M5 West widening

moving goods, people and the economy

Environmental Assessment

VOLUME 3 WORKING PAPERS / SEPTEMBER 2010

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Appendix F

Working paper: Noise and vibration

M5 WEST WIDENING, CAMDEN VALLEY WAY TO KING GEORGES ROAD

NOISE AND VIBRATION ASSESSMENT

ACOUSTICS AND AIR

REPORT NO. 10035
VERSION D

WILKINSON MURRAY

M5 WEST WIDENING, CAMDEN VALLEY WAY TO KING GEORGES ROAD

NOISE AND VIBRATION ASSESSMENT

REPORT NO. 10035
VERSION D

13 SEPTEMBER 2010

PREPARED FOR

ROADS AND TRAFFIC AUTHORITY OF NSW
RTA MOTORWAYS
LOCKED BAG 928
NORTH SYDNEY NSW 2059

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1 INTRODUCTION

The RTA is proposing to widen the western portion of the M5 West Motorway in Sydney's south-east, between Camden Valley Way and King Georges Road, Beverly Hills. This section of the motorway is predominantly a 2-lane dual carriageway and the proposal is to widen this to a 3-lane dual carriageway. To achieve this, two additional lanes will be introduced, generally within the central grass median strip. The primary objective of the proposal is to relieve congestion on the road and accommodate future growth.

This section of the motorway passes through predominately residential areas along its length, broken by pockets of industrial areas. There are also a number of educational facilities and parks that fall within the project catchments.

Wilkinson Murray (Sydney) Pty Limited (Wilkinson Murray) has been commissioned by RTA to provide an assessment of the noise and vibration impacts associated with construction and operation of the upgrade project.

The potential noise and vibration impacts of the M5 West Motorway Upgrade Project can be separated as follows:

- noise and vibration impact on surrounding areas during the construction phase of the project due to the widening of the motorway and ancillary works; and
- noise impacts on surrounding areas during the operational phase of the project after project commissioning due to changed road traffic conditions.

2 DIRECTOR GENERAL'S REQUIREMENTS

The Project Director-General's Requirements (DGRs) were issued for the Environmental Assessment on 6 May 2010. This report has been prepared to address the DGRs that relate to potential noise and vibration impacts. The specific requirements that relate to the M5 West Motorway Upgrade Project are provided below:

*"**Noise and Vibration** – the Environmental Assessment must address the noise impacts of the project during operation, consistent with the Environmental Criteria for Road Traffic Noise (EPA, 1999). The assessment must include specific consideration of impacts to receivers (dwellings, child care centres, educational establishments, hospitals, motels, nursing homes or places of worship), as relevant and identify reasonable and feasible mitigation measures.*

The assessment must address construction noise and vibration impacts consistent with the Interim Construction Noise Guideline (DECCW, 2009) and Assessing Vibration: a guideline (DECC, 2006). The assessment must have regard to the nature of construction activities (including transport, tonal, or impulsive noise generating works and the removal of operational noise barriers, as relevant), the intensity and duration of noise and vibration impacts, the nature, sensitivity and impact to potential affected receivers, the need to balance timely conclusion of noise and vibration generating works with periods of receiver respite, and other factors that may influence the timing and duration of construction activities (such as traffic management). The assessment should present, as relevant, an indication of potential for works outside standard working hours, including predicted noise levels and exceedances, justification for the activity and discussion of available mitigation and management measures."

The Operational Assessment of the M5 West Motorway Upgrade Project is presented within Section 8 of this report and the Construction Assessment is within Section 10.

3 PROJECT AREA AND PROJECT DESCRIPTION

3.1 Operational Phase

The section of the M5 South West Motorway subject of this study is approximately 20km in length, running from King Georges Road, Beverly Hills at its eastern end, to Camden Valley Way, Casula at its western end. The current motorway configuration is predominantly two lanes in each direction separated by a central grassed median.

The Project proposes to provide:

- an additional lane eastbound on the M5 Motorway between Camden Valley Way and the Hume Highway and between Moorebank Avenue and Fairford Road;
- an additional lane westbound on the M5 Motorway between King Georges Road and Moorebank Avenue and between Hume Highway and Camden Valley Way;
- an Operations Management Control System (OMCS) on and in the vicinity of the M5 South West Motorway to provide enhanced traffic monitoring and management; and
- noise attenuation measures for the section of the M5 South West Motorway between King Georges Road and Camden Valley Way to mitigate noise from increased traffic volumes.

No widening is proposed between the Hume Highway and Moorebank Avenue, and near the Georges River, east and west of the toll plaza. The additional lanes elsewhere can generally be accommodated within the central grassed median as envisaged in the original design of the Motorway. Between King Georges Road and Fairford Road, the exiting motorway carriageway is wide enough to accommodate the additional lanes. Construction works here would therefore be relatively minimal, and would consist of milling and re-sheeting of the existing carriageways, construction of a concrete slip form central barrier and line-marking, in addition to construction of the Operational Management Control System (OMCS).

The OMCS motorway control centre would be located at Hammondville and would operate 24 hours a day, seven days per week to identify and manage traffic congestion and incidents on the motorway. It would be a conventional single-storey building constructed of concrete, steel and lightweight framing. It would provide about 200 square metres of office and control room working space.

Variable speed limit signs (VSLS) and Variable Message Signs (VMS) may be provided as part of the OMCS. If provided as part of the project, VSLS would be mounted on gantries along the motorway at about one-kilometre intervals, and in the vicinity of entry and exit ramps. Interlink Roads and its contractors, in consultation with the RTA, would determine the exact location of VMS within the general localities identified above.

There would be minimal disruption to the existing carriageways, and modifications to the drainage and bridge structures would be straightforward. Localised widening to the outside of the carriageways is required at limited locations to allow adequate sight distances for motorists.

