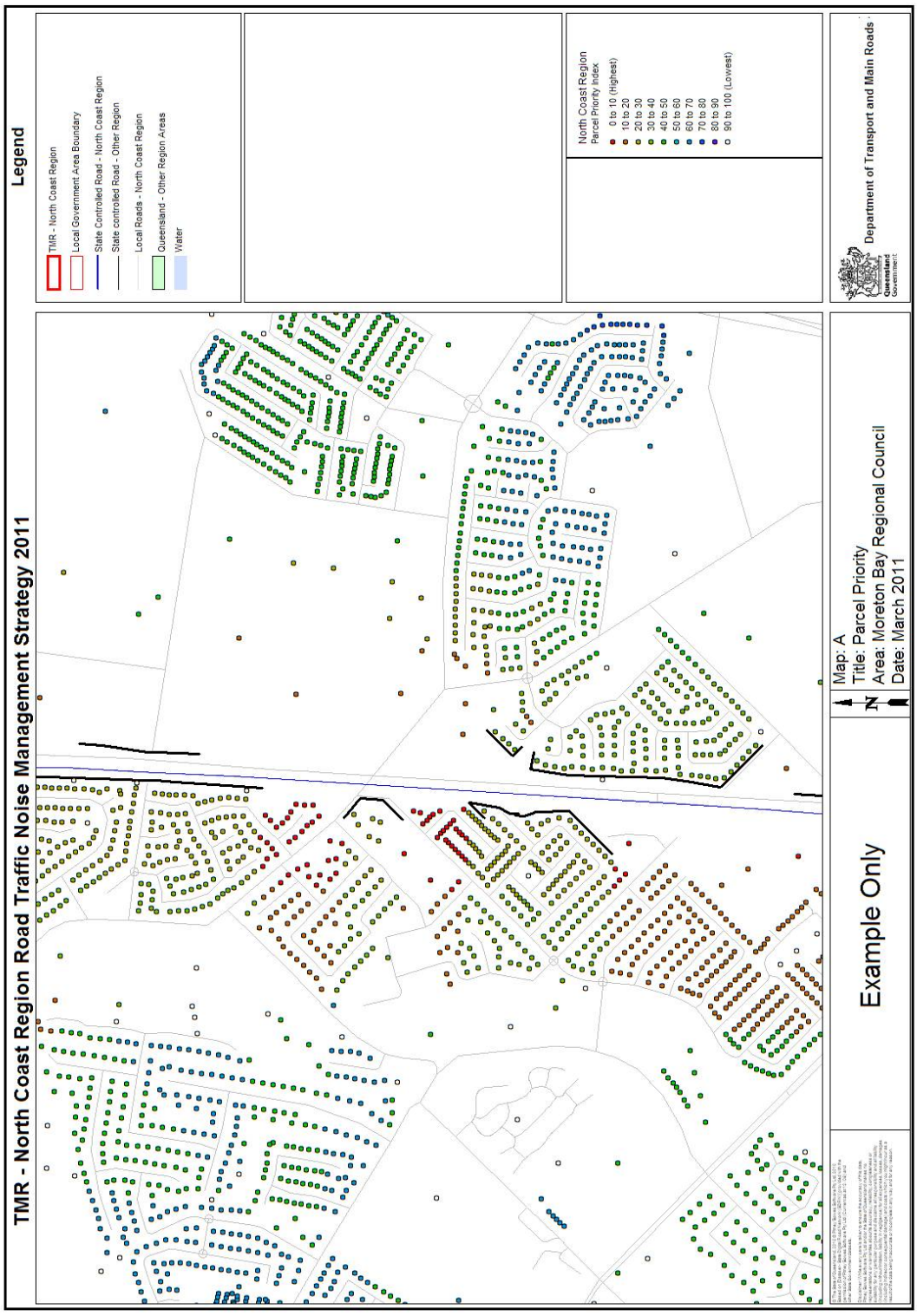
When determining priorities with the regional road network, the following should be considered, but not limited to:

- traffic volumes, composition and speed
- pavement surface type and road longitudinal grade
- terrain and building data
- existing development approval conditions.

Key determinates for prioritising areas/road segments are based on the predicted noise level and the number of affected noise sensitive receptors. All data shall be presented in both a tabulated and graphical format for each road link showing land uses, location of noise measurement sites and other data considered relevant in the strategy development. An example of a plan layout format is shown in Figure 5.1. It should be noted that the preferred presentation of the strategy may vary dependant on the scope of data available, the extent of assessment conducted and specific objectives for each strategy.

It is recommended that the RRTNMS be revised every five years.

Figure 5.1 - Example output of RRTNMS



5.2 Purpose

A region may have already implemented a works program which has resulted in many road traffic noise assessments/noise barrier schemes being undertaken and the subsequent construction of noise attenuation treatments to satisfy the requirements of the current departmental criteria.

The number of noise complaints received by a region is increasing yearly. Added to this, there is better community awareness of environmental issues and therefore a higher expectation that the Department will provide noise attenuation treatments when a noise complaint is made. These expectations fail to recognise the question of priority. Given that there is a finite budget for the provision of noise attenuation treatments, other areas may have an existing and greater noise exposure.

The purpose of a RRTNMS is to achieve the following objectives:

- to assist a region in working towards achieving the Department's obligations with respect to its general environmental duty under the *Environmental Protection Act 1994* and its associated policies related to road traffic noise
- to assist a region with planning of future upgrading of the existing State-controlled road network
- to identify likely road traffic noise impacted areas with respect to the current and projected road traffic conditions (five and ten year horizons)
- to provide an estimate of the number of residences likely to be impacted by road traffic noise above the departmental criteria resulting from traffic travelling on State-controlled roads under the jurisdiction of a region
- to provide a graphical representation of road traffic noise levels for State-controlled roads under the jurisdiction of a region
- to assist a region to prioritise noise attenuation treatments for areas identified as noise impacted according to the number of residences affected, and level of exposure to noise levels above the criterion level
- to propose suitable noise attenuation treatments and estimates of costs for the treatments that will achieve the criterion level
- to assist in the preparation of an appropriate implementation strategy that meets the Department's obligations to provide noise attenuation treatments in accordance with this CoP.

In cases where road upgrades are programmed, priorities determined in a RRTNMS may be subject to change with the provision of noise attenuation treatments being considered as part of the overall planning and design process.

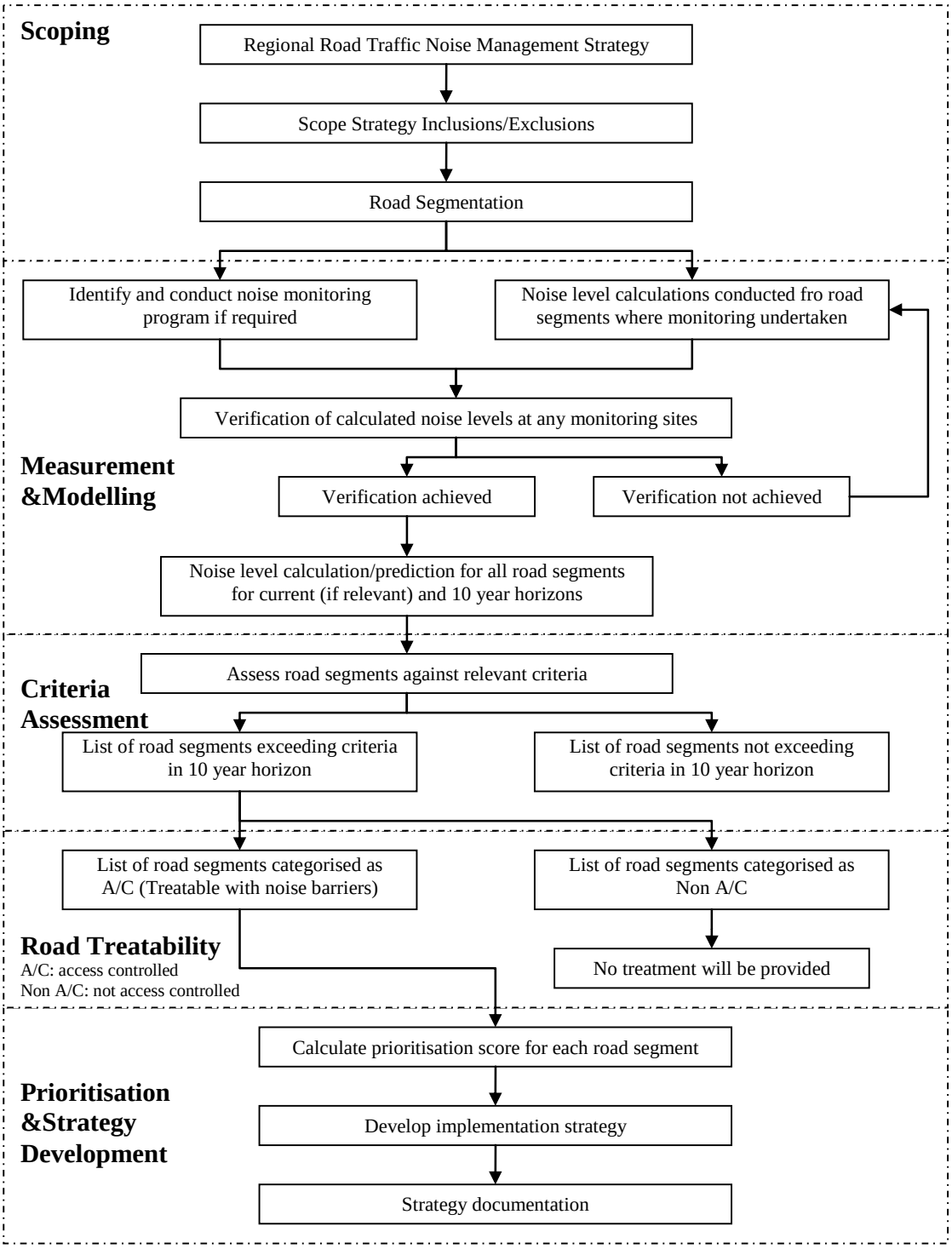
5.3 Methodology

The methodology for a RRTNMS shall be established prior to commencing the strategy and be customised to meet region's objectives. Figure 5.3 describes a generic methodology that can be adopted as the basis for the RRTNMS.

As a minimum, the methodology shall address the following key elements:

- scope, study area and road segmentation
- measurement and modelling
- criteria assessment
- treatability of road segments
- prioritisation and strategy development.

Figure 5.3 - Generic methodology for RRTNMS



5.4 Scope

When scoping the RRTNMS, the key objectives shall be to identify likely noise affected areas under the jurisdiction of the region as a consequence of current and likely future road traffic noise impact, and to prioritise those areas requiring noise attenuation treatments, based on the relevant noise criteria outlined in this CoP.

In order to determine the extent of data input requirements for the strategy, it is necessary to identify the study area and road network to be assessed. Inclusions/exclusions to consider in determining the study area and road network are discussed below.

In general, the study area for a RRTNMS may encompass existing noise sensitive land uses adjacent to the road network under the jurisdiction of a region, and where noise attenuation treatments are able to be provided within the designated road reserve.

The respective region shall outline and confirm the inclusions/ exclusions with respect to identifying the study area for the strategy. These inclusions/exclusions may include, but are not limited to:

- the State-controlled road network (access controlled)
- national roads (access controlled)
- non-access controlled road segments
- on/off-ramps/service roads along road segments
- assessment of existing residential dwellings only adjacent to the subject road network
- assessment of all existing noise sensitive land uses adjacent to the subject road network
- assessment of noise sensitive development that has been constructed adjacent to the subject road network within the last ten years.

With significant residential and other noise sensitive land development being proposed and constructed adjacent to the State-controlled road network in Queensland, the responsibility and provision for noise attenuation treatments should be addressed in the development approval process. Although it is recognised by all stakeholders that the administration of the development approval process is the responsibility of local government, the Department, in a concurrence/advisory role, should ensure that the impact of road traffic noise on all development is adequately assessed and suitable provision made within the development for noise attenuation treatments, if required.

Road segments for the following situations should be addressed on a project-by-project basis:

- where current construction projects are underway or have recently been completed (i.e. completed within the last ten years)
- where funds have been committed in the current QTRIP program for future construction works.

The process of defining the study area shall be undertaken in conjunction with the initial scoping of the strategy. An example of the types of information that would assist with the initial scoping process includes:

- the Region’s current QTRIP program
- digital topographic maps, aerial photographs, ortho imagery, photogrammetry and the digital road network for the study area, where available
- current land use data alongside the road network under the jurisdiction of the Region, where available
- the location of current and future road works (including any proposed noise barriers)
- locations within the study area that are deemed unsuitable for the provision of noise attenuation treatments

- the records of relevant previous correspondence regarding noise complaints
- any other information considered to be relevant to this study and not determined by the Region to be of a confidential nature
- detailed noise studies (current and previous) carried out within the study area.

5.5 Road segmentation

For the purposes of assessment, the road network determined within scope of the strategy shall be divided into representative road segments according to changes in road and traffic conditions (i.e. between intersecting roads/interchanges or at suitable reference points) and grouped into the following categories:

- access controlled road
- non-access controlled road (not treatable with noise barriers).

Providing appropriate treatments for noise attenuation along non-access controlled roads will not be considered due to practicality or technical feasibility issues. With the existence of driveways directly accessing onto these roads, the effective use of noise barriers will be restricted due to the full angle of view not being adequately obstructed.

Road segments shall be suitably labelled by road number, chainage and description of intersecting roads etc. To determine the appropriate segmentation of the study area, further information in addition to that obtained for identifying the study area includes:

- current traffic flow data in both, electronic (where available) and/or hard copy formats (traffic data to include AADT, the percentage of commercial vehicles and the signposted traffic speed)
- pavement surface details along all roads within the study area
- the location of existing noise barriers (where available).

5.6 Measurement

Where a noise monitoring program is incorporated as part of the strategy, the location of noise measurements, the number of measurement locations and the duration of those measurements must be specified and approved prior to any monitoring being undertaken.

The Region should make available any noise measurement results obtained within the past five years over the study area. These measurement results shall be documented in the RRTNMS report and on appropriate plan layouts.

All road traffic noise measurements shall be undertaken in accordance with Chapter 4. Minimum noise monitoring data requirements may vary dependent on the site and land use.

5.7 Modelling

The method of modelling adopted for the calculations and predictions shall complement the format and accuracy of data available as well as be consistent with the region's objectives of the strategy.

Relevant pavement surface correction factors shall be applied to the calculations and predictions in accordance with Chapter 4.

5.7.1 Data inputs

For each road segment, the following data shall be obtained as a minimum:

- existing pavement surface type
- existing 5 and 10 year forecasted AADT volumes
- existing 5 and 10 year forecasted percentage of commercial vehicles
- sign-posted speed limit.

Where greater accuracy of calculated and predicted road traffic noise levels can be achieved through the use of more detailed electronic road design, feature and terrain data, this data should be utilised. However, it is expected that the use of more detailed electronic road design, feature and terrain data would only be necessary where a detailed assessment of a high priority area is conducted based on the outcomes of the RRTNMS.

5.7.2 Assumptions

The following base assumptions shall be adopted in the calculations and predictions where no further detailed information is available for each road segment in the study area:

- flat terrain between the road and receptor
- receptor located at the centroid of the property area
- angle of view to the road of 180 degrees
- receptor height of 2 m
- 50% soft ground component between source and receptor
- 10 year noise level prediction
- 18 hour traffic volume being 94% of AADT
- 5% road longitudinal grade
- no existing barriers or screening
- sign-posted speed limit.

Although these base assumptions are not likely to be representative in all cases, it provides a consistent approach by which an unbiased priority listing can be determined. It is however important to note that these base assumptions may result in significantly higher noise levels than those in reality. Detailed assessment of the impact of road traffic noise associated with each priority is therefore recommended to cater for any unknown factors, which may influence the level of road traffic noise.

Further detailed assumptions may be considered in the strategy where the additional information is available or obtained/determined necessary for the purposes of the strategy at the Region's discretion. These detailed assumptions may include, but are not limited to:

- location, details and acoustic effectiveness of existing noise barriers (by the Department or private development)
- actual road longitudinal grades or categorisation of road gradients for each road segments. The longitudinal grade for each road segment may be categorised as ‘Level’, ‘Rolling’ or

'Mountainous' as described in Table 5.7.2. In cases where more than one longitudinal grade category is contained within a road link, the steepest longitudinal grade shall be used.

- actual horizontal distance from the road edge line to nearest receptor for each road segment
- actual relative height between the effective source position and reception point of the nearest receptor for each road segment
- actual ground surface type between the road source and nearest receptor (i.e. % of absorptive ground) for each road segment.

Table 5.7.2 - Longitudinal grade categories

Longitudinal Grade Category	Longitudinal Road Grade Range	Longitudinal Grade to adopt in assessment for RRTNMS
Level	<5%	2.5%
Rolling	5% - 10%	7.5%
Mountainous	>10%	12.5%

5.7.3 Calculations

Noise level calculations for the assessment year may be conducted using the nominated modelling method for locations where measurement results have been obtained from previous monitoring or measurements conducted for the purposes of the strategy.

Once verification of any measurement locations has been adequately achieved/explained, noise level calculations for each road segment for the assessment shall be undertaken based on the appropriate data inputs and assumptions.

Areas that may have other sources dominating road traffic should be identified. It may be applicable to estimate the relevant contributions from each source in the calculations and predictions.

5.7.4 Verification

The methods used for calculation of noise levels must be outlined in the RRTNMS report and verified if applicable using previous monitoring results and noise measurements carried out within the study area in accordance with Chapter 4.

Additional noise measurements may be required where verification of the modelling with the measurement results is not achieved or cannot be explained in terms of identifying site conditions that would influence the accuracy of the calculations made.

The number and location of measurements will affect the accuracy of results for the strategy. Similarly, calculation methods have inherent inaccuracies. The limitations due to assumptions of the noise calculation methods and how they affect their accuracy shall be stated in the strategy report.

The accuracy of the methodology shall be discussed in relation to the form of output (e.g. the accuracy of noise contours for presenting strategy outcomes).

5.7.5 Predictions

Noise level predictions shall be undertaken for the ten year horizon. The noise level predictions shall be based on the relevant traffic data inputs and the assumptions listed previously.

5.8 Criteria assessment

The acoustic descriptors adopted in the strategy shall include the L_{A10} (18h) and any others as determined relevant based on the scoping of the strategy. Any descriptors must be specified in the RRTNMS report and the criteria should be in accordance with Chapter 3.

The predicted noise levels for each road segment in the ten year horizon are to be assessed against the relevant criteria. Those road segments predicted to exceed the criteria in the 10 year horizon are to be placed in a separate listing for further assessment in the strategy.

5.9 Treatability of road segments

For the purposes of the strategy, the treatability of a road segment is initially categorised based on whether a noise barrier can practically be constructed along a road segment given the road corridor features and adjacent land use access conditions. It should be noted that this judgement may only be based on information initially available from a desktop assessment.

Consideration in recommending noise attenuation treatments needs to be given to the technical feasibility, cost effectiveness, aesthetics, equity, community engagement and practicality.

5.9.1 Treatable with noise barriers

Road segments identified as exceeding the criteria in the ten year horizon and having potential to attenuate road traffic noise with noise barriers are to be assessed further for prioritisation.

5.9.2 Not-treatable with noise barriers

For those remaining road segments exceeding the criteria in the ten year horizon and not having the potential for road traffic noise to be attenuated with noise barriers, the RRTNMS will not consider pavement resurfacing as a suitable treatment option.

5.10 Prioritisation

In order to determine a prioritisation score for the provision of noise attenuation treatments along noise impacted road segments, the following parameters shall be considered as a minimum:

- the level of exposure to road traffic noise levels above the departmental criterion level at the nearest noise sensitive dwelling along the road segment
- the number of noise sensitive dwellings along the road segment impacted by road traffic noise levels above the departmental criterion level.

For the purposes of establishing a prioritisation list, the following base ranking equation may be adopted in calculating a prioritisation score for each road segment identified as treatable with noise barriers:

$$\text{Prioritisation Score} = N \times (PNL - CL) \qquad (5.10)$$

where:

N = number of dwellings exceeding criteria (based on number of dwellings existing at the time of developing the strategy) along the road segment

PNL= predicted noise level for the 10 year horizon at affected noise sensitive dwellings along the road segment

CL= criterion level for the noise sensitive land use along the road segment.

Where further on-site investigation is conducted or detailed information is available, the following parameters may also be considered in the final prioritisation of road segments for detailed assessment:

- provision of existing noise barriers
- amount of attenuation provided by any proposed noise attenuation treatment
- cost-effectiveness, equity and practicality of providing noise attenuation treatments.

5.11 Strategy application

The priorities for the implementation of noise attenuation treatments can be used to contribute to the preparation of future QTRIP programs. These priorities may need to be separated into those roads which are federally (National Roads) or State funded (Other State-controlled roads) and nominated under the appropriate construction and maintenance project types to be consistent with the structure of the QTRIP.

Indicative budgets shall be determined for the necessary attenuation treatments to reduce noise levels to the departmental criterion level up to the relevant planning horizon. All indicative budgets shall be calculated based on the approximate height and length of noise barriers required to comply with the departmental criterion level.

In order to determine the actual cost and technical feasibility of each noise attenuation treatment, detailed road traffic noise assessments are recommended.