There would also be works on the outside of the carriageways, including installation of fixed signage, upgrading of existing sedimentation basins and construction of new basins, drainage works, construction of new noise barriers and OMCS works including installation of trunk cabling and Variable Message Signs. In addition, a number of VMS would be installed on the road network surrounding the M5 South West Motorway.

3.2 Construction Phase

3.2.1 Staging and Timing

Construction of the proposal is anticipated to take approximately two years, with works anticipated to commence in the first quarter of 2011.

The works are broken up into two distinct types - the side works and the central median works. Along the majority of the motorway route, both central median and side works are to be carried out during the course of construction. The approach to completing the two different types of works is to work only in one section at any one time, such that when side works are being performed in a given section, no central median works would be performed in that section and vice versa.

At any one time along the entire 20km motorway route, it is anticipated that there would be four to six construction work sections - two to three in the median and two to three at the motorway edge. Each work section would be approximately 4-5km in length and it is expected that up to approximately 10km of central median works and 10km of side works would be under construction.

Where traffic modelling indicates that there would be benefits in sequencing the opening of the three lanes, then this will be considered in the final staging plans. Any staged opening would ensure that additional weaving or merging is avoided.

3.3 Construction Methodology

3.3.1 King Georges Road to Fairford Road

The existing carriageway in this section of the motorway is of adequate width to provide additional lanes; therefore, no further widening would be required. Works in this area would be less intensive and would include mill and re-sheet of the existing carriageways, construction of a central safety barrier, pier protection for existing overbridges, line marking to suit the new lanes configuration, and OMCS works.

3.3.2 Fairford Road to Camden Valley Way

In the areas between Fairford Road and Camden Valley Way, where widening into the median is being undertaken, the civil engineering works involve the removal of vegetation from the central median, modifications to the drainage system, construction of new pavements for the additional traffic lanes and the construction of a central safety barrier and pier protection for existing overbridges.

Where bridge works are required, they would include piling, construction of concrete structures, installation of precast concrete planks, demolition of existing parapets, construction of approach slabs and installation of bridge joints.

3.3.3 Widening on the Outside of the Motorway

Widening on the outside of either or both sides of the motorway may be required at the locations listed in Table 3-1.

Table 3-1 Locations where Widening Works may be undertaken on the Outside of the Motorway

Chainages		Location Description
Start	End	
12600	12980	East of Gibson Avenue
14740	15300	West of Queen Street
15680	16220	Beaconsfield Street
16610	16880	West of Horsley Road
20890	21230	East of Heathcote Road
22585	23585	Moorebank Avenue (concrete pavement)
24240	24910	West of Hume Highway
25080	25740	De Meyrick Avenue
25900	26380	Kurrajong Road

These works would generally involve full depth pavement construction and drainage modifications.

3.3.4 OMCS

The trunk cabling is generally to be installed on the side of the Motorway using trenching, with any crossings to the other side generally to be provided through boring under the carriageways.

The installation of VMS's and provision for VSLS's generally involves the construction of a trench and the footing, concreting, installation of services and delivery and installation of the sign.

3.3.5 Sedimentation Ponds

Construction of the sedimentation ponds involves localised excavation and drainage pipe installation. Retaining wall structures, gross pollutant traps and water dissipation devices may also be required.

3.3.6 Noise Barriers

There are limited details in relation to rectification of noise barriers. These works would typically involve the replacement of existing panels and possible existing barrier extensions. Where existing barriers are to be removed and replaced with new barriers, piling and reinforced concrete footings along with steel post and concrete panel type construction is envisaged. Details of required noise barriers are not expected to be available until the detailed design phase of the project.

Subject to further consideration during detailed design, it is possible that noise attenuation may also be provided by way of noise mounds, or noise mounds in combination with noise barriers.

3.4 Noise Catchments

The project has been broken up into a number of Noise Catchments Areas (NCA's) based on factors including geographical location, level of noise exposure and location of the ambient noise monitoring provided by the RTA for the purpose of the project. The catchments are shown extending to 300m from the motorway. The use of NCA's is somewhat arbitrary as

predictions have been undertaken at all receivers in these catchements.

Catchments containing residential receivers are:

- CVW_M7_W - Camden Valley Way to M7 west of the M5 motorway. This is a residential area and includes a sports oval to the north of the area.
- CVW_HH_S - Camden Valley Way to east of Hume Highway intersection, on the southern side of the motorway. Mainly residential and includes Daruk Park, located some 100m from the motorway. A number of potential new dwellings have been identified in a new area to the west and south of Flame Street and have been included in the assessment.
- M7_HH_N – Westlink M7 to east of Hume Highway intersection, on the northern side of the motorway. Mainly residential and includes Prestons Public School. A number of potential new dwellings have been identified in the area to the east of Beech Road and have been included in the assessment.
- MA_HLD_S – West of Moorebank Avenue to the Hammondville Toll Plaza, south of the motorway. Residential area and including Hammondville Public School.
- HR_HLD_N – Heathcote Road to New Brighton Golf Club, north of motorway. Residential area and including the Brighton Golf Club at the eastern end.
- HLD_S – West of Henry Lawson Drive, south of motorway. This catchment contains Blue Gum Zoo.
- HLD_HR_N – West of Henry Lawson Drive to Horsely Road, north of motorway. This catchment is mainly residential and includes the University of Western Sydney at its eastern end.
- HR_FR_S – Horsley Road to Fairford Road, south of motorway. This catchment is made up of residential receptors and also includes Panania North Public School.
- QS_GA_N – From Queen Street to Gibson Avenue, north of the motorway. This catchment is residential mainly, but also includes Sir Joseph Banks Public School.
- FR_BR_N – Area east of Fairford Road and west of Belmore Road, north of the motorway. This catchment is residential, broken by a pocket of industrial. McLaughlin Oval is located on the western end.
- BR_KGR_S – West of Belmore Road to King Georges Road, south of the motorway. This catchment is mainly residential and contains the active recreation area in Rotary Park.
- BR_KGR_N – East of Belmore Road (Bonds Road) to King Georges Road, north of motorway. This is mainly residential but also includes Wise Reserve at the western end.

The above naming convention for the noise catchments is made up of the initial character of the two nearest crossing roads (generally major roads) separated by an underscore, followed by “N” ,“S” or “W” representing the direction of the catchment which is generally north or south of the motorway.

The above NCA’s are shown in Figure 3-1 to Figure 3-5.

In addition, six catchment areas were identified containing only commercial land use. These are identified with a prefix with the word “commercial”, and are also shown in blue in Figure 3-1 to Figure 3-5.

Figure 3-1 Aerial Showing CVW_M7_W, NCA - CVW_HH_S and M7_HH_N

Figure 3-2 Aerial Showing NCA – HR_HLD_N, MA_HLD_S, Commercial_HR_HLD_N and Commercial_MA_HLD_S

Figure 3-3 Aerial Showing NCA – HLD_HR_N, HLD_S and Commercial_SC_QS_N

Figure 3-4 Aerial Showing NCA – QS_GA_N, HR_FR_S, Commercial_GA_FR_N and Commercial_HR_FR_S

Figure 3-5 Aerial Showing NCA – FR_BR_N, BR_KGR_N, BR_KGR_S and Commercial_BR_BR_N

4 EXISTING NOISE ENVIRONMENT

The results of recent ambient noise monitoring carried out by others late in 2009 under a separate commission have been provided by the RTA for use in this project. The results are contained within the Heggies report entitled "M5 Motorway, Operational Noise Monitoring, November – December 2009" (Appendix B). These data have been used to set construction noise objectives for the project, and to verify the noise modelling results.

The ambient noise monitoring was conducted, using unattended noise loggers, in order to characterise the existing noise environment adjacent to the Project Area (in relation to both the construction and operational noise assessments) and to establish the noise levels upon which to base the noise emission objectives. Environmental noise monitoring was performed at 20 representative locations along the length of M5 South West Motorway Upgrade Project corridor.

These locations are understood to have been selected based on a detailed inspection of potentially affected areas, giving consideration to other noise sources which may adversely influence the measurements, security issues for the noise monitoring devices and gaining permission for access from the resident or landowner.

The monitoring was completed over two separate surveys. The first of these surveys was between 25 November 2009 and 3 December 2009 and the second survey was performed between 8 December 2009 and 16 December 2009.

A list of the noise monitoring locations is provided in Table 4-1, whilst Figure 4-1 to Figure 4-5 show the locations of the noise monitoring, including the location of maximum noise level monitoring carried out by Wilkinson Murray at 54A Grove Avenue, Narwee.

Table 4-1 Unattended Noise Monitoring Locations

No.	Address	Suburb
1	45 Incense Place	Casula
2	40A Ironbark Avenue	Casula
3	55 Grove Street	Casula
4	43 Acacia Avenue	Prestons
5	15 Foveaux Avenue	Lurnea
6	33 Mary Crescent	Liverpool
7	15 Barwon Court	Wattle Grove
8	17 Fitzgerald Avenue	Hammondville
9	80 Renton Avenue	Moorebank
10	4 Meteren Close	Milperra
11	4 Flanders Avenue	Milperra
12	64 Tracey Street	Revesby
13	23 Carrington Street	Revesby
14	46 Louie Street	Padstow
15	32 Ely Street	Revesby
16	24 Iris Avenue	Riverwood

No.	Address	Suburb
17	4 Arilla Avenue	Riverwood
18	2/62 Kentucky Road	Riverwood
19	41 Earls Avenue	Riverwood
20	60 Parry Avenue	Narwee

Based on the referenced noise monitoring report, unattended noise loggers were deployed adjacent to residential dwellings in order to measure the prevailing levels of road traffic noise over a minimum period of one week. The measurements were conducted at a height of 1.5m above ground and generally at a distance of 1m from the facade of the subject building, in accordance with the *ECRTN*.

All noise measurement instrumentation used in the surveys was designed to comply with the requirements of AS 1259.2-1990 “Acoustics - Sound Level Meters. Part 2: Integrating - Averaging” and carried appropriate and current NATA calibration certificates. The equipment used for the continuous unattended noise surveys comprised Acoustic Research Laboratories Type EL215 and Type EL316 Environmental Noise Loggers.

The calibration of the loggers was checked prior to, and following, each measurement survey and the variation in calibration was found not to exceed 0.5dB at any location.

All noise loggers were set to record statistical noise descriptors in continuous 15-minute sampling periods for the duration of their deployment.

Weather data recorded during the noise monitoring survey periods by the Sydney Bureau of Meteorology was used to assist in identifying potentially adverse weather conditions that could have a detrimental impact on the measured noise levels such as rainy periods, etc.

Figure 4-1 Aerial Showing Noise Monitoring Locations - CVW_M7_W, CVW_HH_S and M7_HH_N

Figure 4-2 Aerial Showing Noise Monitoring Locations - HR_HLD_N, MA_HLD_S, Commercial_HR_HLD_N and Commercial_MA_HLD_S