5.12 Presentation of results

The RRTNMS report shall contain as a minimum, but not limited to the following (refer to Appendix 7 for an example):

- executive summary
- strategy objectives and scope (including a tabulation of all road segments assessed in the strategy)
- methodology framework
- documentation of measurement locations and results of all relevant monitoring data conducted as part of the strategy as well as those measurement results obtained from previous road traffic noise assessments and monitoring
- findings of any detailed road traffic noise assessments that may have been carried out within the study area
- documentation of the modelling method, pavement surface correction factors, data inputs and assumptions adopted for the noise level calculations and predictions
- results of any modelling verification and detailed explanations of verification differences where required
- noise level predictions and relevant data presented in both a suitable tabulated and computerised graphical form (e.g. noise level contours). Land use data shall form an integral part of the presentation
- tabulation of road segments predicted to exceed the relevant criteria in the ten year horizon
- details of the parameters considered in the prioritisation scores and ranking

- prioritisation tabulation of noise impacted road segments potentially treatable with noise barriers
- summary of the relevant factors considered for all the noise attenuation types proposed in the implementation strategy
- indicative cost estimate of required noise attenuation treatments for prioritised road segments
- outline of the recommended noise attenuation implementation strategy.

6 Road traffic noise attenuation strategy

6.1 Road traffic noise attenuation strategies

Both departmental projects and proposed noise sensitive development near State-controlled roads require implementing appropriate road traffic noise attenuation strategies. The Department recognises that implementing some of the noise attenuation strategies may not result in the same noise level for all noise sensitive receptors.

Several noise attenuation strategies are available for both departmental projects and proposed developments. The selection of strategies depends on site specific characteristics and noise sensitive receptors. Any selected strategy or the combination needs to be 'fit for purpose' in the surrounding environment (e.g. built environment and streetscape).

The strategies outlined in Table 6.1 indicate a design philosophy that should be adopted when assessing the impact of a departmental project or a proposed development in terms of road traffic noise. Each strategy has been allocated a Strategy Number (SN) indicating a departmental order of preference. For example, the Department's preference is to construct an Earth Mound (Landscaped) (SN2) rather than Noise Fence (Only) (SN4). However there are many existing built environment situations where construction of an earth mound is not practical.

Table 6.1 - Planning strategies for noise attenuation

SN	Strategy Number and Description	Applicable to the Department	Applicable to Proposed Development
1	Noise Sensitive Use Exclusion Zone (Buffer) or Building Location Envelope	No	Yes
2	Earth Mound (Landscaped)	Yes	Yes
3	Noise Fence and Earth Mound (Landscaped)	Yes	Yes
4	Noise Fence (Only)	Yes	Yes
5	Noise Barrier and Building Design	Yes	Yes
6	Building Design (Only)	No*	Yes
7	Pavement Surface Treatment	Yes	No

*Note: Exceptional circumstances treatments may be applicable for departmental projects.

The listed strategies or combinations of the strategies are likely to be sufficient for most departmental projects and proposed developments. It is not possible, however, to anticipate all future situations and scenarios. A road traffic noise assessment report may identify and recommend alternative strategies.

In implementing the noise attenuation strategies, the Department's primary interest is to ensure the criteria specified in Chapter 3 for departmental projects and criteria specified in the departmental *Environmental Emissions Policy* (EEP) for proposed development are addressed at the following locations:

- at building facades
- in open spaces and recreational areas.

For proposed developments, when applicable, the proposed strategies should be accepted if the strategies:

- comply with the criteria set out in the EEP
- do not affect the safety and efficiency of the State-controlled road.

Acoustical consultants should appropriately integrate preferred strategies from the Department and the local government when designing the required noise attenuation treatments to manage the impact of road traffic noise.

6.2 Noise attenuation strategy decisions

For departmental projects, the Department's preference will be implementing noise attenuation within road corridors by using noise barriers. In rare situations, the Department may consider exceptional circumstances treatments for noise sensitive buildings outside road corridors.

For proposed developments, the process for considering each strategy is outlined in Figure 6.2.

The Department generally discourages noise sensitive development land uses adjacent to the State-controlled road corridor. However, these decisions are made at the land use planning stage in local government planning schemes via state planning policies. Where such policies allow noise sensitive development within noise affected areas, the strategies set out in the following sections should be used to ensure the impact of road traffic noise is minimised.

6.2.1 SN1 - Noise sensitive use exclusion zones

As noise levels reduce with distance, the Department encourages developers to have noise sensitive uses located away from the State-controlled roads from the Noise Sensitive Use Exclusion Zone (buffer). This strategy allows for compliance with noise criteria without needing physical barriers or acoustic building design. With increasing distance of a receptor from a road, noise levels become more constant. A more constant road traffic noise level tends to be more acceptable than a widely fluctuating level.

In many urban areas this strategy may not be viable due to low lot yield, small lot sizes and high land costs. It should only be considered where viable.

This strategy may be used 'in full' or 'in part'. 'In full' means that all receptors in the development comply with the Primary Criteria of the EPP. 'In part' means the development design locates sensitive uses as far from the road as possible to reduce road traffic noise levels. Some receptors may still be impacted by road traffic noise and exceed the criteria. Alternative noise attenuation strategies will be necessary to achieve the criteria for these receptors.

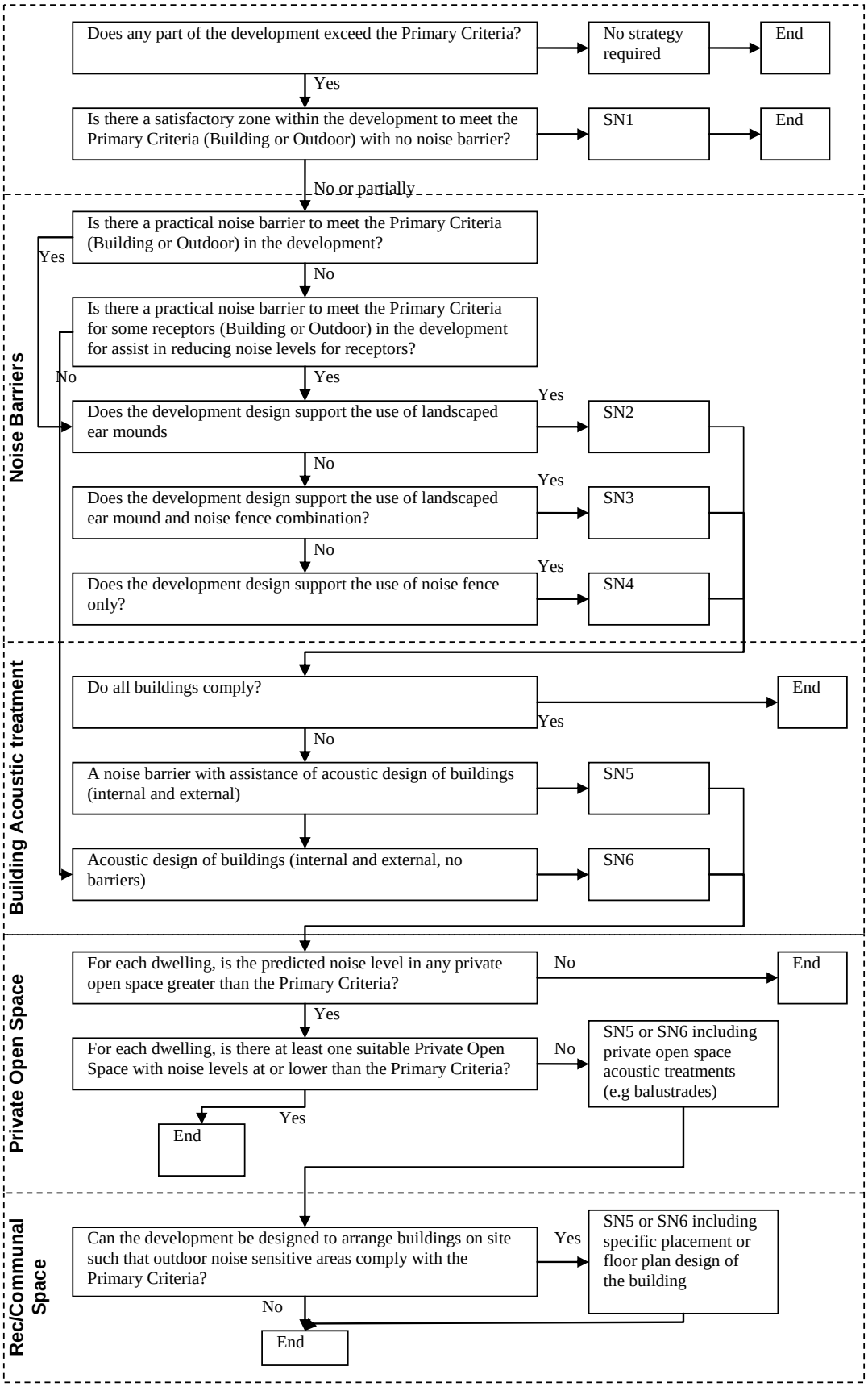
6.2.2 SN2, SN3, SN4 - noise barriers

A noise barrier is defined in the CoP as 'a natural or artificial physical screen located between the source of the noise (road traffic) and a receptor (e.g. residence), which interrupts the path of the noise. A specifically located fence, wall or earth mound may act as a noise barrier. The physical screen shall possess sufficient mass to attenuate the noise'.

A noise barrier can take the forms including:

- earth mound
- earth mound and noise fence
- noise fence.

Figure 6.2 - Strategy decision flow chart for development



An earth mound is the preferred noise attenuation strategy if it can be practically implemented by the applicant. If there is insufficient space for an earth mound in isolation, the next preference is a combination of earth mounds and noise fences. If an earth mound is not possible, a noise fence only needs to be considered.

All noise barriers and landscaping shall be designed and constructed in accordance with the Department's Technical Standards. For detailed requirements regarding landscaping, the Department's Road Landscape Manual should be consulted.

6.2.3 SN5, SN6 - acoustic design of buildings

Where buffers and noise barriers are not adequate to meet the Primary Criteria of the EEP, appropriate acoustic design of the buildings is required to meet the Secondary Criteria. This mainly applies for a Material Change of Use for attached dwellings (e.g. units and townhouses), educational establishments (including childcare centres), health care services (including hospitals), community uses (including places of worship) and offices.

Noise sensitive uses associated with a building may include:

- habitable rooms (e.g. bedrooms)
- private open space (e.g. balconies or patios).

Appropriate acoustic design of buildings includes:

- non-noise sensitive buildings to shield noise sensitive buildings from the noise source
- building design to place habitable rooms away from the noise source, and using building bulk to shield those areas
- building façade treatments that improve the road traffic noise reduction (outside to inside)
- building façade form and function (regardless of special acoustic characteristics) that improve the road traffic noise reduction (outside to inside).

6.2.4 SN7 – pavement surface treatment

Road pavement surface treatment is not an appropriate treatment for noise attenuation for proposed developments. It involves resurfacing the pavement with all the complications of traffic control, traffic congestion, departmental supervision and disruption of departmental works programs.

Pavement surface treatment is considered beneficial for noise attenuation only when the average speed of traffic is at least 60 km/h and free-flowing. Open Graded Asphalt is a quieter pavement surface material than Dense Graded Asphalt. However it has the following limitations:

- kerbs and channels are usually required which tend to obstruct free flowing drainage
- the pavement must be structurally sound
- pavement surface life is shorter
- OGA cannot be overlaid.

6.3 Noise attenuation using noise barriers

The Department generally only considers noise attenuation treatments for access controlled roads within road corridors. The treatments can be in the form of:

- noise barriers (earth mounds, noise fences or the combination)

- road surface treatments.

There are instances where noise barriers may not be implemented within the road corridor due to technical feasibility (an engineering consideration of what can be practicably constructed – minimum height of a noise fence shall be 1.8 m and/or a minimum of 3 dB(A) noise reduction shall be achieved at the façade of the most exposed noise impacted receptor). Technical feasibility may be restricted by:

- topography
- access requirements
- sight distance
- utility services
- presence of local streets
- other noise sources in the area
- security
- vehicle and pedestrian safety
- amenity considerations (streetscape and built environment).

Depending on the situation, it may be possible to combine a concrete safety barrier, retaining wall, earth mound and noise fence (or various combinations of these) to achieve an acceptable outcome regarding:

- acoustic issues (e.g. noise barrier as close as possible to the source or the reception point)
- land acquisition (e.g. resumption)
- engineering or environmental issues (e.g. reduction in the footprint width of a mound).

The following sections focus on the location of noise barriers, noise barrier and concrete safety barrier combinations, and preferred noise barrier options in conjunction with other road furniture for new roads, existing roads or bridges.

6.3.1 Location of noise barriers

Where retaining walls, noise barriers and fences are constructed and owned by the Department, they must be constructed entirely on land controlled by the Department to facilitate maintenance. They must not encroach onto adjoining lands. This includes footings and piling associated with the noise fences.

A developer's noise attenuation treatments (e.g. noise fences) on a private property near a road corridor boundary shall be entirely within the property. Where land is used outside of the road corridor (including buffer strips) for the purpose of noise fences and landscaped earth mounds, it shall be owned and maintained by the private land owners or local government.

Developers' noise barriers may be permitted within the State-controlled road corridor in limited situations where applicants can show alternative structure locations are appropriate. In these situations, an applicant will be:

- conditioned to pay to the Department 10 years maintenance costs upfront. These costs will usually be a minimum of 50% of the construction cost. If future planning is known by the Department (e.g. upgrading within 10 years), then a minimum of 100% of the construction cost

will apply. The construction cost shall be determined from the Department's cost base. The construction cost could include those for the noise barrier, safety barrier, embankment widening, pavement widening and extension of drainage structures.

- required to obtain further approval under the *Transport Infrastructure Act 1994* before any work is undertaken for the design and construction of the barrier.

Barriers within the road corridor will not be permitted if they are inconsistent with the Department's future planning.

In any case, a minimum height of a noise fence should be 1.8 m so that it doubles as a man proof fence. The noise barrier should be landscaped to permit dense screen plantings where possible. Local councils may have height limitations on fences. Any proposed noise barrier should also meet council requirements. The Department will determine the final outcome.

6.3.2 Noise barrier on property boundary

A boundary fence is defined as a structure for enclosing any land. It may include a ditch or embankment, or a hedge or similar vegetation barrier.

Walls (including retaining walls and noise barriers) serve a different purpose than fences. They are engineered for a specific purpose. Walls are not normally a joint responsibility for neighbours because a wall is usually of more benefit to one neighbour.

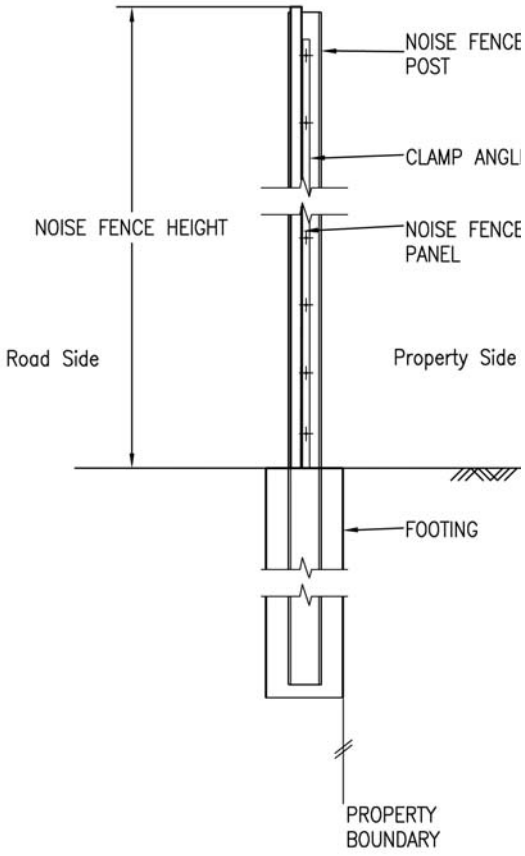
Encroachment on neighbouring property is unlawful. A retaining wall or noise barrier fence, and associated footings and underground piling, may constitute an encroachment. An encroachment can also be an extension of any building, improvement or structure located on one property (e.g. a driveway) across a boundary line and onto adjoining property. The legislation deals with man-made encroachments made with building materials of a substantial and lasting character.

Court orders regarding encroachment could be made for:

- legal costs involved in court proceedings
- compensation to the adjacent owner
- transfer or lease of the land to the encroaching owner
- removal of the encroachment.

Encroachments could result in substantial cost to the Department. Following a community engagement process where it is proposed to construct a noise barrier on a property boundary, the Department shall enter into an agreement with the property owner. A licence to enter and construct a noise barrier shall be developed (refer to Appendix 8 for an example of a deed of agreement). Figure 6.3.2 gives an example of locating a departmental noise fence on the property boundary.

Figure 6.3.2 - Departmental noise fence on property boundary



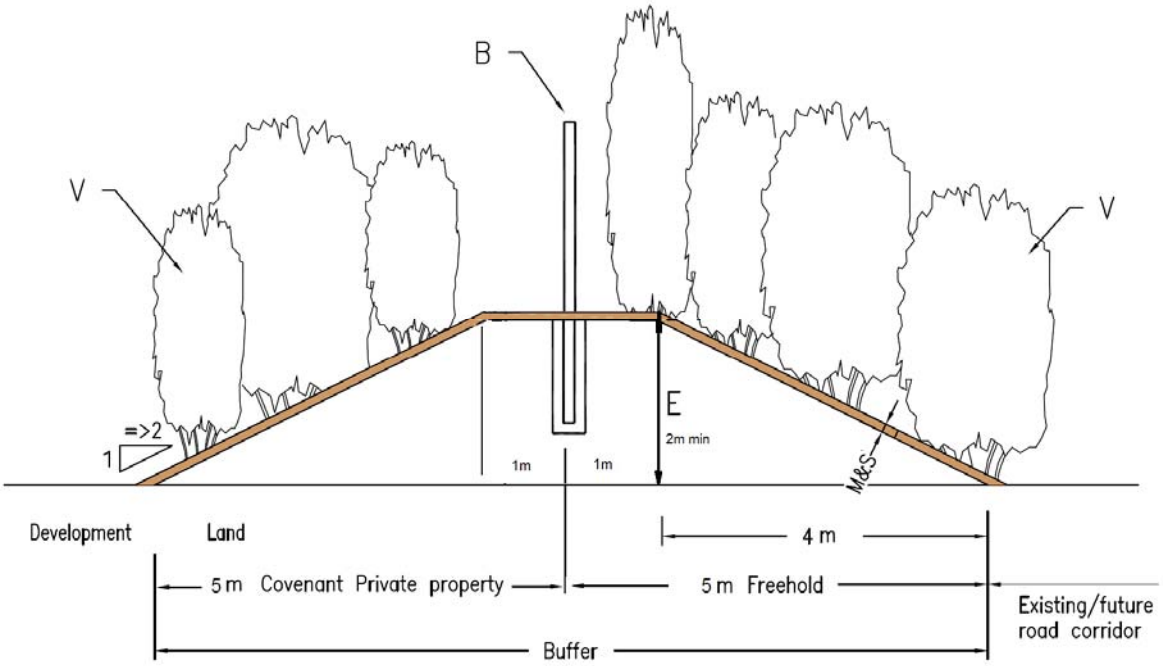
Where a swimming pool exists, the noise fence constructed on the property boundary shall be constructed taking into account all relevant local government by-laws.

6.3.3 Location of earth mounds

Any earth mounds associated with departmental projects shall be placed entirely within the road corridor.

Developers may propose to place earth mounds within the subject development site as shown in Figure 6.3.3. In these situations the property owner will be required to maintain the noise mound in good order, acoustically and structurally. A registrable covenant should be placed on the title for the portion of the land within the private property. The freehold portion of the land will be maintained by the responsible authority (i.e. relevant local government or the Department).

Figure 6.3.3 - Earth mound example



V = Landscaping to the requirements and satisfaction of the Chief Executive Officer of the relevant local government or the Department

E = Embankment material constructed to the Department of Transport & Main Roads Standard Specification MRTS 04.

M&S A minimum 50 mm layer of planting media with a minimum100 mm layer of mulch on top.

B = Noise Fence designed in accordance with Transport & Main Roads Department Transport Noise Management: Code of Practice Volume 1 – Road Traffic Noise.

Note :

All work shall be designed and approved in accordance with the above requirements unless altered in writing by the Director General, Department of Transport & Main Roads.

All work shall be installed and maintained in accordance with the approved plan to the satisfaction of the Director General, Department of Transport & Main Roads. The installed approved works shall be completed prior to the commencement of the use onsite, unless approved otherwise.

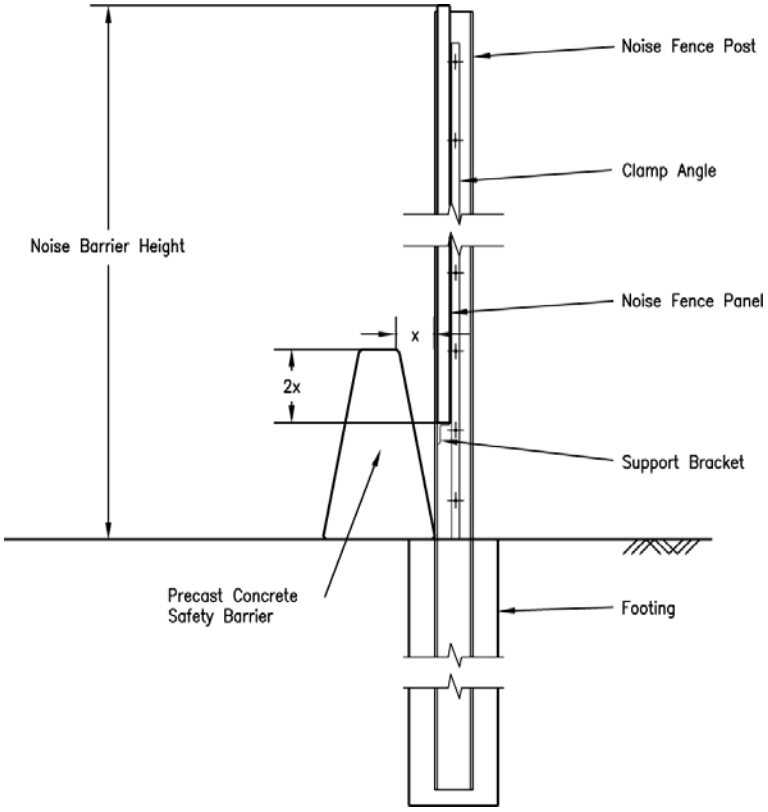
6.3.4 Noise fence and concrete safety barrier

Risk assessment shall be undertaken to decide whether a noise fence can be located on top of a concrete safety barrier or behind the concrete safety barrier. The assessment should consider the possibility of the noise fence falling onto a pedestrian or specific sensitive object, e.g. light pole or electrical switchboard. If the risk is low, it is considered that the noise fence could be located on top of the concrete safety barrier.