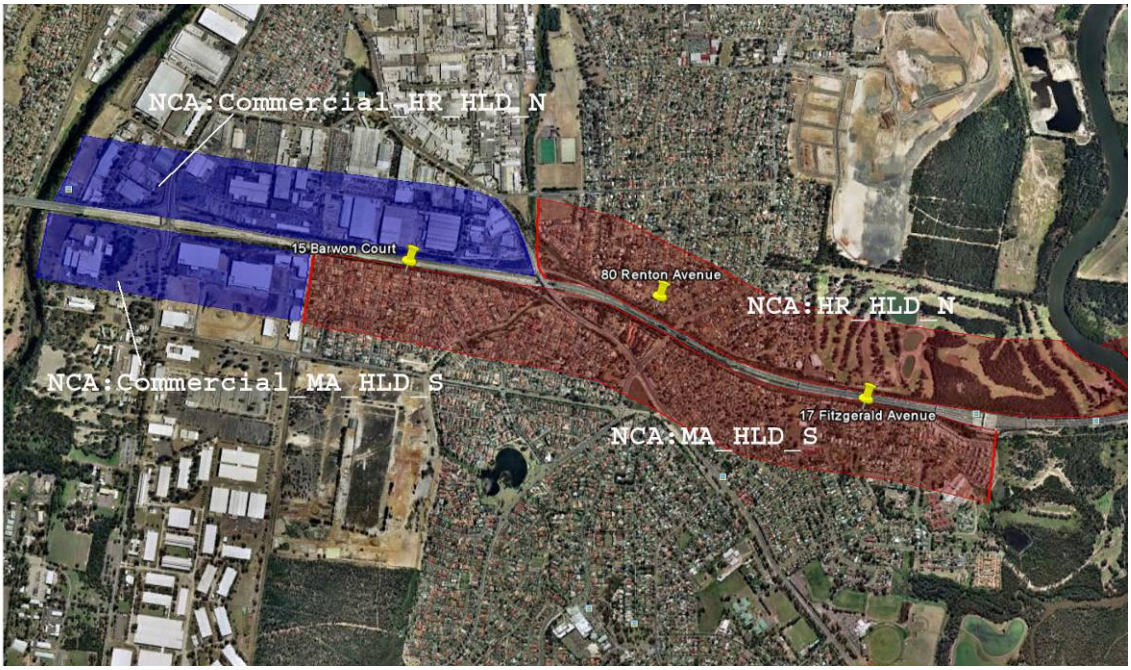


Figure 4-3 Aerial Showing Noise Monitoring Locations - HLD_HR_N, HLD_S and Commercial_SC_QS_N

Figure 4-4 Aerial Showing Noise Monitoring Locations - QS_GA_N, HR_FR_S, Commercial_GA_FR_N and Commercial_HR_FR_S

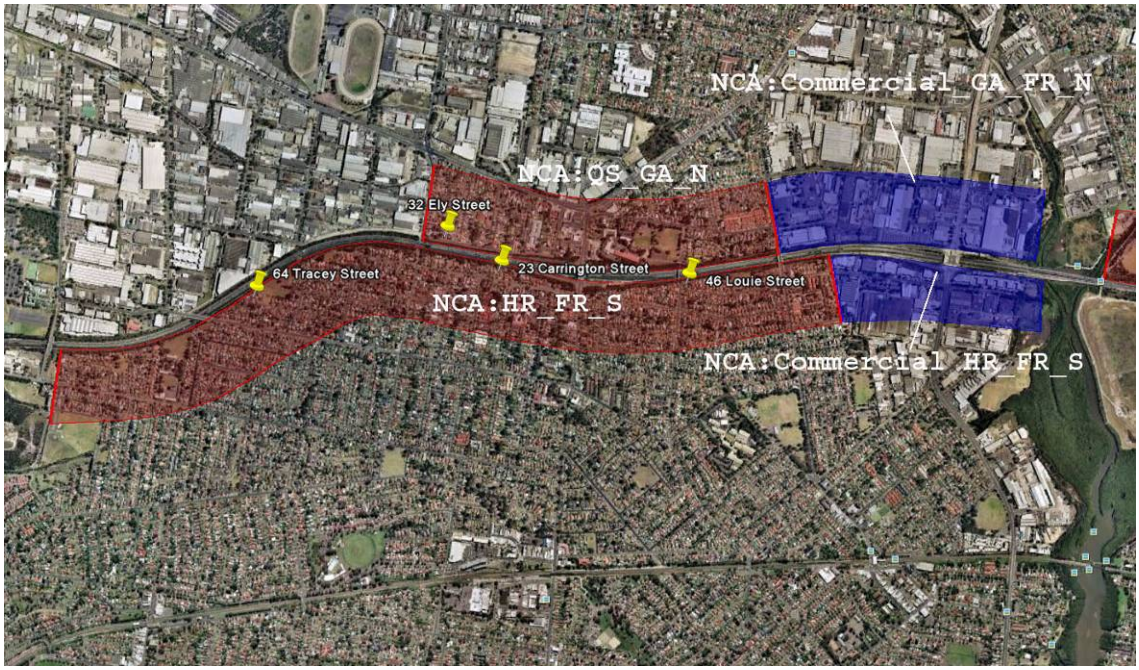


Figure 4-5 Aerial Showing Noise Monitoring Locations – FR_BR_N, BR_KGR_N, BR_KGR_S and Commercial_BR_BR_N