To determine the most suitable cross section for the combination of safety barriers and noise fences, Clause 7.10.3, specifically Figure 7.22 - Working Width, of the Department's *Road Planning and Design Manual* shall be referenced.

If a precast concrete safety barrier is proposed to be used, it is recommended that Option A be used (refer to Figure 6.3.4 (a)).

Figure 6.3.4 (a) – Option A – Precast concrete safety barrier



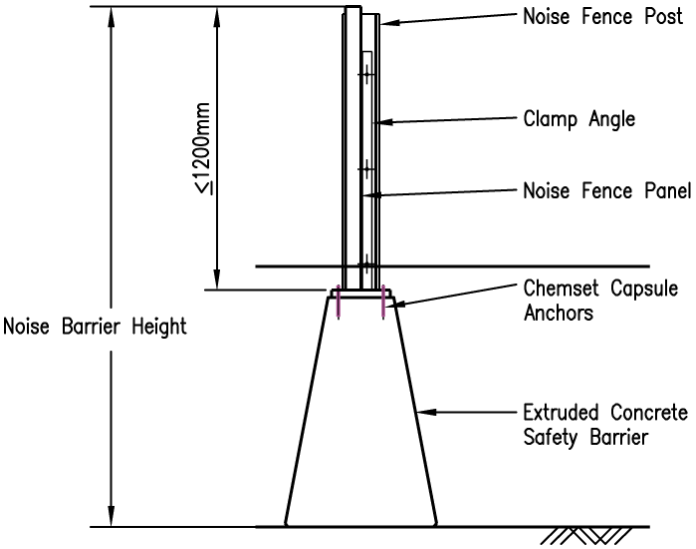
It is considered that there will be sufficient space for the noise fence post to be placed behind the precast concrete safety barrier even though it might be close to the hinge point. This can be easily catered for in the structural design. The noise barrier posts actually support the precast concrete safety barrier.

A gap is permitted below the noise fence in order to ensure any rubbish between the precast concrete safety barrier and the noise fence to pass under the noise fence. The vertical overlap between the precast concrete safety barrier and the noise fence shall be two times the horizontal distance between the top of the precast concrete safety barrier and the noise fence.

Options B, C and D described below can be considered if extruded concrete safety barriers are proposed.

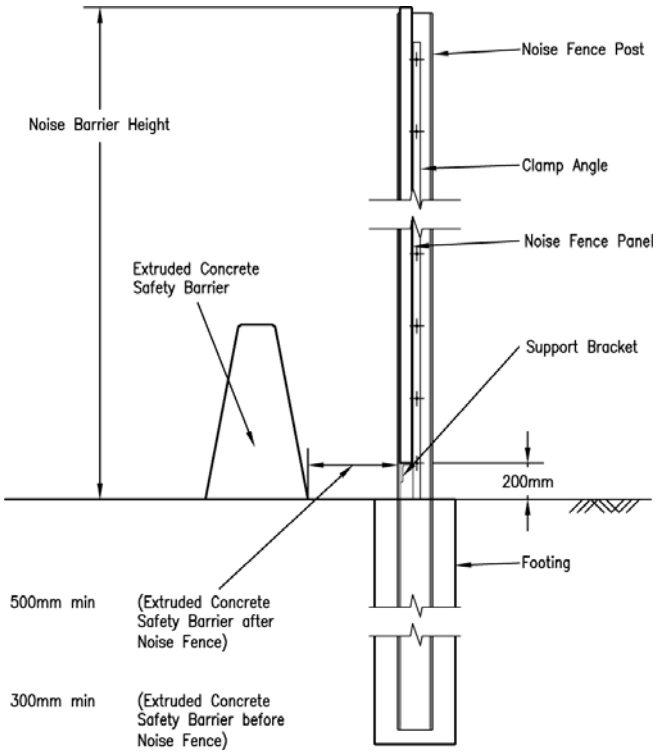
Option B: For low noise fences ≤ 1200 mm above extruded concrete safety barrier, it may be possible to fix the noise fence posts to the top of the extruded concrete safety barrier subject to structural considerations (refer to Figure 6.3.4 (b)).

Figure 6.3.4 (b) - Option B – Extruded concrete safety barrier



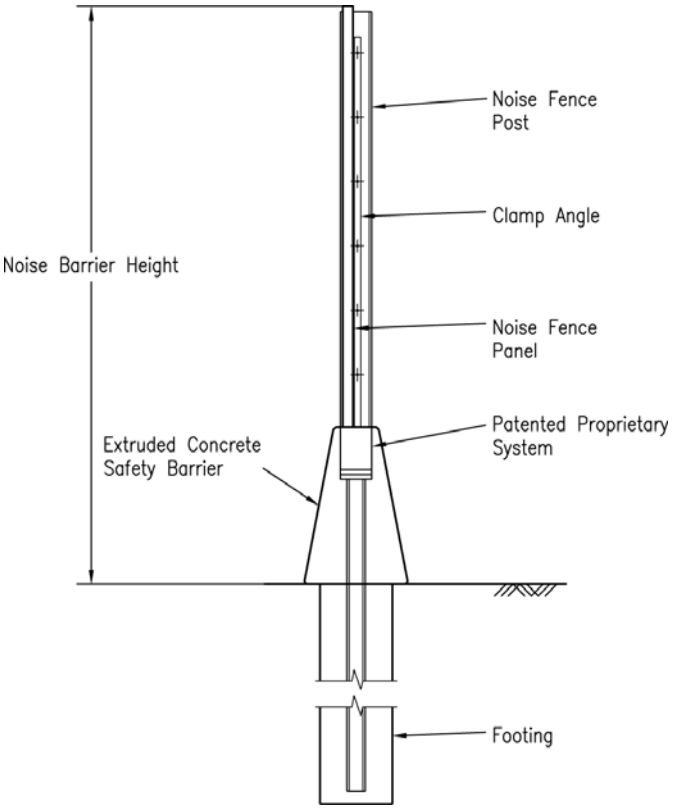
Option C: For visual amenity reasons, the preference would be to locate the noise fence behind the extruded concrete safety barrier. However, for constructability reasons, if the extruded concrete safety barrier is to be placed after the construction of the noise fence, the noise fence posts will need to be located a minimum of 500 mm from the toe of the extruded concrete safety barrier. If the extruded concrete safety barrier is to be placed before the construction of the noise fence, the noise fence posts will need to be located a minimum of 300 mm from the toe of the extruded concrete safety barrier. It will be necessary to provide a gap of approximately 200 mm under the noise fence in these instances to enable rubbish collected between the extruded concrete safety barrier and to be removed under the noise fence. Even if a noise fence post is to be located beyond the hinge point on the fill batter, this can be easily catered for in the structural design (refer to Figure 6.3.4 (c)).

Figure 6.3.4 (c) - Option C – Extruded concrete safety barrier



Option D: For a higher noise fence on top of an extruded concrete safety barrier, a patented proprietary system is available (refer to Figure 6.3.4 (d)).

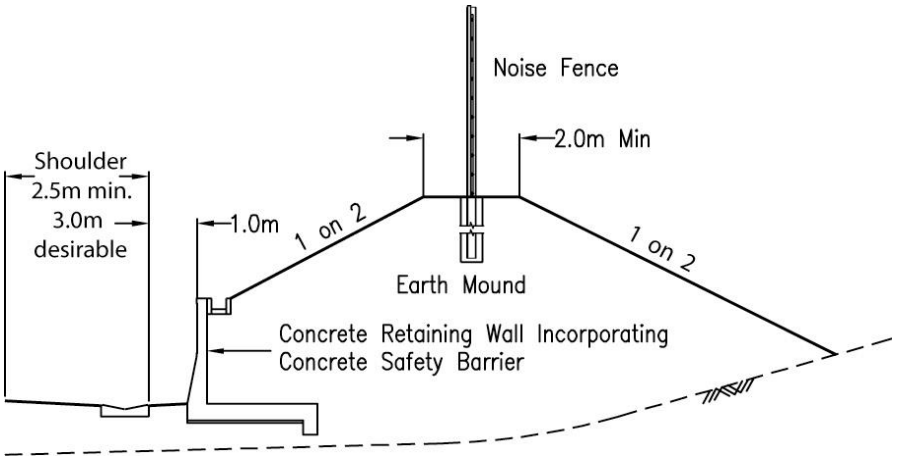
Figure 6.3.4 (d) - Option D – Extruded concrete safety barrier



6.3.5 Noise barriers for new roads

A landscaped earth mound is the preferred noise treatment option for new roads. When a noise fence is used, the maximum preferred height of the noise fence shall be 4 m above the proposed ground level, natural ground level or earth mound level. The minimum offset from a noise fence to the back of any guard rail posts shall be 2.5 m (refer to Figure 6.3.5).

Figure 6.3.5 - Safety barrier, retaining wall, earth mound and noise fence combination



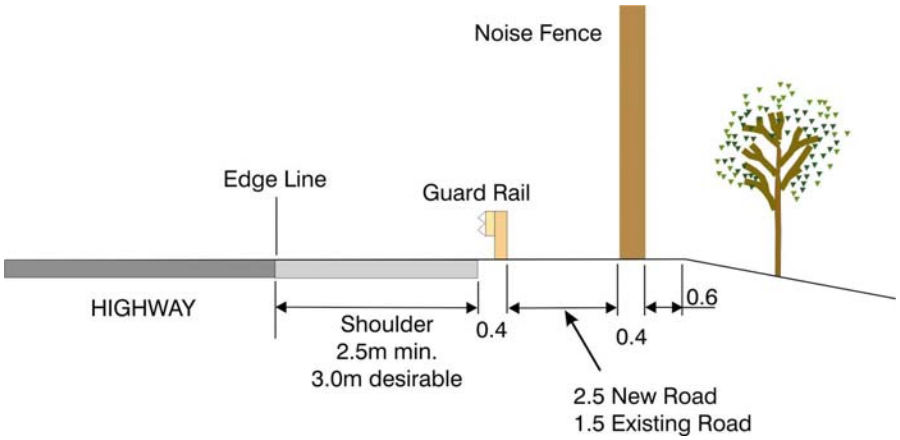
The combination of a noise fence on top of a concrete safety barrier is not preferred for new roads. It may be appropriate to combine these elements if there are savings to be made regarding land acquisition (resumption), engineering or environmental issues.

6.3.6 Noise barriers for existing roads

A landscaped earth mound is also a preferred noise treatment option on existing roads, although this may be often restricted by the corridor. Hence noise fences may be more feasible.

When a noise fence is used, the maximum preferred height of the noise fence (including the combination of a noise fence and a concrete safety barrier) shall be 6.0 m above the existing or proposed ground level or earth mound level. The minimum offset from the noise fence to the back of any guard rail posts shall be generally 1.5 m (refer to Figure 6.3.6).

Figure 6.3.6 - Requirements for safety barriers



6.3.7 Noise barriers on bridges

Being raised above ground level, bridges often present an opportunity for outward views from the road. Transparent noise fences should be considered where there are significant views.

Noise Fences should be offset from the outer edge of the bridge to reduce the tunnelling effect. Horizontal alignment of the noise fence should continue in line with the alignment of the noise fences approaching the bridge (where possible). Generally, elements fixing the noise fence to the bridge should not dominate the design, but should create an integrated appearance.

Where bridges are located on horizontal curvature, noise fences should be offset from the outer road edge on the inside of the curve to reduce obstruction of sight lines. Where structurally practicable, the minimum offset from the outer edge should be determined according to sight line requirements specified in Chapter 7.

6.3.8 Removal or replacement of existing noise barriers

Sometimes, existing noise barriers need to be removed or replaced. A community engagement strategy is required to manage community expectations regarding the permanent removal of noise barriers or temporary removal for a period prior to replacement.

Any re-alignment of noise barriers involving removal or replacement of noise barriers shall not cause noise impacts on adjacent noise sensitive receptors to be measurably increased. This can be supported by road traffic noise modelling, pre and post construction measurements.

The new noise barrier shall generally be at least the same extent and height as the existing noise barrier with a minimum height of 1.8 m. The noise barrier shall incorporate the design requirements detailed in Chapter 7 for greater integration with new or future road works.

6.4 Application of Exceptional Circumstances Treatments (ECT)

In exceptional circumstances for departmental projects, the Department may consider noise attenuation treatments outside the transport corridor for individual noise sensitive buildings. This is at the discretion of the Regional Director.

6.4.1 Applicability of ECT

ECT is applicable to residential, educational, community and health buildings. The following issues shall be noted when considering ECT:

- ECT will only be considered for access-controlled roads, where noise barriers would be a possible noise attenuation treatment option but unsuitable because barriers:
  - are not cost-effective (e.g. barriers for isolated dwellings)
  - cause unacceptable impact upon visual amenity (e.g. required barriers too high and unsuitable for the streetscape / built environment)
  - affect security (e.g. for educational facilities where Crime Prevention Through Environmental Design principles needs to be considered).
- If a row of dwellings is being considered for ECT, the relevant criterion level may not actually be exceeded for some of the dwellings in the row. For consistency, consideration should be given to providing at least mechanical ventilation to those dwellings.

The following ECT treatment options can be considered:

- closing windows
- installing a mechanical ventilation system / air-conditioning system for ventilation/comfort requirements
- architectural treatment of the building envelope.

In providing mechanical ventilations, a mechanical ventilator shall have the following characteristics:

- takes in outside air in accordance with the Building Code of Australia
- removes engine emissions
- low internal noise
- adjustable airflow
- absorbs airborne noise
- quietly provides a healthy supply of clean, fresh air.

For ECT treatments for educational, community and health buildings, it will be necessary to determine an agreed apportionment of capital costs between the Department and the institution concerned.

The Department will not contribute to the running / maintenance costs of the treatment. These will be the responsibility of the dwelling occupier or the institution concerned.

Road traffic noise assessment regarding providing ECT treatments shall be conducted in accordance with Charter 4. In particular, the following shall be considered:

- The acoustical assessment provider shall adopt appropriate quality control procedures when conducting the road traffic noise assessment. Specific quality control measures shall be

implemented when undertaking road traffic noise level measurements, calculations, verification and predictions.

- The assessment methodology, assumptions, measurement results, calculations, predictions and verification outcomes shall be adequately documented in the road traffic noise assessment report to enable an independent acoustical assessment auditor to easily review, test and reproduce the assessment outcomes.
- For highly complex and large scale projects, an audit program is required to be incorporated as part of the assessment process and shall be undertaken by an independent acoustical assessment auditor. This may be achieved by establishing one or more test cases. Each of the test cases is assessed by an assessment provider and reviewed by an independent assessment auditor.

6.4.2 Limitations of ECT

ECT does not apply to the following situations:

- non-access controlled road
- dwellings that are not permanent noise sensitive buildings (e.g. caravan park, cabin or demountable)
- heritage listed buildings or light weight character buildings.

For noise sensitive buildings near access controlled roads, ECT will not be considered if:

- a noise barrier can be reasonably provided in the Regional Director's opinion
- the property owner does not want a noise barrier to be provided.

In this case, the property owner will be requested to sign an Agreement Form (refer to Appendix 9) to acknowledge that he / she:

- does not want a noise barrier to be constructed
- will not be eligible for an exceptional circumstances classification.

Word versions of the agreement are available on the department's *Transport noise management: code of practice* webpage.

A dwelling on a corner block adjacent to a row of dwellings on a non-access controlled road will be considered to be fronting a non-access controlled road even if its access is to a side road. It will not be considered for the provision of a noise barrier or ECT. This is due to consistency issues regarding the provision of noise attenuation treatments for all dwellings in the row.

6.4.3 Implementation of ECT

When ECT provisions prevail, road traffic noise assessment needs to include the prediction of noise levels at the façade(s) of every building where the criterion level is likely to be exceeded for a 10 year horizon. This will provide a preliminary list of buildings which may be eligible for treatment in accordance with the ECT criteria in Chapter 3.

The Department (or its representatives) will engage the acoustical assessment provider which undertook the assessment to conduct an inspection of each building with due consideration being given to the predicted noise level, in order to confirm whether or not the building, and which facades of habitable rooms, are eligible for treatment.

The Department will confirm in writing whether or not the building qualifies and, if so, provide indicative details of the proposed treatment. The agreement and other relevant information in Appendix 10 is provided to assist in this process.

Once the confirmation has been made that the building qualifies for treatment, and the owner(s) agree in writing to proceed, the following process shall be put in place:

- The Department will engage a mechanical ventilation/air-conditioning contractor/consultant to inspect the building and prepare a written proposal including scope of works and a schematic design. The contractor/consultant will be requested to provide a written quote to the Department. The contractor/consultant will be accompanied by the nominated project manager who will co-ordinate all aspects of the work.
- The nominated project manager will contact the building owner(s) in writing to provide details of the proposal and seek agreement in writing to proceed with the treatment. An Agreement Document will be sent to the building owner(s), which will include the scope of works and a schematic design, for signature by the building owner(s) to indicate that the owner(s) is satisfied with the proposal and wish to proceed with the treatment. A (Road) In House Treatment Project Agreement – Frequently Asked Questions document should be provided to the building owner(s).
- When the Department receives the signed agreement, the Department will instruct the contractor/consultant to proceed with the works. The nominated project manager shall instruct the contractor/consultant to undertake an existing condition survey of the building, both inside and out where the works will be undertaken prior to the commencement of these works. The works will be supervised by the nominated project manager.
- On completion of the works, the nominated project manager will request the owner(s) to sign a copy of an Acknowledgement of Installation Form. The owner(s) will be provided with any manufacturer's warranty details for any air-conditioning /mechanical ventilation system(s) and/or architectural treatment of the building envelope installed.
- A current equipment rebate may apply should a building already have an air conditioning / mechanical ventilation system and the building owner(s) requests to keep the existing system. The existing system, in the opinion of the project manager, meets the suitability and functionality requirements of the required equipment e.g. State and Commonwealth legislation, sized correctly, energy efficiency, installed correctly and at least 60% of its warranty remaining. The current equipment rebate may be paid to the owner(s) for the amount that it would have cost the Department to install a new system. The amount shall include the GST component. The Department does not claim back the GST component. The nominated project manager will request the owner(s) to sign a copy of the appropriate agreement.
- This current equipment rebate only applies to those noise sensitive rooms where the predicted external façade corrected noise level exceeds the criterion level. If an applicable noise sensitive room does not have existing air conditioning / mechanical ventilation system, a current equipment rebate shall not apply. The building owner(s) shall be offered the applicable treatment.
- Where the owner(s) has requested that no treatments to the property outside the road corridor be provided, no current equipment rebate will be paid and the nominated project manager will request the owner(s) to sign a copy of the appropriate Agreement.

7 Integrated noise barrier design

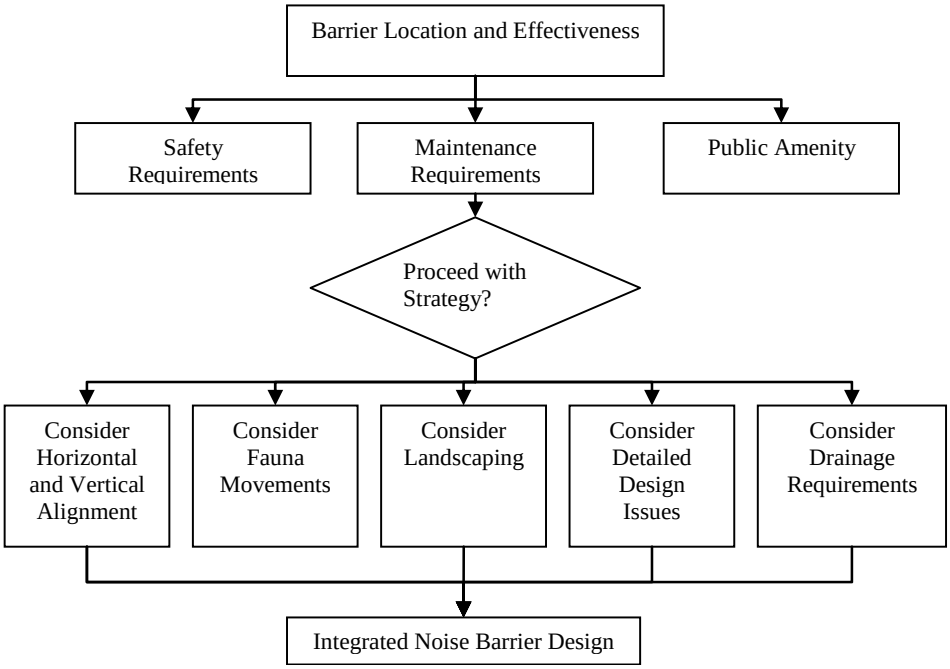
7.1 Introduction

Integrated noise barrier design is an interactive process where social, economic, visual amenity and technical factors are considered to arrive at a preferred noise attenuation strategy. Site conditions between the road and noise sensitive receptors may also change during the design period. Consequently, the final noise barrier design might differ from that proposed in the road traffic noise assessment.

Road traffic noise barrier design is affected by the following factors:

- barrier location and effectiveness
- safety requirements
- maintenance requirements
- public amenity
- fauna movements
- horizontal and vertical alignment
- visual amenity
- community engagement
- detailed noise barrier design issues.

Figure 7.1 - Integrated noise barrier design process



Selection of noise barriers should be based on the following order of preference:

- landscaped earth mounds
- landscaped earth mounds and noise fences in combination
- noise fences.

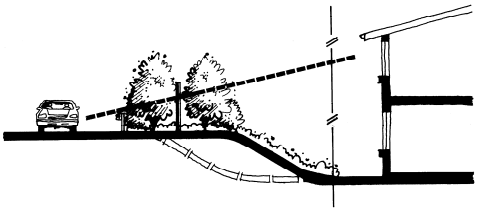
Figure 7.1 outlines an approach to the integrated noise barrier design.

7.2 General barrier locations and effectiveness

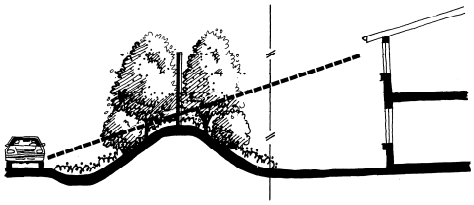
Noise barriers are most efficient when placed close to noise sources or receivers. Figure 7.2 (a) illustrates examples of some possible noise barrier locations.

Figure 7.2 (a) - Possible barrier locations

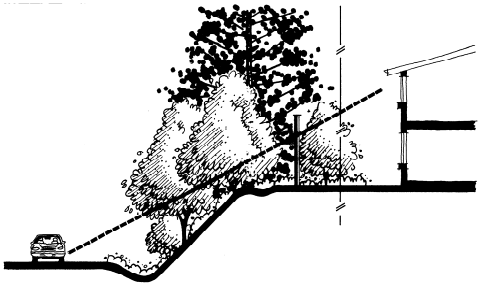
Noise fence on widened embankment



Noise fence in combination with earth mound



Noise fence on top of cutting



Earth mounds and/or noise fences are effective only when the line of sight between the source and reception point is fully interrupted. In some cases, their effectiveness is limited and largely dependent upon the local topography and height of buildings.

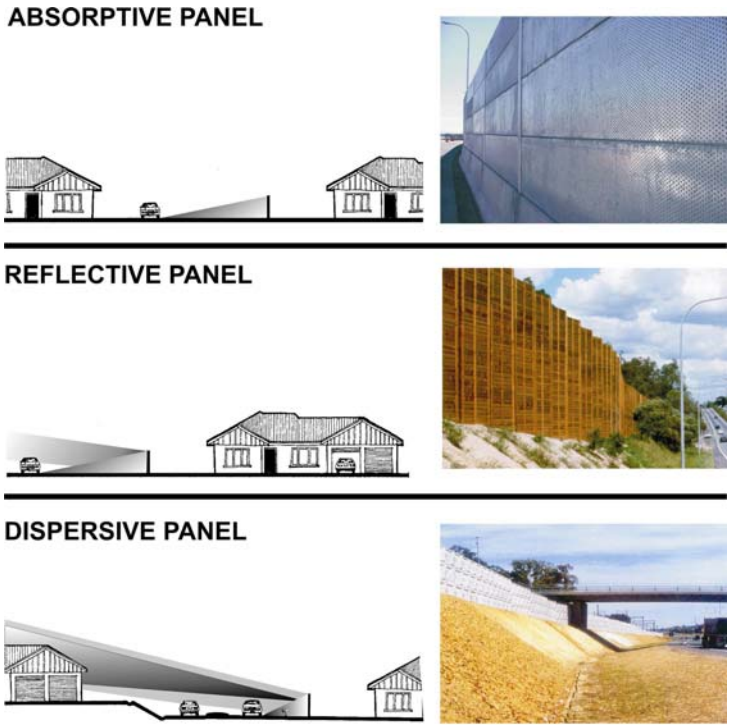
Noise barrier effectiveness also depends on the barrier acoustic properties which include:

- absorption
- reflection
- dispersion
- diffraction.

Absorptive noise fences contain materials that absorb sound waves. Reflective noise fences force sound waves to reflect back off their surface. Dispersive noise fences contain materials and/or patterns that may alter the sound waves that come in contact with the noise fence (refer to Figure 7.2 (b)). Diffraction is a process by which sound waves can bend over a fence.

Appendix 11 provides more information on the range of noise barrier types available.

Figure 7.2 (b) - Types of noise fences



To achieve full acoustic effectiveness, all noise fences shall be designed and constructed in according to departmental Standard Specification, MRTS15 *Noise Fences*. At the date of the noise barrier design, the current version of MRTS15 shall always apply.

Earth mounds shall be designed and constructed according to the departmental Standard Specification, MRTS04 *General Earthworks*. They shall be landscaped according to the departmental Standard Specification MRTS16 *General Requirements Landscape and Revegetation Works*. Maintained landscaped earth mounds constructed to departmental specifications may be considered as an absorptive noise barrier treatment.

The type of ground surface over which road traffic noise travels has a substantial effect on noise attenuation, particularly over large distances. Areas covered with grass are more absorptive than hard, paved surfaces or bodies of water which reflect noise. Dense plantings of trees with an understorey of shrubs may result in a reduction of 3 dB(A) per 30 m of width (Harris, 1988).

7.3 Safety requirements

Safety requirements must be considered when siting noise fences. These requirements should be clearly understood by road planners and designers in the planning, preliminary design and detailed design phases.

Safety requirements are concerned with:

- clear zones
- sight distance
- lighting
- crime prevention.

7.3.1 Clear zones

A clear zone is the roadside area that must be kept free of obstructions. This includes the gore area (the triangular piece of land where roads merge or split). It is generally measured from the edge of the trafficked lane, including road shoulders and verges that provide vehicles with a recovery or emergency stopping area.

Figure 7.3.1 (a) and Figure 7.3.1 (b) illustrate the location of a clear zone within a road corridor. The areas that lie beyond the clear zone are the 'transition zone' and 'undisturbed zone'.

Figure 7.3.1 (a) - Clear zone (plan view)

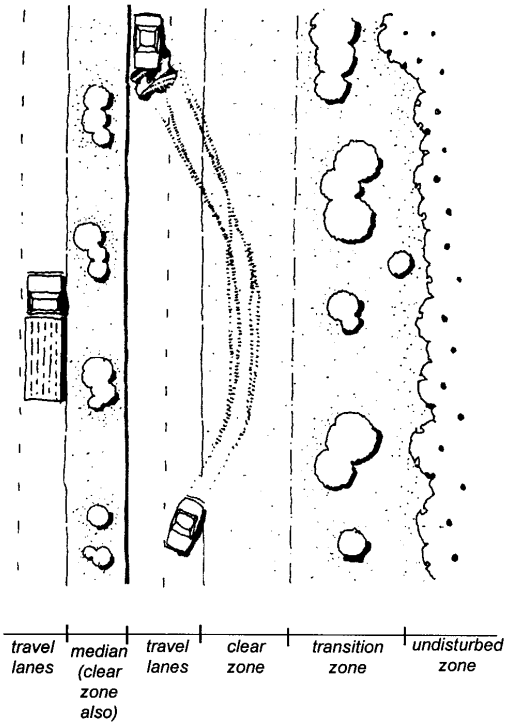
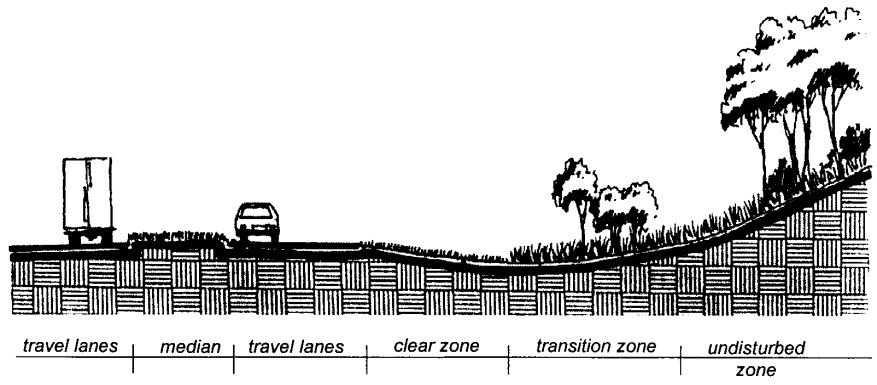


Figure 7.3.1 (b) - Clear zone (section view)



To determine the extent of clear zones for the purpose of siting noise barriers, the following steps should be followed (Chapter 7, Cross Sections, of the *Road Planning and Design Manual 1st Edition* provides guidance on this process):

- determine the required clear zone distance relevant to the design vehicle speed, average daily traffic volume and roadside batter slope

- determine whether the proposed noise barrier lies within the required clear zone
- omit any non-frangible elements in the clear zone. When applying the recommended criteria, consider the horizontal road alignment and any roadside batter slope.

The proposed noise fence shall be protected by safety barriers if it is sited within the required clear zone (refer to Chapter 8, Safety Barriers and Roadside Furniture, of the *Road Planning and Design Manual 1st Edition* for design of appropriate safety barrier requirements).

7.3.2 Sight distance

Sight distance issues need to be considered when siting noise barriers in the following situations:

- Intersections at grade (refer to Chapter 13, Intersections at Grade, of the *Road Planning and Design Manual 1st Edition*)
- Roundabouts (refer to Chapter 14, Roundabouts, of the *Road Planning and Design Manual 1st Edition*)
- Horizontal curvature, bikeways and pedestrian crossings (refer to Chapter 11, Horizontal Alignment, and Chapter 5, Traffic Parameters and Human Factors, of the *Road Planning and Design Manual 1st Edition*)
- Signs should not be obscured from the driver's line of sight (refer to Section 1, Part 2 of the *Manual of Uniform Traffic Control Devices*)
- Merging Traffic (refer to the relevant sections of Chapter 9, Sight Distance, Chapter 13, Intersections at Grade, Chapter 14, Roundabouts, and Chapter 16, Interchanges, of the *Road Planning and Design Manual 1st Edition)*.

7.3.3 Lighting

The location and height of noise barriers should not:

- interfere with overhead lighting
- cast undesirable shadows on the road
- cause non-uniform illumination of the road.

Refer to Chapter 17, Lighting, of the *Road Planning and Design Manual 1st Edition* for lighting standards.

7.3.4 Crime Prevention Through Environmental Design

The concepts and principles of Crime Prevention through Environmental Design (CPTED) shall be considered in the design arrangement and detailing of noise barriers.

There are three main concepts which provide a broad basis for design within public spaces, including road corridors:

- crimes against people and infrastructure are less likely to occur if other people are around to intervene when the space is being used illegitimately
- the presence of people in adjoining buildings and spaces plays a major role if they are able to see, monitor and report what is happening in the public space
- giving people safe choices about where to be and how to anticipate and respond to potential threats, improves personal safety.

There are also specific principles providing guidance on the planning and design of public spaces, which include:

- surveillance
- legibility
- territoriality
- ownership
- management
- vulnerability.

These principles are complementary and need to be applied holistically but not in isolation. This ensures balance between them. These principles need to be considered throughout all stages of a road project.

Figure 7.3.4 provides an example of using transparent barriers to enhance security for pedestrians on pathways beside noise fences which reflects the CPTED principles.

Figure 7.3.4 - Security consideration for pedestrians

For further detail on CPTED concepts and principles, refer to Section 5.4.1 and to the *Road Landscape Manual*, Part C, Chapter 5 – Safety.

7.4 Maintenance requirements

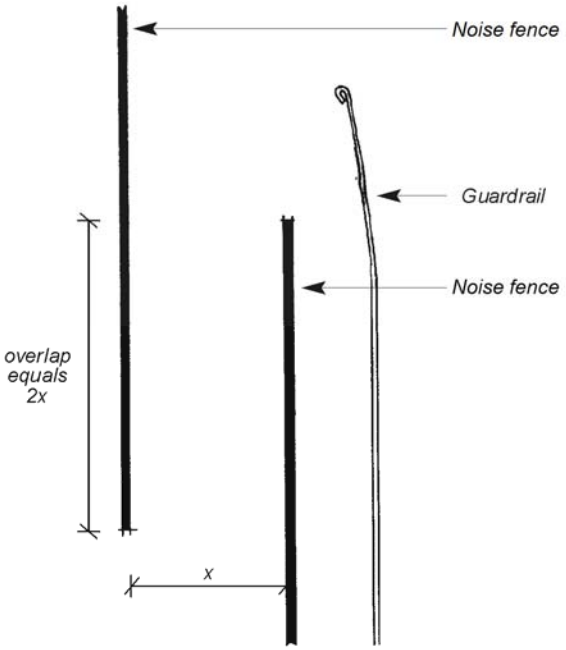
It may be necessary to provide an overlap between noise fence sections to ensure sufficient access for road and roadside maintenance. These overlaps should be incorporated with sufficient distance between noise fence section alignments.

As a minimum, the overlap length shall be at least double the distance between the two noise fence sections (refer to Figure 7.4).

If a noise fence is to be offset to a property boundary fence, the gap must permit maintenance access to the rear of the noise fence. This gap shall be a minimum of 1m wide, and concrete paved according to Standard Specification MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

For noise fences associated with departmental projects constructed on the boundary of private property, a concrete mowing strip shall be constructed on the private property side between the panels and extending approximately 200 mm to the edge of the visible concrete footing. The concrete paving shall also be according to Standard Specification MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

Figure 7.4 - Overlapping of noise fences (plan view)



7.5 Public amenity

Public amenity issues that influence the siting of noise barriers include:

- privacy and security
- shade effect
- air circulation
- views.

Noise fence alignments can serve multiple purposes especially when placed along property boundaries. They can also affect the amenity of the community. For detailed guidance, road designers should consult a suitably qualified landscape architect.

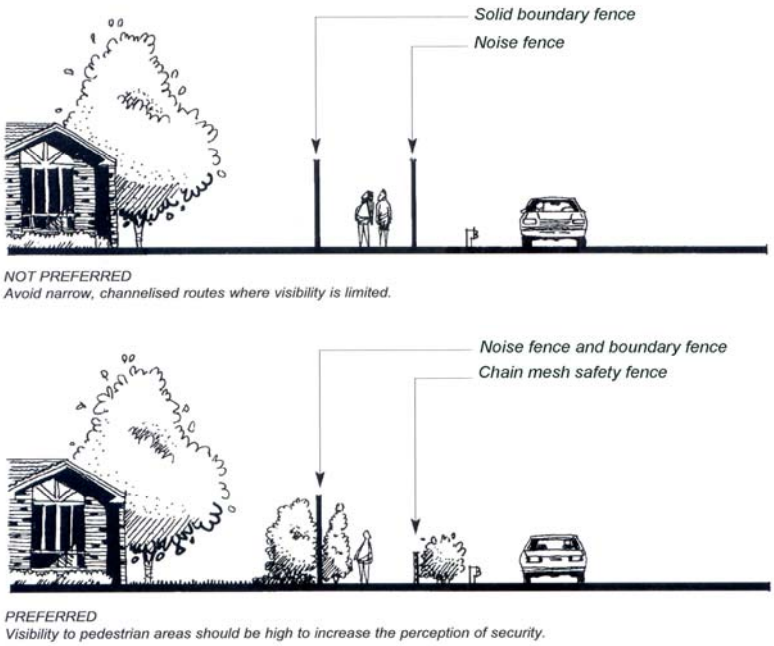
7.5.1 Privacy and security

Privacy implies a degree of protection against visual and physical intrusion. Noise fences can discourage deliberate trespassing, and keep people and animals away from roads from a safety perspective. Security for adjacent housing, pedestrians and cyclists on shared path systems must be considered when designing noise fences. In all situations the concepts and principles of Crime Prevention through Environmental Design (CPTED) shall be considered.

Consolidation of fencing along property boundaries can serve the dual purposes of security and noise attenuation. Near the pedestrian area, the vertical and horizontal alignment of noise fences can play an important role in the perceived level of safety. Long, continuous noise barriers should be avoided to prevent deep shadows (refer to Figure 7.5.1 (a) not preferred).

Boundary fence and noise fence alignments allowing passive surveillance of paths by passing motorists should be encouraged (refer to Figure 7.5.1 (a) preferred). Where possible, spill over lighting from road lighting should not be blocked by noise barriers or vegetation. Where road lighting is inadequate, additional lighting for adjoining pedestrian and cyclist facilities should be considered.

Figure 7.5.1 (a) - Security consideration for boundary fence and noise fence alignments



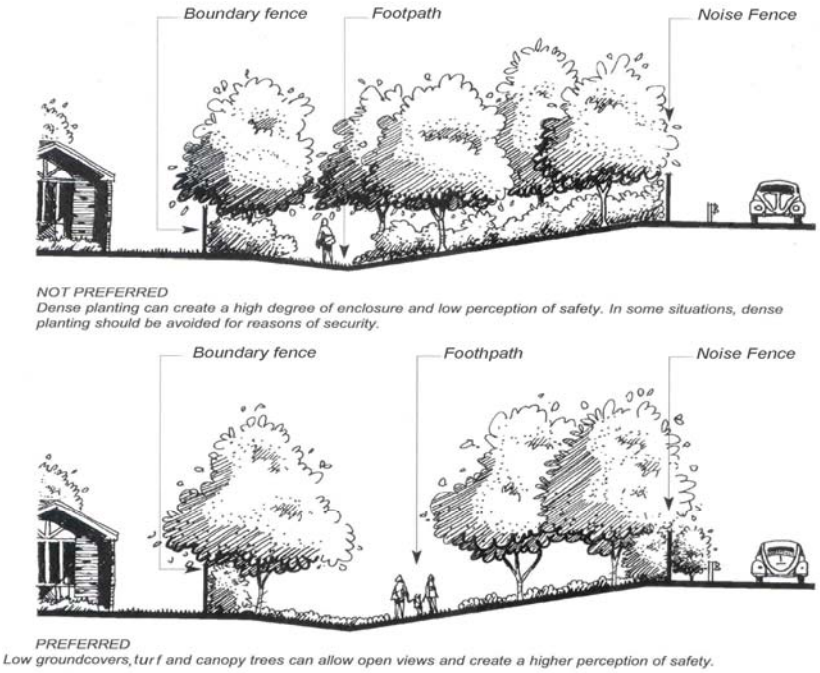
Obscuring or completely blocking views from adjacent land is a primary way to achieve a sense of privacy. Despite this, it may have detrimental effects on views, shade, air circulation, and opportunities for surveillance and improved public safety.

CCTV should be considered where design constraints create public safety issues including poor natural surveillance, to ensure a safer environment for pedestrians and cyclists.

If a noise fence is to be situated offset to a property boundary/fence at a distance of 1 to 4 m, consideration shall be given to providing security gates at either end of the noise fence. This helps prevent undesirable individuals being concealed or having access to the gap between the noise fence and the property boundary/fence. Also, consideration shall be given to providing additional security gates located in line with the side boundary fence of every fourth property. This prevents a clear access route for would be offenders.

Dense planting sometimes can create a high degree of enclosure and a low perception of safety, and should be avoided for reasons of security (refer to Figure 7.5.1 (b) not preferred). In this situation, low groundcovers, turfs and canopy trees can be used to allow open views and create a higher perception of safety (refer to Figure 7.5.1 (b) preferred).

Figure 7.5.1 (b) - Security consideration for planting selections



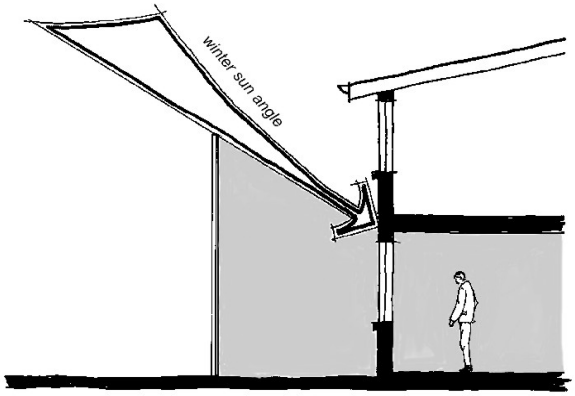
7.5.2 Shade effect

Potentially, shade may dominate the amenity of private areas where noise fences are sited on the northern and eastern property boundaries. This can be further exacerbated when buildings are positioned close to these property boundaries. It is preferred to site noise fences so that the winter sun may penetrate windows (refer to Figure 7.5.2).

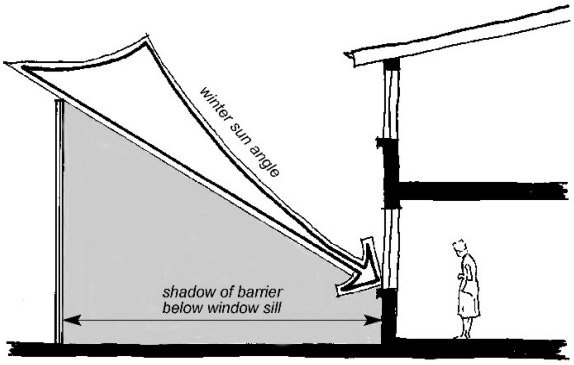
Property owners should be consulted, as there are often conflicting costs and benefits in siting noise fences in such locations. The consultation should highlight the trade-off between the benefits of noise attenuation and the potential negative shade coverage from the noise fence, particularly during winter.

The shade and confinement effects of the noise fence should be considered if it is sited on or near to a property boundary (e.g. within 0 to 3 m). It is recommended that the maximum height of a solid fence be 4 m and any additional height requirements be constructed of transparent materials, in conjunction with community engagement.