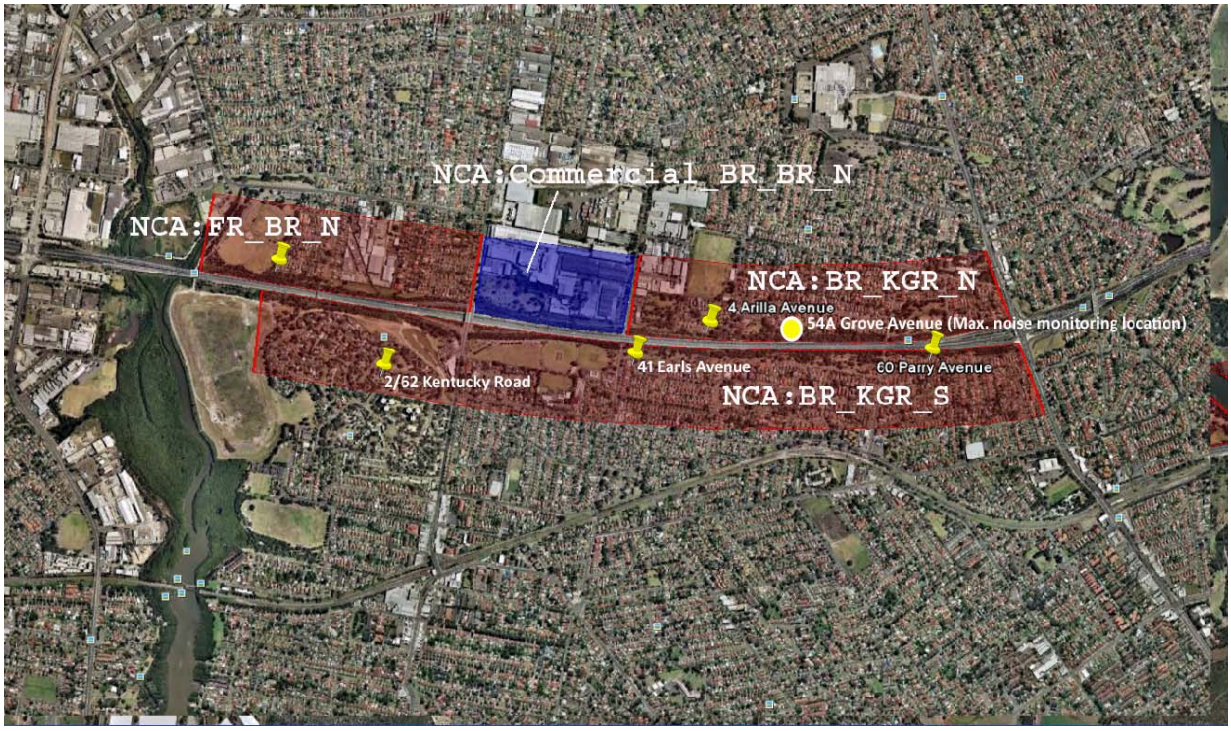


Table 4-2 summarises the measured L_{Aeq} noise levels as reported in the Heggies report. These are assumed to represent road traffic noise in all cases. These data are used to verify and calibrate the road traffic noise modelling.

Table 4-2 Measured Road Traffic Noise Levels

NCA	Address	Suburb	Measured L_{Aeq} Noise Level (dBA)	
			Daytime $L_{Aeq,15hr}$	Night Time $L_{Aeq,9hr}$
CVW_HH_S	45 Incense Place	Casula	56.5	51.8
	40A Ironbark Avenue	Casula	60.0	56.0
	55 Grove Street	Casula	60.2	57.0
M7_HH_N	43 Acacia Avenue	Prestons	58.5	54.1
	15 Foveaux Avenue	Lurnea	60.5	55.6
	33 Mary Crescent	Liverpool	57.3	53.3
MA_HLD_S	15 Barwon Court	Wattle Grove	62.4	58.2
	17 Fitzgerald Avenue	Hammondville	58.5	54.7
HR_HLD_N	80 Renton Avenue	Moorebank	56.7	54.0
HLD_HR_N	4 Meteren Close	Milperra	58.2	54.5
	4 Flanders Avenue	Milperra	56.7	54.1
HR_FR_S	64 Tracey Street	Revesby	59.6	56.3
	23 Carrington Street	Revesby	59.9	57.1
	46 Louie Street	Padstow	57.6	54.5

NCA	Address	Suburb	Measured L_{Aeq} Noise Level (dBA)	
			Daytime $L_{Aeq,15hr}$	Night Time $L_{Aeq,9hr}$
QS_GA_N	32 Ely Street	Revesby	60.3	57.1
FR_BR_N	24 Iris Avenue	Riverwood	56.6	53.9
BR_KGR_N	4 Arilla Avenue [1]	Riverwood	62.8	59.6
BR_KGR_S	2/62 Kentucky Road	Riverwood	57.6	54.9
	41 Earls Avenue	Riverwood	54.9	51.6
	60 Parry Avenue	Narwee	57.4	55.1

Note: 1 Noise logger failed after 5½ days of logging. Recorded data includes full 24-hour periods across both weekend days.

Table 4-3 presents the background noise levels derived from the ambient noise data for the purpose of establishing the construction noise objectives. These are in terms of the Rating Background Level (RBL), which is a measure of background noise defined in the DECCW's *Industrial Noise Policy* (*INP*).

Table 4-3 Summary of Measured RBL Noise Levels – (dBA)

NCA	Address	Suburb	Measured RBL Noise Level (dBA)		
			Daytime	Evening	Night Time
CVW_HH_S	45 Incense Place	Casula	52	49	38
	40A Ironbark Avenue	Casula	57	52	42
	55 Grove Street	Casula	57	52	39
M7_HH_N	43 Acacia Avenue	Prestons	54	50	38
	15 Foveaux Avenue	Lurnea	57	54	45
	33 Mary Crescent	Liverpool	56	53	43
MA_HLD_S	15 Barwon Court	Wattle Grove	57	55	42
	17 Fitzgerald Avenue	Hammondville	55	53	39
HR_HLD_N	80 Renton Avenue	Moorebank	52	49	41
HLD_HR_N	4 Meteren Close	Milperra	54	50	38
	4 Flanders Avenue	Milperra	49	49	45
HR_FR_S	64 Tracey Street	Revesby	55	53	47
	23 Carrington Street	Revesby	54	53	40
	46 Louie Street	Padstow	52	51	39
QS_GA_N	32 Ely Street	Revesby	54	52	39
FR_BR_N	24 Iris Avenue	Riverwood	50	51	44
BR_KGR_N	4 Arilla Avenue	Riverwood	57	56	45
BR_KGR_S	2/62 Kentucky Road	Riverwood	52	52	39
	41 Earls Avenue	Riverwood	50	50	40
	60 Parry Avenue	Narwee	51	51	43