Figure 7.5.2 - Noise barrier shade effects



NOT PREFERRED
Noise barrier blocks winter sun on northern and eastern windows

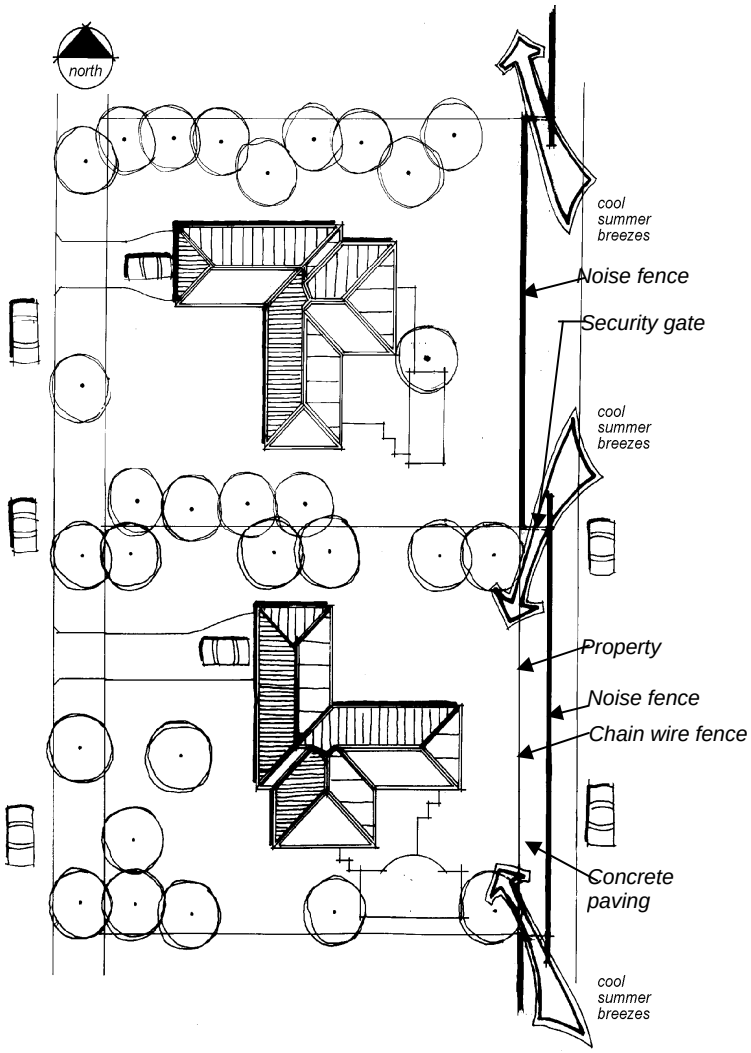


PREFERRED
Winter sun should not be blocked at northern and eastern facing windows

7.5.3 Air circulation

The alignment of noise barriers can block cooling summer breezes, reducing the amenity of indoor and outdoor spaces of adjacent properties. Noise fences greater than 3 m may be overlapped by separate sections to create gaps for breezes to be channelled (refer to Figure 7.5.3). Infill panels of chain wire fencing/security gates can be used at the overlap to ensure safety/security while maintain air circulation.

Figure 7.5.3 - Overlapping noise barriers for air circulation



7.5.4 Views and transparent barriers

Views may be impacted by a noise barrier or materials used in a noise fence. For a view to be retained, it must exhibit a characteristic that is recognised as being significant to the area, the travelling public and the community at a local, state or national level.

The significance of a view, or particular element of a view, must be recognised by:

- State or Federal legislation (e.g. heritage listed buildings, Wet Tropics Areas)
- international convention (e.g. World Heritage Areas), or
- the local community (e.g. a view of high scenic value such as bay views or scenic views to a hinterland which is a permanent part of the landscape (refer to Figure 7.5.4)).

Figure 7.5.4 - Retaining view of high scenic value using transparent barriers

Specific elements of a view may not be recognised against the above criteria as significant for visual amenity. However, they may be recognised by the community generally as having high scenic value and significance to preserve for future generations.

Sometimes, a proposed noise barrier may substantially obscure the direct line of sight to the view. Alternative noise attenuation solutions such as noise barrier design (e.g. realignment, reduction in height) and material selection (e.g. transparent panels), change to pavement surface types or exceptional circumstances treatments may be considered in those areas. This applies where residents who are directly adjacent to a State-controlled road corridor:

- have a view that cannot be lost in the future (that is, future land development could not limit the view)
- have direct uninterrupted line of sight from the existing residence, over the road corridor, to a view that cannot be lost in the future. This means future land development could not limit the view, where a view is obtained across an adjacent privately owned land. The home owner has no control over the neighbouring property (e.g. the neighbour may plant a tree or make extensions to their building or redevelop the site etc.), and
- have a distinct quantifiable benefit from that view.

Transparent material in noise fences may be considered for the retention of a view, or portion of the view, or to provide a transparent window for pedestrians on pathways beside noise fences to fulfil CPTED principles (refer to Figure 7.3.4). Transparent material may also be considered for use in the upper sections of noise fences taller than 4m, to reduce shade effects to a residence as per Section 7.5.2.

Transparent material may only be considered in areas where the majority of residents are eligible and in favour of using transparent material in the noise fence design. It is not considered:

- where there is a history of vandalism and graffiti of the Department's assets
- for preserving the view for the purpose of commercial visibility.

The following issues shall be considered when designing the inclusion of transparent material in noise fences:

- proximity to carriageway or residential buildings
- height of transparent material above the ground
- glare for motorists
- strobing effects

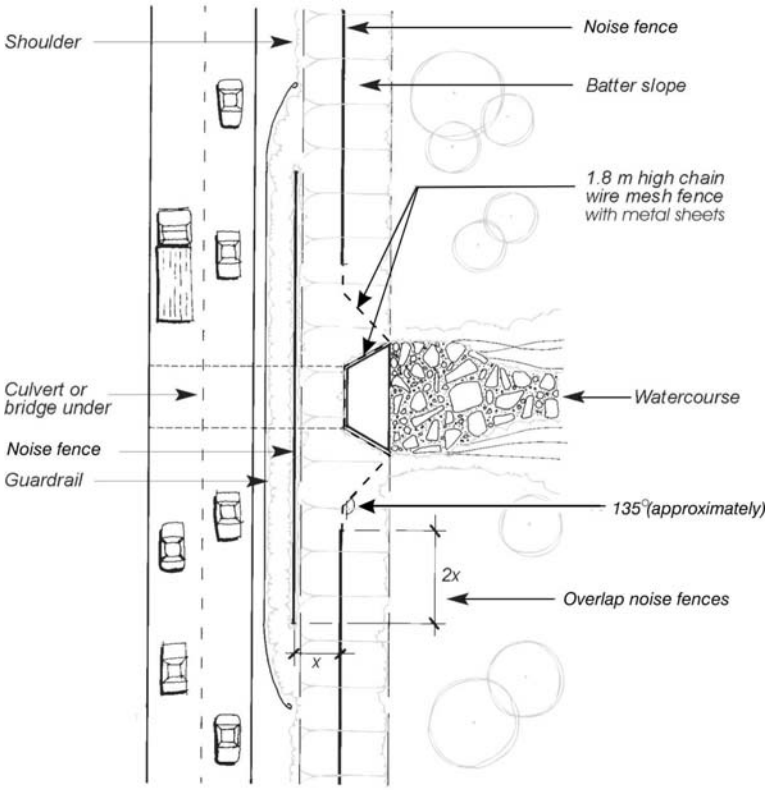
- environmental issues (e.g. birds colliding with the panels)
- undesirable shadows cast through coloured transparent material on to the pavement surfaces or adjoining residences
- material constraints and capabilities.

7.6 Fauna movements

Roads may cross fauna movement corridors, particularly in association with creeks and rivers. In areas where fauna corridors have been identified, wildlife fencing is preferred to be integrated with noise barriers. This measure should direct fauna to culverts, bridges and purpose designed fauna crossings. Fencing is most appropriate when the opening of the culverts (or bridges) is greater than 1.2 m in height.

The preferred fencing is black chain wire, and 1.8 m in height (refer to the departmental Standard Drawing 1602). If koalas use the corridor, the fencing should be fitted with a 600 mm wide metal strip secured to the top of the chain wire fence (refer to departmental Standard Drawing 1603). When placed adjacent to watercourses, the fencing should not be placed below the top bank where it may impede normal flow. The fencing should align with the end of the noise fence and extend to the transition point of the batter toe and top of the bank (refer to Figure 7.6).

Figure 7.6 - Integration of noise fence and wildlife fencing



7.7 Horizontal and vertical alignment

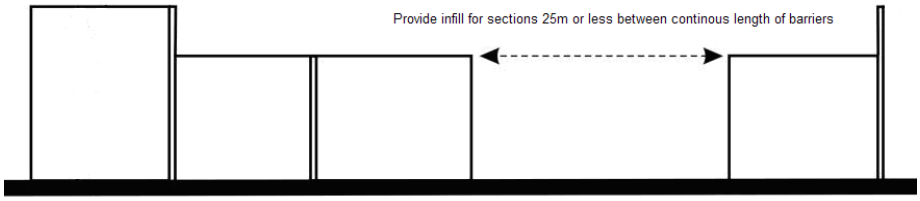
Noise barrier design involves providing a design layout that is appropriate to the road landscape and local environment. The horizontal and vertical alignment of barriers should generally reflect the requirements of relevant sections of this Chapter.

Where a noise fence is to be located on the inside edge of horizontal curvature, it should be offset from the outer edge line of the road to reduce the obstruction of sight lines. The minimum offset from the outer edge line should be determined according to sight line requirements specified in the *Road Planning and Design Manual*.

Consideration of the following issues will aid the appropriate horizontal and vertical design of noise barriers:

- Generally, noise fences should use standard, rectilinear barrier panels for consistency of appearance, and ease of manufacture, supply and installation. Standard panels also assist in aligning horizontal joints throughout the wall.
- Panel lengths and post placements should be chosen to support the construction of neat, evenly curved fence sections where required. Disjointed and awkward wall curves with visible kinks and sharp bends should be avoided.
- The vertical alignment of a noise fence should generally be reflective of, and complimentary of the road geometry as much as practicable. A rationalised smooth, flat top line parallel to the road surface is the preferred configuration, particularly where the noise fence abuts the road edge.
- The horizontal alignment of noise fences directly adjacent to the road should be parallel to the road. Alternative alignments (e.g. staggered and offset) are permissible at distances nominally greater than 5 m away from the roadway. This accommodates landforms and increases the amount of available vegetation screening width.
- For aesthetics, sufficient horizontal space should be allowed to set back the noise fence from the edge of the road by at least one-and-a-half times its height, where possible.
- Continuity of noise fence sections should be promoted by in-filling small gaps (25 m or less) with additional noise fences. This should occur even though noise attenuation is not required for those sections, refer to Figure 7.7 (a).

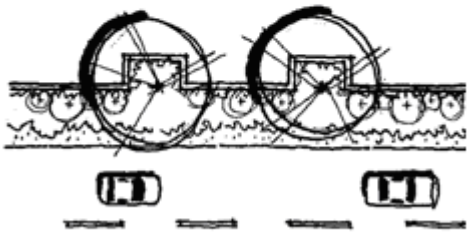
Figure 7.7 (a) - In-fill sections of noise fences



- The monotonous appearance of straight lengths of noise fences should be broken up by providing staggered wall alignments or landscaped offsets in the barrier alignment where possible, refer to Figure 7.7 (b). Offsets should be a minimum of 1.5 m with 2 m preferred.

Figure 7.7 (b) - Staggered wall alignment

Staggered wall alignment



Planting niches in wall alignment

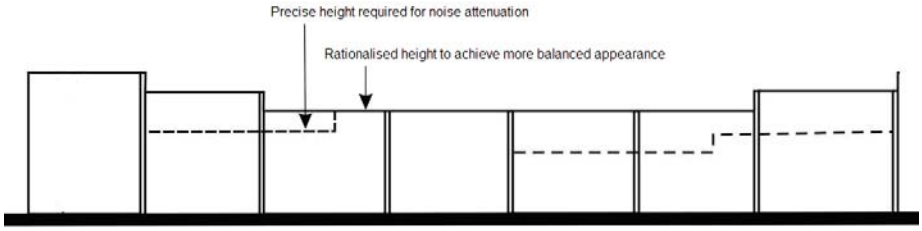
- Horizontal panel joints within a noise fence are to be on the same horizontal plane/height level to present long horizontal lines across the fence, refer to Figure 7.7 (c). This can be achieved through combining consistently sized panels, levelling sills and burying the base of panels.
- The proposed vertical and horizontal designs for a new noise fence shall be checked on site before finalising the design and construction. Any potential conflicts with existing services, road furniture and terrain variations should be identified and any conflicts should be resolved by redesign.

Figure 7.7 (c) - Preserving horizontal lines on uneven ground

The anticipated noise levels at various receptor points may result in varying height requirements for noise fences. An elevation assessment along the length of the area to be treated shall be undertaken to rationalise the height of the proposed noise fences. The following is concerning noise barrier rationalisation and integration with the road landscape.

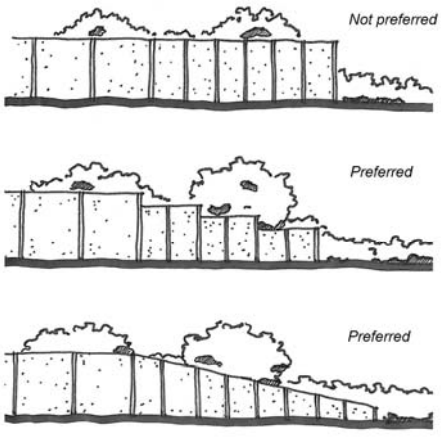
- The overall height of noise fences should be rationalised from that required for noise attenuation to evenly ‘stepped’ heights, to provide a smooth transition between noise fence heights and/or along undulating terrain. Localised peaks and troughs on the top of noise fences should be avoided (refer to Figure 7.7 (d)). A uniform modular approach to stepping noise fences is preferred to a sloping profile. The module size should reflect the scale of the material being used (e.g. a single panel / sheet member or proportional steps compatible with the panel type and size).

Figure 7.7 (d) - Rationalisation of noise fence heights



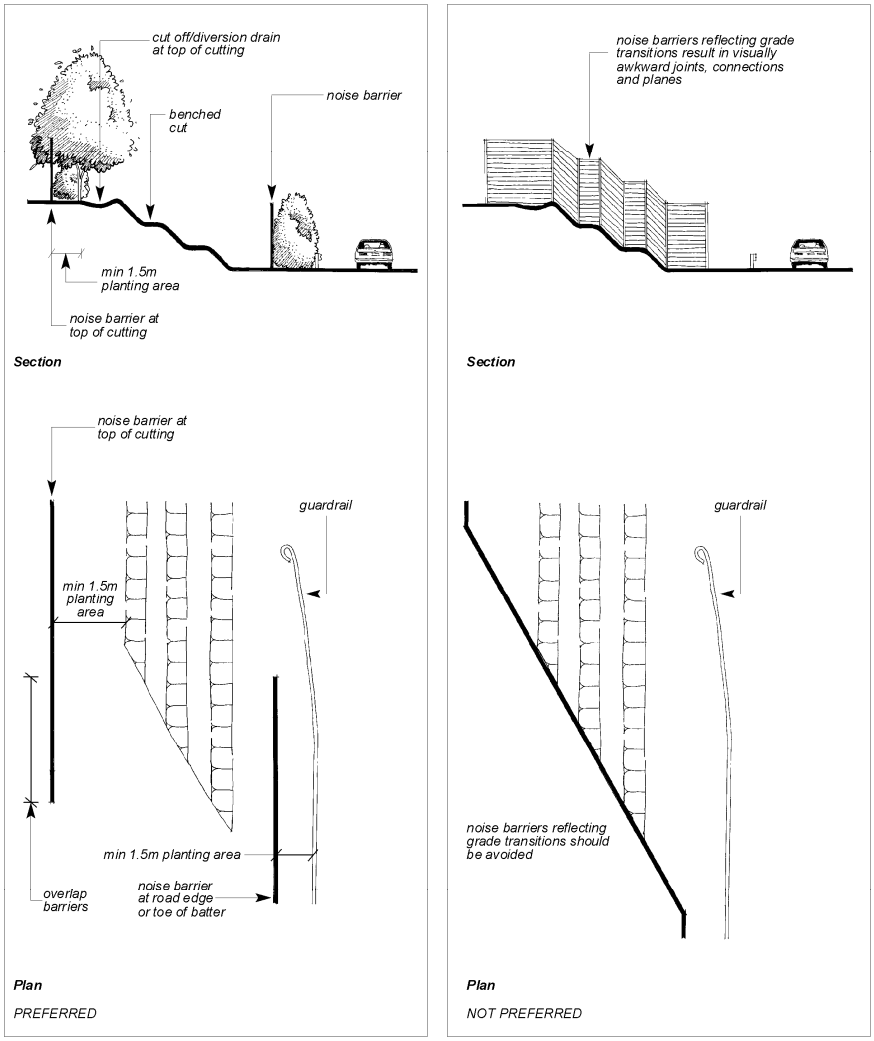
- Rationalising the barriers' panel arrangement shall not compromise the minimum noise fence height requirements for noise attenuation (i.e. the top of the lowest panel at the steps shall be equal, or greater than the minimum noise fence height requirements for attenuation).
- Where noise fence sections are stepped in height, the dimensions between steps (i.e. between the top of noise fences) should be consistently stepped with maximum increment 200 mm either:
  - with the panel height, where consistently sized panels have been used, or
  - using a custom sized half panel at the top of the fence, where consistently sized panels have been used throughout the rest of the fence, or
  - in equal increments of nominally 200 mm (maximum). This may be achieved by using custom sized panels at the top of a fence.
- The jointing arrangement should be maintained on the same horizontal plane/height level throughout the fence.
- Where steps are at every second post, then steps should be at every second post for the entire length of the noise fence, to create a consistent pattern. Using sill beams and burying panels may be necessary to achieve the consistent line on the top of the noise fence.
- Termination of noise fences should be treated as a design feature with a higher level of design finish. Noise fence ends should not finish abruptly. The height should be gradually diminished to a minimum end height of 1.8 m, to integrate within the surrounding environment by incorporating design features (refer to Figure 7.7 (e)). Where possible noise fences should also integrate with security and fauna fencing alignments to provide effective roadway exclusion.

Figure 7.7 (e) - Termination of noise fences



- A minimum 100 m transition zone should be provided between noise fence sections of significantly differing heights, where noise fence heights are gradually manipulated to visually integrate the height transition.
- Where noise barriers are installed on bridges, as far as practicable they should be tilted away from the carriageways and be integrated with bridge parapets. They should extend for a minimum distance of 20 m either side of the bridge abutments. A minimum 100 m transition zone should be provided where possible to integrate noise fences on road sections with noise fences on bridges.
- Where noise fences interface with batters, the vertical and horizontal alignments should be designed not to create awkward transitions in grade (refer to Figure 7.7 (f)). Vertically and horizontally separated noise fences are preferred which create an overlap above and below batters.
- Where a new noise fence is proposed to connect to an existing noise fence section, it shall be designed and / or stepped to match the existing noise fence section. The minimum noise fence height requirement for noise attenuation should be maintained.

Figure 7.7 (f) - Vertical and horizontal transitions at cut / fill interface



7.8 Visual amenity

Noise barriers can have a large impact on road amenity, as they are installed typically over long distances. This is particularly the case where corridor width constrains planting of an effective vegetation screen between the walls and the carriageway. The layout, selection of barrier forms (e.g. earth mound, noise fence or the combination), design, material selection and finish of noise attenuation structures is often critical to promoting high value road amenity.

The aesthetic design quality of noise attenuation structures can be visually enhanced through effective urban design solutions. Aesthetic design can provide an enhanced visual experience for drivers and deliver an important part of community infrastructure. Responsive noise barrier design should aim to provide a practical design layout and selection of materials that are both visually stimulating and appropriate to the local landscape setting.

Generally, noise barriers should have a simple theme that relegates their structure to the background. This promotes integration with the existing natural or constructed landscape.

There are four design elements which may improve the visual amenity of noise barriers, reduce their visual mass and assist integration with the road landscape. These design elements are:

- landscaping and mounding
- urban design treatments
- textures and finishes
- community art and murals.

Wherever possible, noise barriers should be screened by vegetation. This assists in reducing their mass and physically and visually integrating them into the corridor. Vegetation should be combined with mounds to reduce the height of noise fences.

Where vegetation is not possible due to site constraints, additional urban design treatments should be considered. Urban design integration measures can create a sense of ownership and a reflection of community values. Special features such as materials, wall texturing, paint arrangements or community art can reflect contemporary and historical influences. This adds another dimension to visual integration. Urban design treatments also present opportunities for the local community to become involved in noise barrier design.

7.8.1 Landscaping and mounding

The most effective method of integrating noise barriers and improving the general aesthetics of the road corridor is by screening the barrier with vegetation. Landscape screening treatments mitigate potentially negative visual impacts. It also reduces the overall massive appearance of the noise barrier structure (both out of and into the road corridor).

Landscape screening treatment is also the most effective method of graffiti management, as vegetation prevents physical access and visually screens graffiti damage from view. Landscaping shall be placed in front of noise barriers where ever possible as part of the Department's graffiti management strategy (refer to Figure 7 8.1 (a)). Where not likely to be a hazard to pedestrians or maintenance personnel, species with sharp leaves may be used to deter access.

Figure 7.8.1 (a) - Landscaping in front of noise barriers

Preferred

Not preferred

Maximising vegetation screening along both sides of noise fences help integrate the noise fences within a continuous landscape corridor. Where possible, a vegetated screening zone with a minimum width of 1.5 m (preferred 2 m width) should be provided to both sides of noise fences. If screening is only possible to one side of the barrier, priority shall be given to screening the road facing side.

Planting used to screen noise barriers shall attain a minimum height equal to 75% height of the noise fence (preferably the full height). Where maintenance personnel access is required, the following are minimum planting offsets from noise fence alignments:

- 1 m for groundcover/grass species
- 1.5 m for shrub and tree species.

Landscaping in front of noise fences may eliminate the need for costly urban design elements. Generally, screen planting should be prioritised over intensive urban design treatments.

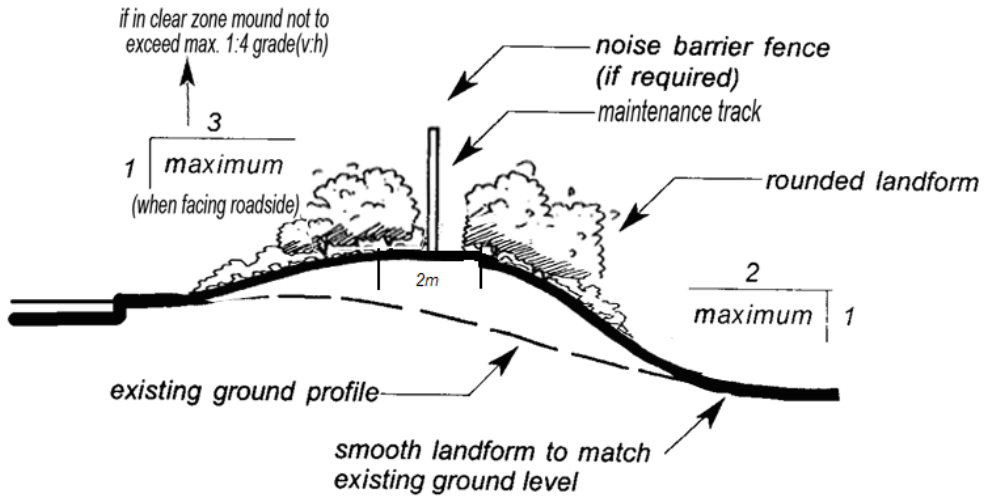
Where available corridor width allows, earth mounds (with or without noise fences) are the preferred noise attenuation measure. Earth mounds should be landscaped (refer to Figure 7.8.1 (b)) to:

- support vegetation treatment of suitable plant species
- reflect the surrounding landscape character
- soften the roadside environment
- integrate noise attenuation structures.

It is also preferred that earth mounds:

- integrate with existing surrounding land profiles
- avoid regular linear forms
- incorporate rounded and undulating shapes which vary in height and width
- support road drainage requirements to avoid localised ponding and runoff.

Figure 7.8.1 (b) - Landscaped earth mounds



7.8.1.1 Landscape assessment process

The landscape assessment process is outlined in the Department's *Road Landscape Manual* and involves the following steps:

- describe existing landscape conditions
- identify interaction with road proposal
- undertake detailed studies (if necessary)
- undertake a combined assessment of effects
- develop strategies to reduce any potential impact that noise attenuation treatments may have on the visual, ecological and social environment.

7.8.1.2 Urban design treatments

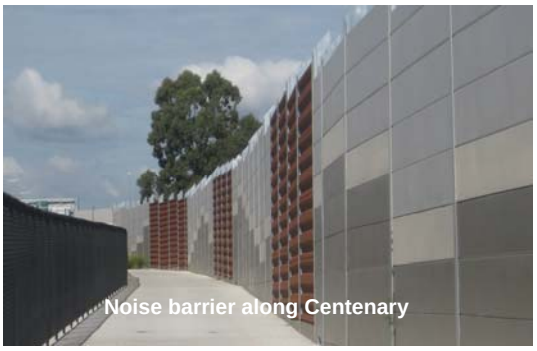
The design and arrangement of urban design elements must aim to minimise road user distraction and visual intrusion, presenting an uncluttered road environment. Treatments incorporated in noise barriers should be integrated with surrounding urban design treatments and finishes to create a unified road corridor.

Urban design treatments should be easily recognisable as belonging to a suite of unified elements, for example noise fences, bridge structures and retaining walls. This can be achieved by developing a palette of materials, finishes, colours, textures, patterns and detailing that is consistently applied along the road corridor. The palette should reflect ambient conditions, local materials, land forms and character. This palette should symbolise elements of the local, regional landscape character or national identity. Consideration should be given as to the enduring aesthetic appeal of proposed urban design treatments and finishes. Urban design treatments should aims to promote a contemporary though 'classic' design response, as opposed to treatments that respond to ephemeral design trends.

Treatments such as colour and texture finishes should be co-ordinated to enhance the physical, functional, safety and aesthetic aspects of the elements to which it is applied. Ideally, urban design elements should be simple, refined and without any beautification or adornment (refer to Figure 7.8.1.2 (a)).

Figure 7.8.1.2 (a) - Urban design treatment


Pre-cast concrete panels on Gateway Motorway


Noise barrier along Centenary


Noise barrier with pattern along Joint Levee Rd

Intensive urban design elements should only be provided at high visibility and low speed road sections where elements including noise fences cannot be effectively screened with landscape treatments. The design and arrangement of urban design elements must aim to minimise road user distraction and visual intrusion into the road landscape, presenting an uncluttered road environment. The perspective view of how a noise barrier integrates into the road corridor shall be considered to ensure a visually pleasing outcome. Noise fence design should also be considerate of the amenity of adjacent properties.

Variations within noise barriers and combinations of noise barrier types and materials may arise as a result of road design, local conditions and community input. Transitions between noise barriers of different materials, heights and colours can cause disharmony (refer to Figure 7.8.1.2 (b)) and should be carefully considered and avoided where possible. Overlapping and separating horizontal and vertical alignments can be an effective approach to reducing this perception.

Figure 7.8.1.2 (b) - Transition between materials causing disharmony

Generally all urban design elements shall be of a durable and robust construction that promotes resistance to degradation, damage, vandalism, unauthorised use and removal. Structural, functional

and acoustic effectiveness of noise barriers shall never be compromised by urban design features. Noise barriers must achieve the required extents, heights and noise attenuation detailed by the relevant acoustical assessment.

The process for managing the design of features and community art on noise barriers should be directed by a suitably qualified landscape architect, with required inputs from other project disciplines. For further detail on urban design considerations, refer to Part C, Chapter 3 Urban Design, *Road Landscape Manual*.

7.8.1.3 Textures and finishes

Urban design elements, such as materials, finishes, detailing, textures and patterns should be incorporated into road infrastructure in a co-ordinated approach. They should enhance the physical, functional, safety and aesthetic aspects of the element to which they are applied.

Purpose designed noise fences provide significant opportunities to utilise and develop distinctive designs, features and finishes. Due to their potentially significant expense, this type of design is more suited to:

- high profile locations
- adjacent lower speed environments
- locations where landscape screening treatments cannot be provided.

Higher quality urban design finishes are suited to gateways, key entries and landmarks such as interchanges and intersections, bridges and overpasses. These areas offer road users a greater opportunity to notice and appreciate such treatments.

Aesthetic surface treatments may also be required for concrete, steel and similar materials in close proximity to the road. This is to prevent motorists momentarily being distracted or blinded by glare or light reflection (morning and evening sunlight, headlight and ambient road lighting) from inappropriately textured surfaces (refer to Figure 7.8.1.3).

Figure 7.8.1.3 - Fine textured surface causing unwanted glare

Any imagery should be bold, incorporating textures and patterned finishes with minimum complex detailing, particularly in high speed environments where excessive detail will be visually ineffective and potentially distracting. Textures and patterns should be deeply and widely ribbed recesses or highly textured finishes to disrupt plain surface areas and render them less attractive to vandals. A minimum 15 mm depth (greater where possible) raised/recessed pattern should be used to ensure sufficient depth for it to be visually obvious and promote shadow casting effects.

Textures and finishes shall also be free draining, self cleaning surface finishes to mitigate the occurrence of dirt and mould build up and resulting staining. Appropriate structural and joint detailing, smooth and non-pitted surfaces shall be incorporated as necessary to minimise water retention by the structure.

Consideration should be given to the implications of the complexity of the urban design texture and pattern to additional materials, weight, engineering requirements, construction timeframes and associated costs.

In less visible locations or high speed environments, finishes of the noise barriers shall be plain, uniform and monochromatic and constructed in one material type without patterns or images on their surface. This assists in relegating barriers to the background and visually integrating them within the existing natural and urban surroundings.

7.8.1.4 Painting

All noise fences, except for heavy weathered steel panels, shall be painted in accordance with Standard Specifications MRTS15 and MRTS88 as part of the departmental graffiti management strategy.

The colour palette shall be limited to the Colorbond® colour range for consistency and to assist in current departmental graffiti management strategy of painting out graffiti. Having a small range of colours allows crews to match paint easily. Painting is significantly easier, more efficient and cost effective than applying anti graffiti paint, which requires water blasting each time it is vandalised, and reapplication of the anti graffiti paint after several cleaning operations.

Colour selection should be complementary to the landscape setting. As a general rule, the further the noise barrier is from the road, the darker the colour should be. This creates an illusion of greater depth. Selection of colours for noise barriers close to the road should complement the adjacent road infrastructure. This will foster a sense of unity and coordination among built elements within the corridor.

Special accent colours as a feature within the corridor can be used to contrast with the overall precinct theme. This can create a local identity and ‘sense of place’ for an area. Further advice on the use of colour can be sought from a suitably qualified landscape architect.

Where new noise fence submissions do not have paint colours nominated, or where existing noise fences are to be painted and do not have a colour nomination, they shall be painted as per the dominant colour used within the road corridor or adjoining noise fences. Alternatively, they shall be painted as follows. For urban backgrounds/context or close to the road:

- Colorbond® Dune
- Colorbond® Paperbark

For vegetative backgrounds/frontages or set back from the road:

- Colorbond® Wilderness
- Colorbond® Monument

Paint shall be commercial grade, exterior quality, low sheen acrylic with a minimum 10 year warranty on finishes. All finishing, pre-treatment and coating works shall be specified and applied in a manner not to void manufacturers’ warranty.

Noise fences shall be painted on both sides with similar colour treatments. Posts shall be painted the same colour as the noise fence to further assist in graffiti management. Where levelling sills are required, they shall be painted the same colour as the noise fence. In the instance an absorptive steel panel is placed on a levelling sill, the levelling sill will be painted with the dominant colour used in the road corridor or the adjoining noise fences.

7.8.2 Community art and murals

Noise barriers present an opportunity to include features such as community art, including murals on both sides of the noise barriers. They also present opportunities for the local community to become involved in noise barrier design. Murals have traditionally been used as a means of integrating local themes within road infrastructure and minimising graffiti vandalism.

Community art can be used to reinforce special identities or tell a story at significant locations along the journey. This 'place making' may allow for the integration of community art as individual artistic elements or as part of an overall theme.

Community art may be used to maximise the sense of community ownership and the individual identity of locations. It can enhance road user orientation and produce visual diversity, making travel interesting and stimulating within safety constraints (refer to Figure 7.8.2 for an example). Community art fronting the affected community may also enhance the sense of neighbourhood ownership.

Community art may also be considered to minimise the likelihood of the noise barrier being targeted for graffiti or vandalism (the evidence of this is inconclusive).

Acoustic effectiveness of noise barriers (e.g. absorptive panels) should never be compromised by such features. The process for managing the design of features and community art on noise barriers should be directed by a suitably qualified landscape architect.

Figure 7.8.2 - Community art

7.8.2.1 Potential issues with murals

Many issues have been encountered by the Department regarding use of murals on noise fences. Keen community and political interest in murals has sometimes overshadowed the Department's road safety, worker safety, cost and maintenance concerns.

Although murals aim to integrate with the existing natural and urban surrounds, this objective has not always been achieved, with inappropriately scaled, distracting, bold, and literal imagery being used. The distraction of drivers in an urban environment by detailed and literal images is undesirable from a road safety perspective. Murals, by their very nature, tend to offer a high level of external driver distraction, the road safety implications of which are not always clear and are certainly not adequately considered or assessed. Establishing a definitive casual link between external visual imagery (such as

noise fence murals) and driver distraction, is difficult since undertaking field studies may risk creating serious incidents. However, in an urban environment, it is an established road safety practice not to place visually bold images (distractions) at 'decision point' locations such as the approaches to intersections and interchanges.

There is evidence that murals do not necessarily eliminate the practice of tagging, which has necessitated the repair or reinstatement of murals. Repair or 'touching up' of a mural may require the original artist to be re-engaged and the success depends on the availability of funds and the artist. Such issues should be considered in any contract for murals. Environmentally-induced degradation also requires murals to be repainting approximately every ten years. Existing mural paint tends to peel off during the pre-prime/cleaning process for the new paint applications. Once a mural reaches a particular age or level of deterioration it requires complete removal and re-preparation of the surface, prior to repainting.

Replacement, maintenance, and 'touch ups' of murals must be carried out in a safe working environment, with consideration of Workplace Health and Safety requirements. Murals located in proximity to the road require lane closure or significant traffic control, in order to install or maintain/repair the mural in a safe environment. This can add significant ongoing costs for the Department where murals are vandalised or have become degraded over time

7.8.2.2 Suitable locations for murals

Murals should be generally limited to the rear of noise fences, where they face public open spaces, community facilities or schools. Murals should not be used on noise fences in the following situations:

- at locations such as the approaches to intersections and interchanges or other areas deemed 'decision points' where drivers must gain a comprehension of the messaging contained on traffic signs.
- along State-controlled roads with a speed limit greater than 80 km/h
- facing State-controlled roads where adequate room is available for screen planting
- where adequate screen planting exists
- on weather resistant steel panels or absorptive panels
- at locations that require lane closure, or significant traffic control, in order to install or maintain/repair the mural
- on noise fences known to be scheduled for replacement, or within a corridor scheduled for upgrade within years 1-2 of the QTRIP
- in areas where existing/previous murals have been vandalised beyond an easily repairable condition.

7.8.2.3 Suitable theme, content and scale for murals

Murals aim to integrate with the existing natural and urban surrounds. This objective has not always been achieved, as evidenced by the number of complaints received by the Department regarding existing murals. The following points shall guide the determination of suitable theme, content and scale:

- Consideration should be given as to the enduring aesthetic appeal of proposed content. Content promoting a contemporary design response should be aimed for, as opposed to treatments that respond to ephemeral design trends.
- The murals theme shall be of relevance to the location and/or community.
- Mural theme or content shall not offer a high level of driver distraction.
- Murals facing road environments shall visually integrate and 'blend' the structure within the context of the existing natural or urban surroundings.
- Murals facing road environments shall contain subtle imagery and integrate the structure into the surrounding environment. Literal images, other than that of native wildlife, shall not be used.
- Murals shall not contain detailed text or messages. Murals may incorporate suburban names as a means of identifying with location.
- Only murals on the rear of noise fences, facing spaces such as schools, parks or other community facilities, can use more detailed, literal imagery.
- Murals shall be of appropriate scale, relative to the area it is being applied, and be of an appropriate level of detail. High levels of intricate detail are to be avoided.
- Murals shall not contain any commercial advertising. A small portion (maximum 50 cm x 50 cm) may be used in a lower corner to acknowledge sponsors, who have contributed the funds to implement a mural and/or to acknowledge the artist who has created the mural.

7.8.2.4 Materials for murals

All painting for murals shall be according to Standard Specification MRTS88 *Painting New Work*. Paint shall be commercial grade, exterior quality, low sheen acrylic with a minimum 10 year warranty on finishes. All finishing, pre-treatment and coating works shall be specified and applied in a manner not to void manufacturers' warranty.

7.8.2.5 Mural proposals and approval process

The process of reviewing and approving a mural shall be undertaken with adequate consideration of Workplace Health and Safety, road and operational safety requirements and material durability. Elements such as visual amenity and integration, appropriate design theme and content must also be reviewed and approved prior to a mural being implemented.

A mural proposal shall include:

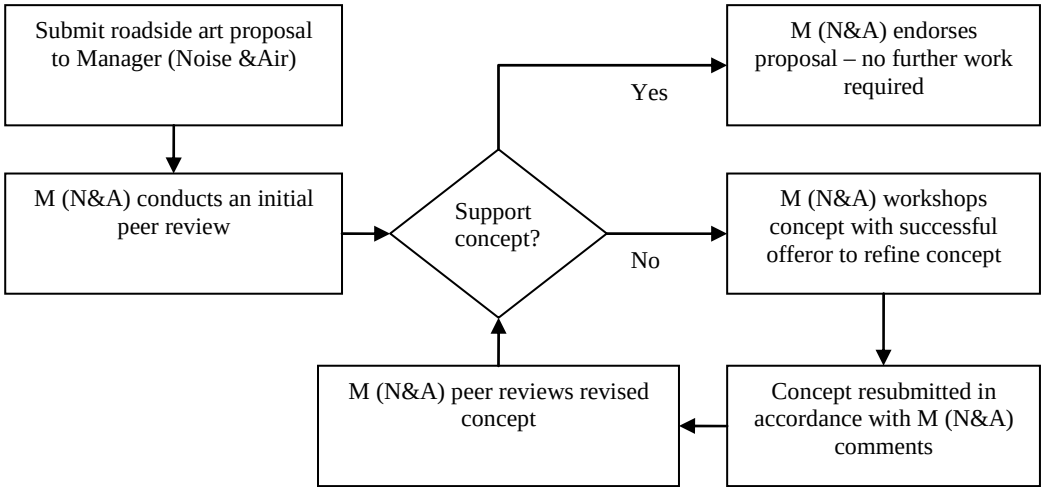
- location
- theme, content and scale – demonstrated though a concept sketch and supporting rational explanation
- details of the proposed artist, including examples of their work
- documented painting material constraints and specifications required by MRTS88 *Painting New Works*, for approval
- *Workplace Health and Safety Act* provisions
- traffic management plans in accordance with the *Manual of Uniform Traffic Control Devices*, Part 3, in relation to installation and future maintenance

- work method statements
- any other plans or permits required for approval.

The Region shall make a preliminary determination if a location is appropriate. Once a preliminary location is determined, a proposal shall be developed and submitted for review by the Department's Manager (Noise and Air) in Engineering and Technology Branch, in order to provide surety that visual amenity and integration objectives are addressed and the chosen design theme, content, scale and materials are appropriate. The proposal may be required to be further developed or adjusted based on feedback from the Department if necessary.

Once the content and material aspects of the proposal have been approved, the Region shall review the proposal to ensure it adequately encapsulates Workplace Health and Safety, road and operational safety considerations. Figure 7.8.2.5 describes the process of reviewing and approving a mural proposal.

Figure 7.8.2.5 - Process for approving murals in the road corridor



7.9 Community engagement

If an existing noise barrier is to be replaced, there is no need to engage with the contiguous residents to obtain a consensus. However, the residents should be informed of the proposal.

Providing new noise barriers often requires a negotiated outcome balancing acoustic benefits and public amenity changes for the community. The balance of amenity is highly subjective. The needs, views and concerns of the community should be determined through a program of community engagement. This program shall be carried out according to the Department's Community Engagement Policy, Principles, Standards and Guidelines to ensure the most acceptable outcome is obtained.

Community engagement may include one-on-one discussions with affected property owners, or public workshops with an independent facilitator or letter-drops. The aim of the engagement is to obtain the opinions of the affected community on road traffic noise management strategies and proposals.

The following shall apply:

- An appropriate consultation protocol must be implemented to ensure the community is provided with realistic appraisals of what the post construction noise will be like for those living near the road (i.e. after construction of noise barriers). The community's expectations should not be raised above what can reasonably be delivered.

- Where post construction complaints regarding road traffic noise impacts arise, these complaints should be addressed according to the noise assessment requirements set out in Chapter 4.

The following community engagement process should be followed to determine the community attitudes regarding a proposal to construct noise barriers beside a State-controlled road:

- Given the opportunity to provide a response only to the owners of residences or other noise sensitive development where the departmental criteria are exceeded. Tenants and other residents within three rows of the project will be given information on the proposal but will not be given the opportunity to provide a formal response. Seeking a formal response from residents where the departmental criteria has not been exceeded has often provided results that did not give appropriate consideration to those residents that were most impacted.
- Identify the owners of residences from a digital cadastral database (DCDB) or a local government rates database.
- Contact commercial development owners for their response if a noise barrier proposal may impact on road exposure. A balance needs to be considered regarding fairness for both road exposure for the commercial development and noise impact upon noise sensitive development. Each situation shall be considered on a case by case basis. This may require the use of exceptional circumstances treatments rationale and criteria for noise sensitive buildings.
- Distribute an information letter to Local, State and Federal politicians for advice and input. This includes a proposal letter to residents, a plan showing the proposed noise barrier heights and locations and a resident's proforma information pack (refer to Appendix 12 (a)).
- Distribute the residents' information packs after any responses from politicians. These include the letter to residents, a plan showing the proposed noise barrier heights and location and a resident's response form. The response form is only given to owners where the departmental criteria are exceeded.
- Record the distribution of the resident's information packs in a tabular format and plan (refer to Appendix 12 (b)).
- Prepare a public display to be placed at a prominent location within the area of interest if necessary. This should be carried out at the same time as distributing the resident's information packs. Examples of locations include a shopping centre and a library. Liaison with the manager /owner of the location will be required.
- Hold a public meeting with an independent facilitator at a prominent location within the area (e.g. local community hall) if necessary. This should be completed before the required residents' response date. At this meeting, present the proposal in more detail. Provide residents with the opportunity for questioning the proposal and providing verbal feed back. The presentation may include display material and a power point presentation (including 'before' and 'after' visualisation of proposed barriers).
- Collate and analyse residents' responses. This may include a summary in a tabulation format and plan (refer to Appendix 12 (c). It is recommended that the actual residents' response forms be an appendix to a community engagement report.