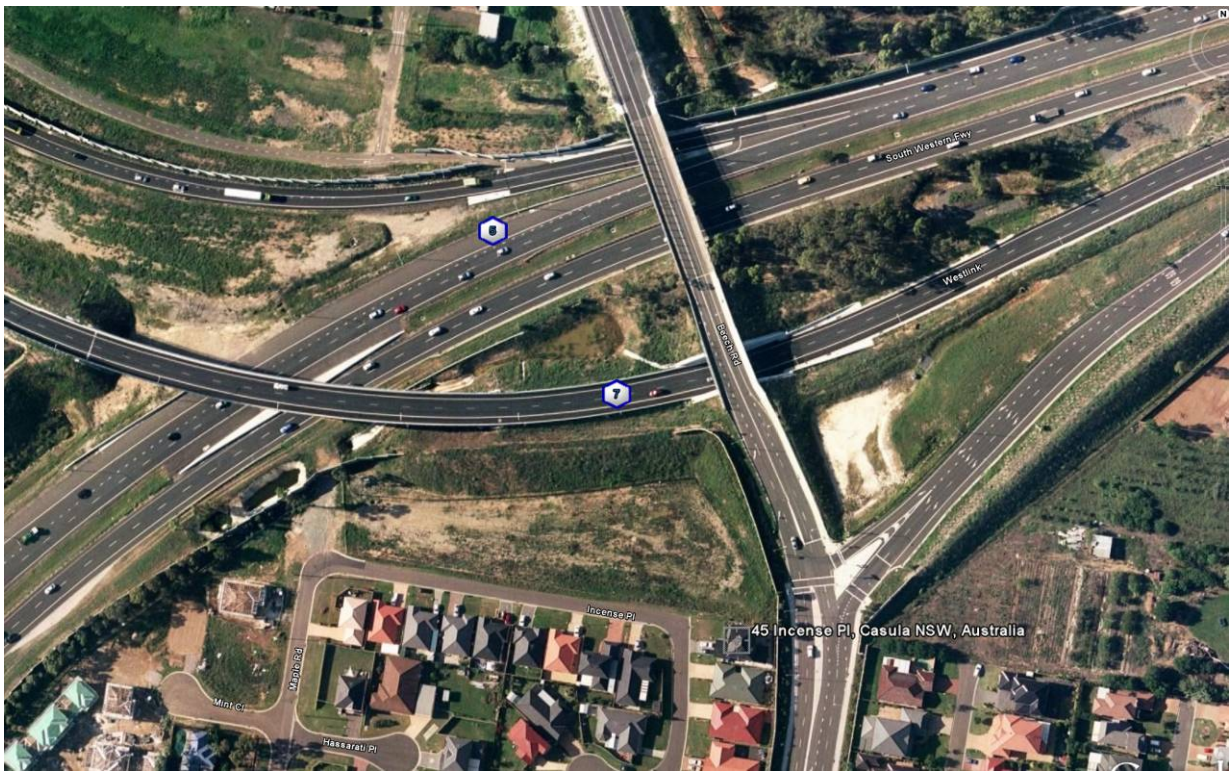
Note: Background noise levels above are Rating Background Noise Levels based on procedures contained within the DECCW's *Industrial Noise Policy*; and Daytime (7.00am-6.00pm), Evening (6.00pm-10.00pm) and Night time (10.00pm-7.00am).

4.1 Discussion

In developing the construction noise objectives for each catchment, where there was more than one background noise measurement, the lowest RBL value for any measurement location in the catchment was used to develop the target construction noise levels.

The monitoring location at 45 Incense Place was excluded from the subsequent traffic noise verification analysis as the measured noise levels were not considered to be representative (in terms of dominant noise levels) of typical motorway operation. Figure 4-6 shows the location of 45 Incense Place, which shows the residence to be some distance from the motorway immediately adjacent to Beech Road.

Figure 4-6 Aerial Location Map for 45 Incense Place, Casula



5 ROAD TRAFFIC NOISE CRITERIA

5.1 Noise Criteria for Residences

Criteria for assessment of road traffic noise are set out in the NSW Government's *Environmental Criteria for Road Traffic Noise (ECRTN)*. The RTA has also published the *Environmental Noise Management Manual (ENMM)* to assist in implementing the *Environmental Criteria for Road Traffic Noise.*

Under the *Environmental Criteria for Road Traffic Noise*, road developments are classified as either "new road" or "redevelopment of an existing road". Practice note (i) of the *Environmental Noise Management Manual* describes the circumstances under which each of these applies. For all noise-sensitive locations considered in this project, the proposal would be classified as a *"redevelopment of existing freeway/arterial road*". The criteria set out in Table 5-1 would therefore apply. The criteria in columns 2 and 3 of the table are referred to as "base" criteria. These should be met in all cases, where possible. Criteria in the fourth column of the table are referred to as "allowance" criteria.

Table 5-1 Environmental Criteria for Road Traffic Noise Criteria for Operational Traffic Noise - Residences

Type of Development	Noise Level Criterion		Where Criteria are already Exceeded
	Day (7am-10pm)	Night (10pm-7am)	
Redevelopment of existing freeway / arterial road	$L_{Aeq,15hr}$ 60dBA	$L_{Aeq,9hr}$ 55dBA	In all cases, the redevelopment should be designed so as not to increase existing noise levels by more than 2dB. Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In many instances this may be achievable only through long-term strategies.

In applying Table 5-1, the noise level criterion applies to the predicted noise level at a time 10 years after opening of the project (design year), which in this case is the year 2023. The "existing" noise levels are described in the *Environmental Noise Management Manual* as "future existing" levels – that is, noise levels due to traffic on existing roads as predicted at a time immediately before opening of the project (2013).

Where the "base" criteria in Table 5-1 are already exceeded, Practice Note (iv) of the *Environmental Noise Management Manual* provides further discussion of situations where provision of additional controls would be considered "feasible and reasonable". In particular, for "redevelopment of existing freeway/arterial road" it is generally *not* considered reasonable to take action to reduce noise levels to the target levels if the noise levels with the proposal, ten years after project opening, are predicted to be:

- within the "allowance" criterion – that is, 2dBA above "future existing" noise levels; and
- not "acute" – that is, less than 65 dBA $L_{Aeq,15hr}$ and 60 dBA $L_{Aeq,9hr}$.

The RTA has a Noise Abatement Program for existing roads where the RTA targets locations or lengths of existing roadways where road traffic noise levels are very high and are considered excessive for noise sensitive land uses. Noise affected sites are not currently given priority for noise treatment unless road traffic noise levels are at least 65dBA $L_{Aeq,15hr}$ or 60dBA $L_{Aeq,9hr}$.

5.2 Other Noise Sensitive Receivers

Road traffic noise criteria for other (non-residential) noise sensitive receivers are contained within Table 2 of the *ECRTN*. These criteria are summarised in Table 5-2.

Table 5-2 Road Traffic Noise Criteria for Non-Residential Sensitive Land Uses

Type of Development	Noise Level Criterion		Where Criteria are already Exceeded
	Day (7am-10pm)	Night (10pm-7am)	
Places of Worship	$L_{Aeq,1hr}$ 40dBA (internal)	$L_{Aeq,1hr}$ 40dBA (internal)	To achieve internal noise criteria in the short-term, the most practical mitigation measures are often related to building or facade treatments. Where existing levels of traffic noise exceed the criteria, all feasible and reasonable noise level control measures should be evaluated and applied. Where this has been done and internal and external criteria cannot be achieved, the proposed road should be designed so not to increase existing traffic noise levels by more than 2dB
Hospital Wards	$L_{Aeq,1hr}$ 35dBA (internal)	$L_{Aeq,1hr}$ 35dBA (internal)	
Existing School Classrooms	$L_{Aeq,1hr}$ 45dBA (internal)	-	
Active Recreation (eg Golf Courses)	Freeways and Arterial Roads: $L_{Aeq,15hr}$ 60dBA	-	
Passive Recreation and School Playgrounds(1)	Freeways and Arterial Roads: $L_{Aeq,15hr}$ 55dBA	-	

Note 1 This is interpreted by Wilkinson Murray to be the part of school playground which may be used for outdoor teaching or learning activities. The remainder of school playgrounds can be considered as active recreation areas.

There are a number of non-residential noise sensitive locations within the general project catchments. The potentially most affected locations as well as the larger and more significant parks and recreation areas are summarised in Table 5-3.

Table 5-3 Potentially Most Affected Non-Residential Noise Sensitive Areas

Noise Catchment No.	Suburb	Noise Sensitive Receptor
CVW_M7_W	Prestons	Sir Roden Cutler VC Rest Area
CVW_HH_S	Casula	Daruk Park
	Casula	Casula High School
M7_HH_N	Prestons	Prestons Public School and Childcare Centre
	Lurnea	Lurnea High School
MA_HLD_S	Hammondville	Hammondville Public School
	Hammondville	Lieutenant Cantello Reserve
HR_HLD_N	Hammondville	Fellowship Baptist Church
	Hammondville	New Brighton Golf Club
HLD_S	Milperra	Deepwater Regional Park
HLD_HR_N	Milperra	Riverlands Golf Club
	Milperra	Milperra Public School
	Milperra	University of Western Sydney
HR_FR_S	Panania	Panania North Public School
	Revesby	Broderick Gillawarna School
QS_GA_N	Revesby	Sir Joseph Banks High School
FR_BR_N	Riverwood	Canterbury Bankstown Tennis and Bowling Club
	Riverwood	McLaughlin Oval
BR_KGR_S	Riverwood	Salt Pan Creek Reserve
	Riverwood	Hannans Road Public School
	Riverwood	Lance Hutchinson Oval
	Riverwood	Rotary Park
BR_KGR_N	Narwee	John Mountford Reserve (including play area)
	Narwee	Wise Reserve

5.3 Noise Criteria for Childcare Centres

The Prestons Child Care Centre could be potentially affected by operational road traffic noise.

For childcare centres, the Department of Planning guideline "*Development Near Rail Corridors and Busy Roads – Interim Guideline*" recommends a maximum internal level of L_{Aeq} 40dBA.

There are no specific criteria for external play areas in childcare centres. Whilst most use of these external areas is akin to an active recreation area, some use may be more closely related to a passive recreation area. For passive recreation areas the criterion is $L_{Aeq,15hr}$ 55dBA compared with 60dBA for active recreation.

6 AIRBORNE CONSTRUCTION NOISE OBJECTIVES

The *NSW Interim Construction Noise Guideline (ICNG)* presents the process to assess construction in NSW. The *ICNG* was developed by the Department of Environment Climate Change & Water (DECCW) taking into consideration that construction is temporary, noisy and difficult to ameliorate. As such, the *ICNG* was developed to focus on applying a range of work practices most suited to minimising construction noise impacts, rather than focusing only on achieving a numeric noise level.

The *ICNG* recommends that standard construction work hours should typically be as follows:

- Monday to Friday 7.00am to 6.00pm.
- Saturday 8.00am to 1.00pm.
- No work on Sundays or public holiday.

Additionally, it recommends quantitative management noise goals at residences as presented in Table 6-1.

Table 6-1 Construction Noise at Residences using Quantitative Assessment

Time of Day	Management Level $L_{Aeq\ (15\ min)}$	How to Apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected RBL + 10dBA	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided.

Time of Day	Management Level $L_{Aeq\ (15\ min)}$	How to Apply
Outside recommended standard hours	Noise affected RBL + 5dBA	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dBA above the noise affected level, the proponent should negotiate with the community.

In addition to the above criteria, where any work is conducted during the night time period (10.00pm-7.00am), the DECCW recommends that to protect against sleep disturbance, $L_{A1,1min}$ noise levels should not exceed the background level by more than 15dBA at any residence. In practice, the $L_{A1,1min}$ level can be represented by the maximum noise level.