- Document the location and response of the residents on another copy of the distribution plan. It is recommended that a 75% residents' response rate be received in order for the Department to make an informed decision. If there has been an insufficient response, consider undertaking a second distribution of the residents' information pack to those who have not responded. The first letter to the residents may require some minor rewording to reflect the purpose of second distribution (refer to Appendix 12 (d)).
- Determine a consensus of residents' opinions after analysis. It is recommended that, unless there are extenuating circumstances, the majority rules. If there is an equal 'in favour' and 'not in favour' response, it shall be assumed that a majority in favour has been reached. An examination of the majority rules principle shall consider the possibility that some barrier sections may not be constructed. For example, a situation might arise where residents on one side of a road do not want barriers while those on the other side do want the barriers installed. If a barrier is to be constructed only on the side of the road where the residents are in favour, reflection of road traffic noise shall be considered. Absorptive barriers may be required on this side of the road.
- Convey the process outcome to all owners and tenants by a covering letter and an appropriate plan (refer to Appendix 12 (e)).
- Review the residents' opinions of the final outcome and all incoming comments, departmental constraints and community benefits.

7.10 Detailed noise barrier design

Acoustical assessments for departmental projects and noise sensitive land development applications shall be approved by the Engineering and Technology Branch of the Department prior to detailed noise barrier design being undertaken. Noise barrier design drawings shall also be approved by the Engineering and Technology Branch of the Department before commencement of noise barrier construction.

Barriers for departmental projects shall be designed and constructed by pre-qualified consultants and contractors. Applicants for pre-qualification for this purpose are assessed by the Department and placed on a register at a level appropriate to their capability and experience.

Noise fences and earth mounds can be a very effective means of reducing road traffic noise if designed and constructed to the appropriated standards. The design and construction of noise barriers shall comply with this CoP as well as the following departmental standard specifications:

- MRTS03 *Drainage, Retaining Structures and Protective Treatments*
- MRTS04 *General Earthworks*
- MRTS14 *Road Furniture*
- MRTS15 *Noise Fences*
- MRTS16 *General Requirements Landscape and Revegetation Works*
- MRTS88 *Painting New Work*
- Appendix 13 (a) and 13 (b) (barrier design and construction)
- *Road Planning and Design Manual*.

Noise barrier design drawings are to depict, detail and consider all design elements including, but not limited to the following:

- adequate survey data extents used as the basis of the design
- location, height and length as identified from an approved road traffic noise assessment report
- horizontal and vertical alignment
- material and construction type
- post spacing
- potential conflicts such as services, existing road furniture, terrain variations and other structures
- structural details
- drainage considerations
- urban design textural finishes and detailing
- paint finish/colour arrangement
- maintenance requirements
- safety barrier systems (if required).

The design drawings and documentation must refer to other relevant standard drawings (e.g. departmental Standard Drawings 1605, 1606, 1607, 1608), approved noise fence system drawings, technical standards and specifications and supplementary specifications (if required). At the date of commencement of a design, the current version of these documents shall always be applicable.

7.10.1 Drainage requirements

When a noise barrier will cut off a drainage path, an appropriate hydraulic design shall direct the flow to an appropriate outlet (refer to *Road Drainage Manual*). This may involve providing:

- drainage slots at the base of a noise fence
- culverts in table drains where a noise barrier crosses a table drain
- batter chutes
- overlaps in the noise barrier alignments
- erosion control treatments and / or flow dissipation measures where flows have been concentrated
- not building the noise barrier (especially for higher flood levels than the ‘design’ flood where a noise fence may totally cut off storm water flow paths).

Earth mounds may be used as part of the noise attenuation structure. The design of earth mounds should support road drainage to avoid localised ponding or negative impacts on drainage paths.

8 Proposed noise sensitive development

8.1 Introduction

This chapter provides information to assist applicants for noise sensitive development near State-controlled roads in:

- preparing development proposals on how to assess road traffic noise impacts
- proposing road traffic noise attenuation strategies
- applying the *Queensland Development Code Mandatory Part 4.4* (QDC MP4.4).

8.2 Development criteria for road traffic noise

When choosing relevant criteria for a proposed development, reference shall be made to the Department's *Policy Position Statement, Development on Land Affected by Environmental Emissions from Transport and Transport Infrastructure* (the *Environmental Emissions Policy* - EEP).

These criteria provide practical and achievable road traffic noise attenuation strategies which balance the:

- General Environmental Duty of the Department, the developer and the public
- private and public sector costs of providing and maintaining noise attenuation treatments in new developments
- physical limitations on the amount of road traffic noise attenuation which can be achieved against standard urban design practices.

The criteria from the EEP have been adopted in *Module 1, Community Amenity – Managing Noise and Vibration Impacts from Transport Corridors State Code – State Development Assessment Provisions*, available on the Department of State Development, Infrastructure and Planning website.

Assessment of road traffic noise impact against these criteria shall be conducted as per Chapter 4. Measurement of existing noise levels will generally be required for proposed developments. However, for a development involving a single lot on which a single dwelling is permitted to be constructed or a Reconfiguration of Lot into two or three such lots, measurement can be at the discretion of a suitably qualified consultant (RPEQ engineer). In some instances, the requirement for monitoring may also be relaxed for low risk development involving an office, accommodation, medical, educational or religious facility after providing evidence of the low risk nature and consulting with the Department. Monitoring would still be necessary for developments resulting in more than three residential lots or for multi-unit dwellings to be built on a single lot.

If measurements are not undertaken then the most conservative (quietest) background L_{A90} levels shall be assumed in determining the applicable criterion. In addition, the noise modelling discussion within the Road Traffic Noise Assessment report shall provide an assessment of the model accuracy and relevance to the site through comparison with any QDC noise contours shown as passing through the proposed lots on the government NAPmap website.

It shall be noted that, although noise measurement may not be required in such instances, the road traffic noise attenuation strategies (including noise barriers) in Chapter 6 still need to be considered in the development proposal, and be implemented if necessary.

8.3 Development assessment road traffic noise report

A noise sensitive area can be created by a development near an existing State-controlled road. The applicant may be required to undertake a Road Traffic Noise Assessment addressing the impact of road traffic noise from the nearby State-controlled road. Appendix 14 specifies the detailed requirements for a road traffic noise assessment report for development applications. Appendix 15 presents an example of such a report.

Some of the specific issues for a development application report include:

Receptor heights: The receptor height used in the acoustical calculations should be 1.5m above the finished floor level or mid window height, whichever is higher. A height of 0.5 m below the eaves height is also acceptable. For residential subdivisions where the finished floor level is not known, the receptor heights shall be assumed at 1.8 m and 4.6 m above an assumed building pad level, for ground and upper floors respectively. The Road Traffic Noise Assessment Report should identify all prediction locations with identifiers on a suitable drawing.

Pad levels, finished floor levels and ground elevations: All Road Traffic Noise Assessment Reports should include data regarding:

- pad levels (assumed, designed or confirmed)
- proposed finished floor levels (assumed, designed or confirmed)
- other ground elevation details for areas such as child care centre playgrounds, communal open spaces and private open spaces.

Without sufficient information regarding elevation data, the Department may not be able to assess the impacts on the proposed development. For consistency, elevation data should be referenced to Australian Height Datum (AHD).

Noise barriers: Detailed design specifications of any proposed noise barriers should be provided in the Road Traffic Noise Assessment Reports. The design specifications should include:

- horizontal alignment of the structure
- top edge of the structure in AHD
- bottom edge of the structure in AHD
- relative height above the existing or future ground level in metres.

This information is required to ensure clear transmission of the design specifications to the responsible structural and civil design engineers.

AS 3671: This CoP does not provide specific guidance on interpreting AS 3671. The Department recommends the following be observed when conducting assessments near State-controlled roads:

- The correct number of building element components should always be used. Each calculation should include all the relevant facades. Neglecting components on the assumption that their actual contribution is negligible due to their proposed construction should be justified, either by calculation or by demonstrating the proposed construction in architectural drawings.
- The external design noise levels should always be façade corrected.

- Providing architectural treatment specifications based on 'Construction Categories' as defined in AS 3671 is not generally acceptable. The definitions can be used as a guide regarding traffic noise reduction (TNR) values.
- The estimated reverberation time should not be less than 0.5 seconds. Appropriate reverberation times should be assumed for large volume rooms and rooms with a likelihood of acoustically reflective surfaces.
- For AS 3671 calculations, any possible attenuation by balcony treatments should not be used in reducing the predicted external façade noise levels. Any possible sound or noise amplifications caused by untreated balconies should not be used in similar calculations.
- The external level used for determining treatments should be based on the maximum L_{Aeq}(1h):
  - in the day (6 am to 10 pm) for habitable rooms commonly used during the day
  - in the night (10 pm to 6 am) for habitable rooms commonly used during the night
  - during the period of use for habitable rooms only over a limited period.

The relationships between the measured L_{A10} (18h), L_{A10} (1h) and L_{Aeq} (1h) for the respective time period usually should be assumed as consistent for a 10 year horizon. Any inconsistency should be appropriately justified.

Shielding and attenuation objects: Existing dwellings and buildings that will be retained may be included in an acoustical assessment. Future dwellings or buildings shall not be included in an acoustical assessment.

Sources: When verifying the noise model, State-controlled roads and any local government roads should be included. Their respective contributions to the overall calculated noise level should be documented.

For the 10 year horizon prediction, only State-controlled roads should be included in the assessment and noise attenuation strategies is developed for the noise level contribution from State-controlled roads.

The departmental interest is limited to noise emitted from State-controlled roads. A suitable noise attenuation strategy may require an integrated design if there are also noise emissions from a local government road.

Staging of development (example only): Figure 8.3 shows a linear development with a master plan in place. Stages of development are proposed to be completed over a 20 year time horizon. These stages will have a significant impact on the traffic over a 30 year period.

A road traffic noise assessment shall be undertaken to determine the road traffic noise impact for the typical 10 year horizon after completion of the development (i.e. 30 year time horizon). The traffic data in this case is predicted for a 30 year time horizon – that is, 10 years after the completion of the whole development.

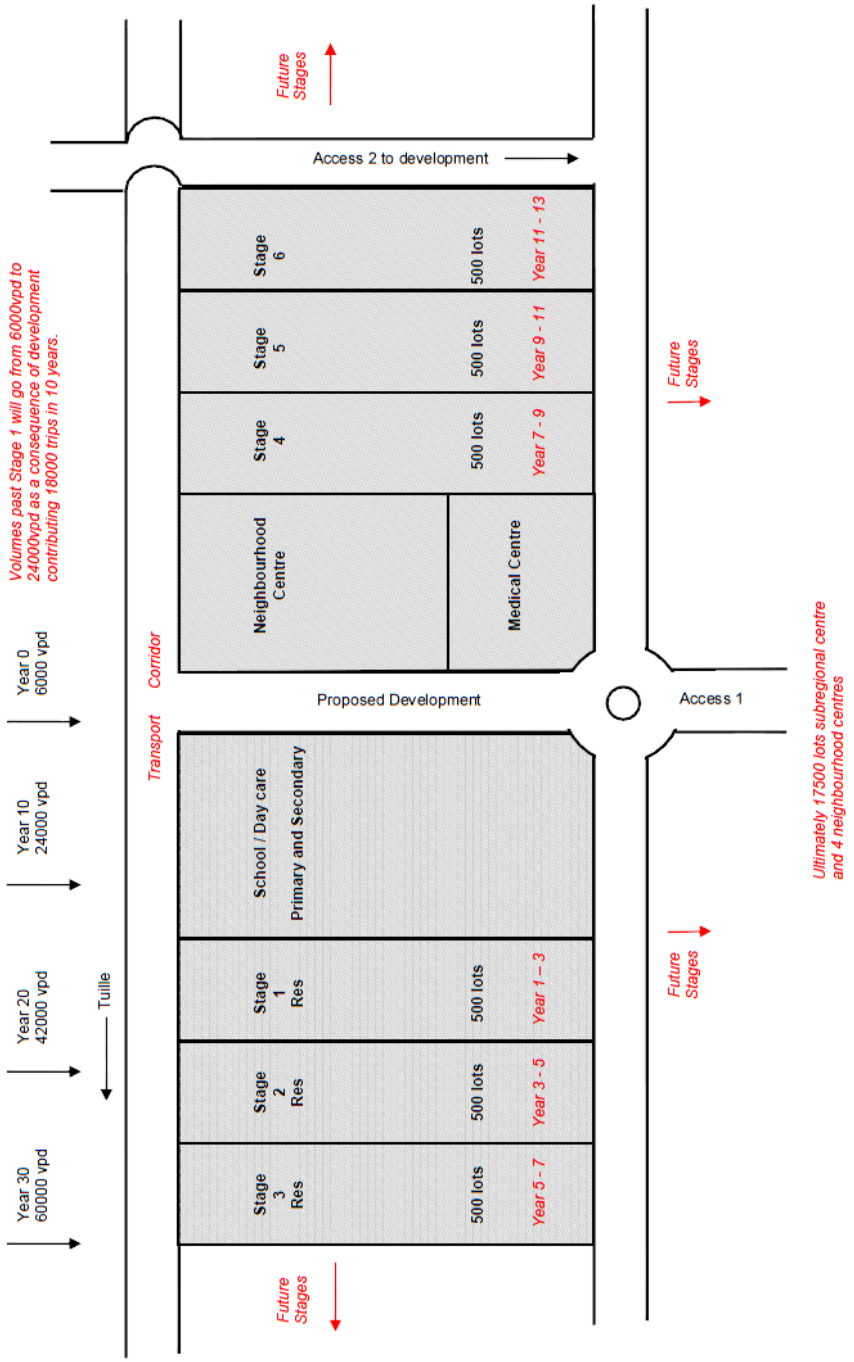
The noise barrier requirements should be determined for this 30 year time horizon. Given that the traffic must double to achieve a 3 dB(A) increase in noise level, it is likely that the increase in noise level over 30 years would be about 10 dB(A). This increase is due to the predicted traffic increase from, for example, 6000 vehicle pay day (vpd) in year zero to 60,000 vpd in year 30, i.e. 18,000vpd average each 10 years.

The road traffic noise impact for the first 10 year horizon and subsequent 10 year horizons should be calculated. The height of the noise barrier should be determined accordingly.

The footings and the post sizes shall be determined for the 30 year horizon, but the barrier height should be that required for the first and subsequent 10 year horizons. Assuming that each stage of development proceeds on a 10 year program, the height of barriers associated with each stage should be determined for each stage. These barriers should be provided by the developer.

Any increase in noise barrier height required for the earlier stages due to the traffic increase, shall be provided by the Department. This will be provided by using noise barrier height extension mechanisms provided in the earlier stages.

Figure 8.3 - Staging of development example



8.4 Queensland Development Code Mandatory Part 4.4 (QDC MP 4.4)

The Queensland Government introduced QDC MP4.4, Buildings in a Transport Noise Corridor, on 1 September 2010, refer to http://www.dsdip.qld.gov.au/resources/laws/queensland-development-code/current-parts/mp-4-4-buildings-in-transport-noise-corridors.pdf

QDC MP4.4 seeks to reduce road and rail traffic noise impacts on the activities of occupants in new and renovated residential development within Transport Noise Corridors (TNC). The intention is to ensure that a consistent standard for noise reduction is set across the State. Streamlining the development process reduces costs, uncertainty and timeframes for government and the community.

QDC MP 4.4 addresses State-controlled road and railway noise for residential development within Transport Noise Corridors. It specifically addresses noise for habitable rooms of Class 1, 2, 3 and 4 buildings (including houses, townhouses, units, hotels and motels) at the building works stage. The Building Class definition can be found from the Building Services Authority website at: http://www.bsa.qld.gov.au/SiteCollectionDocuments/Builders_Contractors/Fact%20Sheets/BCA%20Classes%20of%20Building.pdf

QDC MP4.4 is considered an acceptable means of achieving only the Department's internal criteria. The Department's primary interest for proposed residential buildings is noise levels at building facades and in private open spaces.

QDC MP4.4 only applies to a Building Application and not to a Development Application. The Department cannot set the requirements of the QDC MP4.4 as a Condition of Development as it is a legislative requirement.

With QDC MP4.4, noise attenuation requirements become part of the Building Code. Building certification for Class 1, 2, 3 and 4 buildings is not a departmental responsibility.

8.4.1 Transport Noise Corridors

The *Building Act 1975* has been amended to provide for the designation of land as a Transport Noise Corridor by gazette notice. The Act establishes criteria for state and local governments to designate TNC.

The designated corridors generally cover land within 100 m of a State-controlled road. This extends to 250 m where there are high noise levels due to significant volumes of traffic or high proportions of heavy vehicles (mainly along motorways and major arterials). Designated corridors can be amended as circumstances change.

TNC for State-controlled roads were designated by gazette on 13 August 2010. TNC for franchised roads were designated by gazette on 29 April 2011. A franchised road means a road to which a road franchise agreement applies. This is usually a toll road.

Effectively, this means that most transport corridors which are the responsibility of the Department will have been designated transport noise corridors under the Building Act.

8.4.2 QDC MP4.4 and applications

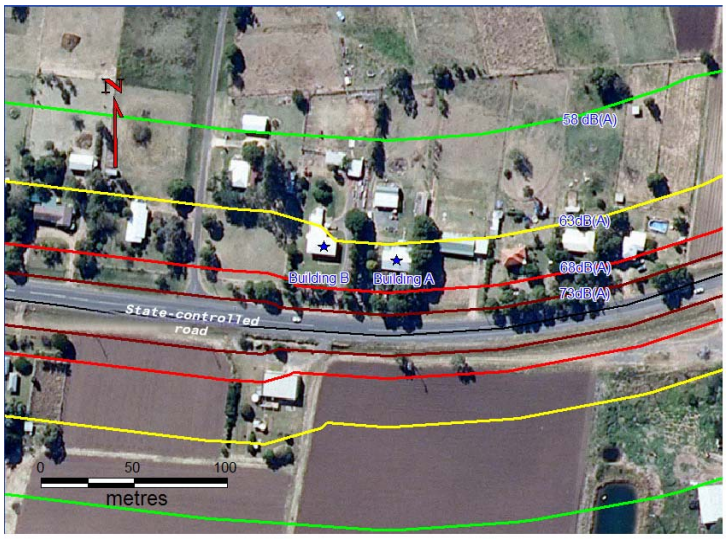
QDC MP4.4 is a mandatory component of the Queensland Development Code. It applies consistently across the State to all new residential buildings and residential building renovations within designated TNC.

QDC MP4.4 sets mandatory building standards comprising various building material specifications to reduce internal noise levels. It details noise reduction requirements for habitable rooms across five

noise categories. It also contains information on acceptable building materials for floors, walls, roofs, windows and doors to achieve appropriate noise reductions. The actual level of noise reduction required will depend on the property's noise category.

The noise category applying to a building or site within a designated TNC is based on the noise levels modelled for the location (refer to Figure 8.4.2 for an example). Applicable categories can be found from the NAPmap search tool: http://napmap.smarteda.qld.gov.au/planmapweb/.

Figure 8.4.2 - QDC example noise contours



Alternatively, the noise category can be determined by a detailed noise assessment prepared by a suitably qualified person under Schedule 3 of the QDC MP4.4.

Each noise category is based on the predicted external noise level (refer to Table 8.4.2). It reflects a required noise reduction level (Transport Noise Reduction - TNR). Each category has an associated list of indicative building material specifications to achieve the specified weighted sound reduction index (Rw). This results in a reduction in transport noise from the exterior of a habitable room to the internal living space.

Table 8.4.2 - Determination of noise categories

Noise Category	Road Traffic Noise Level* (State-controlled roads and designated local government roads) L_{A10} (18h) dB(A)	Railway Noise Level* Single event maximum noise L_{Amax} dB(A)
Category 4	≥ 73	≥ 85
Category 3	68 - 72	80 - 84
Category 2	63 - 67	75 – 79
Category 1	58 - 62	70 - 74
Category 0	≤ 57	≤ 69

*Note: Façade noise level 1 m in front of the most exposed façade of the proposed or existing building and rounded to the nearest whole number. For example, 57.4 is 57 and 57.5 is 58 for roads, and 69.4 is 69 and 69.5 is 70 for railways.

Checking compliance with the QDC MP4.4 is the responsibility of building certifiers. The QDC MP4.4 lists acceptable building materials to achieve the required TNR values. It enables certifiers to approve the listed building materials when undertaking building inspection and certification.

It should be noted that a single property can be partially within a noise category or lie across multiple noise categories. In these cases, the requirements will depend on where the actual building is located. If the building sits wholly within a single noise category area on the property, then that noise category's requirements will apply. This is the case even though other parts of the property may be in a higher or lower noise category. Where a building sits across multiple noise category areas, the requirements of each noise category will apply to the respective parts of the building.

8.4.3 Alternative solutions

Alternative solutions to those in QDC MP4.4 Schedule 2 can be used if the alternative solution is determined to comply with, or at least be equivalent to the relevant performance criteria of the materials (refer to Section 14(4)(b) of the *Building Act 1975*).

Building certifiers are responsible for assessing whether an alternative solution complies with the QDC MP4.4 performance criteria. They may rely on a competent person to assist with the assessment. It is recommended that, in cases where a noise assessment forms part of an alternative solution, that the assessment:

- be conducted by a suitably qualified person
- meet the requirements for noise reports as outlined in Schedule 3 of the QDC MP4.4.

A Registered Professional Engineer of Queensland (RPEQ) is a suitably qualified person. It is recommended that the property owner discuss alternative solutions and possible requirements with a building certifier in the early design stage.

'Acceptable solutions' defined on the QDC MP4.4 are based on the Rw which is the weighted sound reduction index in dB (decibels). It describes the airborne sound insulating performance of a building element and is a laboratory-measured value defined over the frequency range 100 to 3150 Hz (refer to ISO717 Part 1). It applies to walls, ceilings, roofs, floors, doors and windows. The higher the Rw value, the greater the sound insulating performance of the building element.

'Acceptable solutions' are as follows as per QDC MP4.4:

The external envelope of habitable rooms in a residential building located in a transport noise corridor complies with the minimum Rw for each building component specified in Schedule 1 of the QDC MP4.4 to achieve a minimum transport noise reduction level for the relevant noise category by:

- *using materials specified in Schedule 2 of the QDC MP4.4, or*
- *using materials with manufacturer's specifications that, in combination, achieve the minimum Rw value for the relevant building component and applicable noise category.*

Australian Standard AS 3671: Acoustics – Road traffic noise intrusion – Building siting and construction, may be used to determine the minimum Rw for each building component on all sides of a building.

Providing the building certifier gives approval, an alternative solution may permit the applicant to redefine the noise category locations by taking into account the effect of a noise barrier and terrain on the noise levels. The whole building shall be designed according to the intent of QDC MP4.4. Legislation allows that where buildings have had a detailed noise assessment carried out, each part of

the building can be designed with regard to its specific noise exposure level. The required noise reduction levels relating to L_{A10} (18h) levels for roads and to L_{Amax} levels for rail (in single whole number increments) are specified in Schedule 1 of the QDC MP4.4.

It is highly likely that an alternative solution will result in a reduced noise category requirement and reduced construction cost to the applicant/developer.

8.5 Post conditioning requirements

There are several activities required to be performed by the applicant/developer after the assessment manager issues a decision notice that includes the State of Queensland's conditions of development. Some of the possible activities are outlined below:

Noise barrier design, construction and certification: Several strategy implementations under development conditions require the development applicant to submit designs to the Department for acceptance. This usually occurs after the Department issues its response. By providing an agency response before satisfactory completion of a design, the Department is assisting the process of development.

Departmental officers may review the submitted design and provide comments to the applicant or applicant's representative that the design is either satisfactory or unsatisfactory. If the design is unsatisfactory, further work will be required by the applicant until the design is deemed satisfactory by the Department.

The Department requires certification (RPEQ) regarding the design and completion of the construction works according to the accepted design.

Maintenance of noise attenuating structures and architectural treatments: Maintaining noise attenuating structures or building elements will be the responsibility of the landowner or steward of the land in which the structure or building element is placed, unless another suitable agreement is arranged. A noise fence constructed in the road corridor will be the responsibility of the Department.

Architectural treatment certification: The Department requires a Building Construction Certification – Acoustics for non-residential noise sensitive buildings where architectural treatments are to be installed to the façade of a habitable room, to be signed by a Registered Professional Engineer of Queensland (RPEQ).

For residential buildings where QDC MP4.4 applies, Building Construction Certification – Acoustics or a Queensland Development Code (QDC MP4.4) Certification – Acoustics should be signed by a Registered Professional Engineer of Queensland (RPEQ).

These certificates are required to ensure that each habitable room within the property is provided with the required building envelope construction to meet recommended internal noise levels or transport noise reduction. This compliance only applies to the design and construction of the building at the time of the inspection by a RPEQ. Refer to Appendix 16 for the example of certificates.

Ventilation to habitable rooms of residential buildings, educational, community and health buildings: Where it is required to close all external openings to a room to achieve internal road traffic noise criteria, adequate ventilation to the room becomes an issue. The Department requires only those noise sensitive rooms that have openings to be closed to achieve the EEP internal criteria and be supplied with an appropriate form of ventilation which is deemed to satisfy the Building Code of Australia (BCA).

The Department recommends that any form of ventilation supplied to a room also considers the thermal comfort of the room. A ceiling fan is not an acceptable form of ventilation as it does not provide a healthy supply of clean and fresh air.

9 Managing noise complaints

9.1 Introduction

Road traffic noise is recognised as a concern for many people living adjacent to or near motorways and arterial roads that have high traffic volumes and individual noisy vehicles. The Department Regions that have high populations on noise sensitive land use are frequently approached by the public with complaints concerning road traffic noise.

It is difficult to assess the noise impact on a person as individuals have varying sensitivities to road traffic noise and its effect on their lifestyle.

9.1.1 Ombudsman recommendations

Since the opening of the Pacific Motorway (Logan to Nerang) in October 2000, ongoing concerns had been received from the community residing near the Pacific Motorway. These concerns related to the impact of road traffic noise on their amenity.

Complaints were lodged with the Queensland Ombudsman (QO) by the community group known as the Residents Against Increased Noise (RAIN) at about the time of completion of the new motorway in October 2000.

The complaints concerned the Department's action in upgrading the Pacific Motorway, particularly its decision to construct sections of the pavement surface with concrete rather than asphalt. The decision to use concrete had caused RAIN to complain about the impact of road traffic noise on their everyday lives.

In January 2002, the then Minister for Department of Main Roads requested that an independent review be carried out. The review was to determine whether the Department had met its obligations for noise management under the Pacific Motorway Project – Impact Management Plan.

The review was undertaken and a report was prepared (Samuels and Brown 2002). The report made recommendations with reference to those noise management practices adopted and implemented on the Pacific Motorway Project.

Subsequently, the QO also made a number of recommendations in the final investigation report 2007. The Department has adopted the recommendations, of which Recommendation 19 as below is particularly relating to this Chapter.

Recommendation 19

The section on complaint management in the revised Noise Code be amended to provide details of potential remedial measures for complainants whose complaints are substantiated, including reimbursement of noise testing costs.

9.2 Managing individual complaints

9.2.1 Public information brochure for road traffic noise

A brochure 'Managing Road Traffic Noise' has been prepared by the Department for general issues to the public. It briefly explains what the Department does to minimise the impact of road traffic noise. A link to this brochure can be found on the department's *Transport noise management: code of practice* webpage.

9.2.2 Normal road traffic noise

The Department Regions should maintain a road traffic noise monitoring and recording database as part of a corporately mandated complaints management system. A monitoring and reporting process for road traffic noise issues should also form par to the complaints management system. A process overview for noise monitoring and reporting has been prepared for Regions (refer to Appendix 17). A Regional Road Traffic Noise Management Strategy can provide input to this process.

Following a noise complaint and depending on the available information, the Department may assess the impact of road traffic noise by noise measurement and/or calculation. If the impact is below the departmental criterion level for a 10 year horizon, the complainant will be advised. Should the complainant dispute the assessment results, they should be advised that they may engage an appropriately qualified acoustical consultant at their own expense initially. The assessment shall be undertaken according to the Department's criteria and methodology (refer to Chapters 3 and 4).

Upon request, the Department will provide a list of appropriately qualified acoustical consultants to the complainant. This list can be obtained from the Manager (Noise and Air) of the Road Design Unit of Engineering and Technology Branch.

Should a complainant's case be substantiated to the Department's satisfaction, at the regional Director's discretion, the Department may consider one or more of the following:

- reimburse the complainant's acoustical consultant's costs
- reassess the extent of the impact and determine the actual treatment priority for noise attenuation according to Regional Road Traffic Noise Management Strategy (if available) and funding availability
- provide exceptional circumstances treatments outside the road corridor.

A set of example responses to public complaints and enquires is attached in Appendix 18, which is concerning the following situations:

- Appendix 18 (a) – noise barriers request, issues relating to standard of existing noise barriers and concerns about engine compression brake noise. The inwards and outwards correspondence is provided.
- Appendices 18 (b) and 18 (c) – responses to residents where the measured noise level is above the departmental criterion level. Appendix 18 (b) provides a response when a road traffic noise assessment is planned as a regional priority. Appendix 18 (c) provides a response which applies where the measurement is above the departmental criterion level but no immediate attenuation measures are to be provided due to funding limitations.
- Appendix 18 (d) – where the measured level is below the departmental criterion level.

9.2.3 Other noise complaints

Complaints from the general public about individual noisy vehicles are not always the Department's responsibility. The Region should handle the complaint as follows:

- For noisy defective vehicles on any road: In addition to regular enforcement activity, the Department has a system enabling members of the public to report vehicles operating in a defective state. This includes excessively noisy vehicles. The person reporting the vehicle is required to provide their name, address and telephone contact, along with the following vehicle details:

  - registration plate number
  - vehicle make
  - location observed
  - time and date observed
  - nature of the defect.

  This information can be reported to the Manager (Compliance) in the Region where the vehicle was sighted. For details of the local regional office (compliance), please contact the Department on 13 23 80.

- For heavy vehicles including engine brake noise on local government roads: refer the complainant to the relevant local government.
- For heavy vehicles including engine brake noise on State-controlled roads: the complaint should be handled by the Manager (Compliance) in the Region where the vehicle was sighted. Usually the Department is not able to provide a solution. Treatments such as signage or planning of a future bypass or alternative route may be possible.

  Appendix 19 relates to a complaint about increased noise pollution caused by heavy vehicles. The inwards and outwards correspondence is provided. The regional office may respond according to information provided in Appendices 19 (b), 19 (c) and 19 (d).
- For complaints from the general public about the noise level of pedestrian push-button assemblies, the complaint should be handled by the regional office (compliance) with support from the Noise and Air Unit of the Road Design Section. Reference should be made to AS 2353 (1999), Australian Standards, Pedestrian push-button assemblies.

9.3 Engine brake noise

Engine brake noise is a source of community complaint against the heavy vehicle industry. It may be addressed through improved vehicle maintenance and signage. The major cause of excessive engine brake noise is inadequate mufflers that do not provide enough noise attenuation.

The National Transport Commission has investigated ways to control engine brake noise without introducing unfair restrictions on industry or creating a safety issue. Engine brakes are important safety devices. Reactive investigation based on complaints is a means of addressing noisy engine brakes, rather than placing arbitrary restrictions on their use. Trucks failing recommended tests may simply need to have their mufflers replaced in order to pass.

Addressing engine brake noise is important for areas with noise sensitive receptors. It is however not a general noise reduction approach for the Department since engine brakes are applied for a short period of typical total truck journey times (e.g. on steep terrain). Also, engine braking events are too short to affect long term noise descriptors such as L_{A10} (18h).

The Department, with the support of the heavy vehicle industry, mainly relies on an education and awareness campaign. This is aimed at reaching a larger percentage of truck drivers and raising community awareness in an effort to reduce engine brake noise in urban areas.

The departmental strategy to deal with engine brake noise combines two aspects:

- An educational brochure has been produced and is distributed to the trucking industry (refer to Appendix 19.

- Signs asking truck drivers to limit the use of their engine brakes may be installed at key locations, such as where vehicles enter a town or city. Reference should be made to the departmental *Traffic and Road Use Management Manual* - Engine Braking, for signage guidelines.

Research on the effectiveness of signs has provided mixed outcomes. Some trials indicate that using signs provides no improvement in limiting engine compression brake noise in the immediate vicinity of the signs. Others indicate that the appropriate placement of these signs on approaches to country towns has a positive response from truck drivers and adjacent residents.

Glossary

For the purpose of this CoP, the following definitions apply:

Access Controlled Roads - roads where direct access has been effectively restricted by various means e.g. access can only be achieved at an intersection or interchange.

Ambient Noise - the all-encompassing noise associated within a given environment. It is the composite of sounds from many sources, both near and far.

Annual Average Daily Traffic (**AADT**) - the total yearly traffic volume in both directions divided by the number of days in the year.

Assessment Manager - for an application, an assessment manager is

- the entity prescribed under a regulation as the assessment manager for the application.
- without limiting of the above, the regulation may state that the assessment manager for an application is the entity decided by the Minister for State Development, Infrastructure and Planning.

The assessment manager is responsible for the administration of development applications *(Sustainable Planning Act 2009)*

Assessment Provider - Suitably qualified acoustical consultant /contractor (RPEQ) or Transport and Main Roads project staff with demonstrated experience in conducting Road Traffic Noise Assessments, on behalf of Transport and Main Roads and / or private land developers.

Attenuation - reduction in the intensity of a noise level.

Australian Design Rules (ADR's) - set out design standards for vehicle safety and emissions. They are developed through a consultative process involving government, industry, employee and consumer representatives and are published by the Commonwealth Department of Transport and Regional Services.

Average Daily Traffic (ADT) - the total number of vehicles in a time period (more than one day and less than a year) divided by the number of days in the period. It is a figure that may be used for a specific time period for purposes relating to that time period.

Background Noise - the underlying level of noise present in the ambient noise, excluding the noise source under investigation, when extraneous noise is removed. This is described using the L_{A90} descriptor.

BCA - Building Code of Australia.

Building Envelope - external façade of a building including external windows, doors, walls, roof, floor etc. through which noise may enter a building.

Building Location Envelope - a specified location within a lot subject to the requirement of local government, environmental, acoustical and developer preference etc. It is an instrument whereby local government can control where a building will be located on a lot and is fixed by a metes and bounds description.

Building Pad Level - the level of the finished earthworks.

Calculated Noise Level - the existing noise level at the time of an assessment as estimated by the calculation model.

Communal Open Space - an area on the Lot used for the recreational uses and social activities of the residents and landscaping where a significant portion of the attached residential development units do not have exclusive access to ground floor private open space as required by the relevant Planning Scheme for the local government area in which the lot is located. It may contain shared facilities such as a swimming pool, barbecue area, tennis court or children's play equipment.

Community Building - can be applied to:

- a church
- a church hall
- a memorial hall
- a school of arts
- a scout hall
- any other building used by the community for gatherings or meetings (generally non - commercial)
- any emergency services (including police) building used for sleeping and/or training.

Advice Agency - for an application, is

- an entity prescribed under a regulation as an advice agency for the application; or
- if the functions of the entity in relation to the application have been devolved or delegated to another entity - the other entity.

Concurrence Agency - for a development application, means an entity prescribed under a regulation as a concurrence agency for the application, or if the functions of the entity in relation to the application have been devolved, or delegated to another entity, the other entity (*Sustainable Planning Act 2009*).

CoP - an abbreviation for this Code of Practice.

dB(A) - the abbreviation for the unit of measurement of sound. (A) refers to an 'A' weighting that represents the response of the human ear to sound.

Development - is any of the following:

- carrying out building work
- carrying out plumbing or drainage work
- carrying out operational work
- reconfiguring a lot
- making a material change of use of premises (*Sustainable Planning Act 2009*).

Ecologically Sustainable Development - the protection of the environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (Section 3*, Environmental Protection Act 1994*).

Educational Building - a school, child care centre, public library, public lecture hall, art gallery (other than for business purposes), museum, sheltered workshop and any other place used or intended for use for the training or teaching of persons.

Environment - includes:

- ecosystems and their constituent parts, including people and communities
- all natural and physical resources
- the qualities and characteristics of locations, places and areas, however large or small, that contribute to their biological diversity and integrity, intrinsic or attributed scientific value or interest, amenity, harmony and sense of community
- the social, economic, aesthetic and cultural conditions that affect, or that are affected by things mentioned in above (from *Environmental Protection Act 1994*).

Environmental Nuisance - any unreasonable interference to an environmental value by noise (e.g. road traffic) or air/water contaminants (Section 15, *Environmental Protection Act 1994*).

Environmentally Sustainable Transport - transport infrastructure and related services and systems are provided and managed in a way that accords with the principles of Ecologically Sustainable Development.

Existing Roads - No Roadworks - includes no roadworks or rehabilitation works limited to an overlay (bitumen seal or asphalt) or any normal or routine maintenance works.

General Environmental Duty - a person must not carry out any activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practicable measures to prevent or minimise the harm (Section 36, *Environmental Protection Act 1994*).

In determining the criteria that define reasonable measures, the Act then specifies the following parameters to consider:

- the nature of the harm or potential harm
- the sensitivity of the receiving environment
- the current state of technical knowledge for the activity
- the likelihood of successful application of the different measures that might be taken
- the financial implications of different measures as they relate to the type of activity.

Good Environmental Management Practices - the management of the road network to achieve ongoing minimisation of the impact of road traffic noise through cost-effective measures assessed against the measures currently used nationally and internationally.

Habitable Room - as defined in the BCA, for example, can be applied to a bedroom, living room, dining room, lounge room, music room, home theatre room, kitchen, sewing room, play room, family room, sun room and study.

Health Building - premises used or intended mainly for use for the long term or overnight medical or surgical care or treatment of persons and includes institutional residences, mental institutions and doctors surgeries or the like (which provide medical care on an outpatient basis).

Heavy Vehicle - all vehicles with an unladen weight exceeding 1525 kg.

L_{A10} (18h) Road Traffic Noise Level - the level exceeded for 10% of any measurement period; the usual period of measurement is 1 hour. The hourly L_{A10} level therefore, is the traffic noise level exceeded for 6 minutes in the hour. The 18 hour L_{A10} level (L_{A10} (18h)) is the arithmetic average of 18, hourly L_{A10} traffic noise levels measured in consecutive hours between 6 am and 12 midnight.

L_{A10} (12h) Road Traffic Noise Level - is the arithmetic average of 12 hourly L_{A10} traffic noise levels measured in consecutive hours between 6 am and 6 pm.

L_{An} (1h) Road Traffic Noise Level - the level exceeded for n% of a 1 hour period.

L_{A90} (8h) Road Traffic Noise Level - the arithmetic average of the level exceeded for 90% of each hour between 10pm and 6am.

Leq - the continuous sound level having the same total energy as the time varying sound being measured.

Noise Sensitive - can be applied to:

- a dwelling (detached and attached) including house, townhouse, unit, reformatory institution, caravan park or retirement village
- a library, child care centre, kindergarten, school, school playgrounds, college, university, museum, art gallery or other educational institution
- a community building including a place of public worship
- a hospital, respite care facility, nursing home, aged care facility, surgery or other medical centre
- a hotel, motel or other premises which provides accommodation for the public
- a protected area, or an area identified under a conservation plan as a critical habitat or an area of major interest under the *Nature Conservation Act 1992*
- a public park or gardens that is open to the public (whether or not on payment of a fee) for use other than for sport or organised entertainment (passive recreation only).

Noise - unpleasant or unwanted sounds. For the purpose of this code, noise is taken to be the perceived / subjective sound generated by road traffic.

New Road - a new access controlled road in a proposed or existing unused corridor adjacent to existing residences or in a proposed corridor where formal approval by a local government or other statutory authority for adjacent land development is current at the date of acquisition, even if the development is not yet in existence. A new road may include the upgrading of a road (State or local government) to one of a higher functional road hierarchy where there is an increase in the contribution to road traffic noise exposure of at least 3 dB(A). The higher functional road hierarchy must be an access controlled road of at least a collector / distributor function. Also a new road is applicable to the situation where land acquisition (resumption) is taken beside an existing corridor and all State - controlled road lanes fall outside the existing corridor.

Noise Barrier - a natural or artificial physical screen located between the source of the noise (road traffic) and a receptor (e.g. residence), which interrupts the path of the noise. A specifically located fence/wall and/or earth mound can act as a noise barrier. The physical screen must possess sufficient mass to attenuate the noise.

Noise Descriptor - specific, commonly used noise indices which are used to express noise levels during particular times of day such as 1 hour (maximum hour during day-time or night time) or 18 hour (6am - 12 midnight) e.g. $L_n(T)$ or $L_{eq}(T)$.

Noise Index - used to denote a single number measure of the environmental noise level, usually in A-weighted decibels, dB(A) e.g. L_n or L_{eq}..

Non - Access Controlled Roads - roads where the adjacent land use has direct access.

Predicted Noise Level - the future noise level for the planning horizon as estimated by the calculation model.

Private Open Space - any area on the Lot used for the recreational needs of the residents as required by the relevant Planning Scheme for the local government area in which the Lot is located and may include decks, balconies, verandahs and covered ground level outdoor recreation areas where the Private Open Space area forms an integral part of a building design.

Propagation - the wave process whereby sound energy is transferred from one part of a medium to another.

QDC MP4.4 - Queensland Development Code Mandatory Part 4.4, See Department of Housing and Public Works website.

Receptor - normally a point 1 metre in front of the most exposed building facade. The height of the receptor is determined on a case by case basis but is at mid window height for each storey but no less than a minimum of 1.5 metre above the Finished Floor Level.

Retrofitting - the addition of treatments designed to attenuate road traffic noise (changes in road surface and/or erection/ extension of noise barriers) on an existing road without any significant roadworks.

Road Corridor - the area of land between existing or proposed new road boundaries.

Rw - weighted sound reduction index (related to Sound Transmission Class).

Sound - the sensation produced in the ear as a result of fluctuations in atmospheric pressure. The production of sound is always achieved by a vibrating object. The transmission of sound is always through a material medium such as air or water.

Sound Energy - a sound source will produce a certain amount of sound energy per unit time. The sound energy flows away from the source giving rise to a certain sound pressure.

Sound Power - the sound energy emitted per unit time from a source.

Sound Pressure - a vibrating object creates slight fluctuations in atmospheric pressure that expand outwards, travelling through the air and forming a sound wave. This small fluctuation in pressure is called sound pressure which is capable of being detected by the human ear.

Sound Transmission Class (STC) - for a partition separating two enclosed spaces: a single number evaluation of its ability to attenuate sound passing between the two spaces (from AS1633-1985).

State-controlled Road - a road or a part of road defined under Section 3 and a future State-controlled road pursuant to Section 40 of the *Transport Infrastructure Act 1994*.

Traffic Noise Corridor (TNC) - means land designated under Chapter 8B of the *Building Act 1975* as a transport noise corridor.

Traffic Noise Reduction (TNR) - means the level of reduction of transport noise required from the façade of the building to the internal environment, as identified in Schedule 1 of QDC MP4.4.

Type 1 Multi-modal Corridor - means a transport corridor that includes a State-controlled road and at least one of the followings:

- a busway
- a light rail
- a railway (with less than 15 passing trains per day).

Upgrading Existing Road - a substantial upgrading such as duplication or additional through lanes within some portion of the existing road corridor. Some additional lanes may fall outside the existing road corridor where land acquisition (resumption) is required.