The *ICNG* presents the following noise management levels for non-residential premises:

- Active recreation areas (such as parks) external $L_{Aeq\ (15\ min)}$ 65dBA
- Passive Recreation areas external $L_{Aeq\ (15\ min)}$ 60dBA
- Industrial premises: external $L_{Aeq\ (15\ min)}$ 75dBA
- Offices, retail outlets external $L_{Aeq\ (15\ min)}$ 70dBA
- Classrooms, hospitals, places of worship internal $L_{Aeq\ (15\ min)}$ 45dBA

For the childcare centre, although they are classified as noise sensitive commercial receivers it is recommended that criteria are considered on a project specific basis. In this case we consider the residential noise criteria should be adopted.

7 CONSTRUCTION VIBRATION OBJECTIVES

Impacts from vibration can be considered both in terms of effects on building occupants (human comfort) and the effects on the building structure (building damage). Of these considerations, the human comfort limits are the most stringent. Therefore, for occupied buildings, if compliance with human comfort limits is achieved, it will follow that compliance will be achieved with the building damage objectives.

7.1 Human Comfort

The DECCW's *Assessing Vibration: A Technical Guideline* provides acceptable values for continuous and impulsive vibration in the range 1-80Hz. Both preferred and maximum vibration limits are defined for various locations and are shown in Table 7-1.

Table 7-1 Preferred and Maximum Peak Particle Velocity (PPV) Values for Continuous and Impulsive Vibration

Location	Assessment Period [1]	PPV (mm/s)	
		Preferred Values	Maximum Values
Continuous Vibration			
Critical areas [2]	Day or night time	0.14	0.28
Residences	Daytime	0.28	0.56
	Night time	0.20	0.40
Offices, schools, educational institutions and places of worship	Day or night time	0.56	1.1
Workshops	Day or night time	1.1	2.2
Impulsive Vibration			
Critical areas [2]	Day or night time	0.14	0.28
Residences	Daytime	8.6	17.0
	Night time	2.8	5.6
Offices, schools, educational institutions and places of worship	Day or night time	18.0	36.0
Workshops	Day or night time	18.0	36.0

Notes: 1 Daytime is 7.00am to 10.00pm and night time is 10.00pm to 7.00am.
2 Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas. Source BS 6472-1992.

These limits relate to a long-term (16 hours for daytime), continuous exposure to vibration sources. Where vibration is intermittent, a Vibration Dose Value is calculated, and acceptable values are shown in Table 7-2.

Table 7-2 Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime [1]		Night Time [2]	
	Preferred Value	Maximum Values	Preferred Value	Maximum Value
Critical areas [2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes: 1 Daytime is 7.00am to 10.00pm and night time is 10.00pm to 7.00am.
2 Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas. Source BS 6472-1992.

The dose value takes into account the degree of intermittency of the vibration. For this project, any vibration being generated would be generated for a significant part of any day, and the difference between an assessment using dose values and one using peak particle velocity is considered very small. In practice, vibration from the proposed construction works can be assessed in accordance with Table 7-1, but a more detailed analysis would be carried out during the Detailed Design stage of the project.

7.2 Building Damage

In terms of the most recent relevant vibration damage objectives, Australian Standard AS 2187: Part 2-2006 “Explosives - Storage and Use - Part 2: Use of Explosives” recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 “Evaluation and measurement for vibration in buildings Part 2” as they “are applicable to Australian conditions”.

The British Standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

The recommended limits (guide values) from BS7385 for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table 7-3 and Figure 7-1.

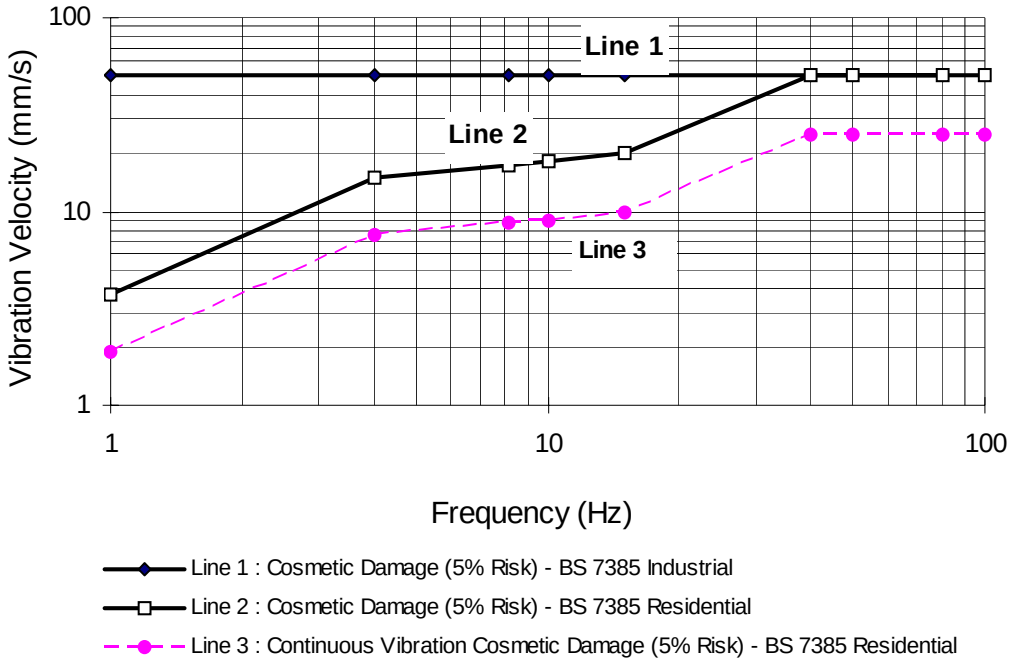
Table 7-3 Transient Vibration Guide Values - Minimal Risk of Cosmetic Damage

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

The standard states that the guide values in Table 7-3 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings. Rockbreaking/hammering, vibratory rolling and sheet piling activities are considered to have the potential to cause dynamic loading in some structures (eg residences) and it may therefore be appropriate to reduce the transient values by 50%.

The British Standard goes on to state that "*Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity*". In addition, a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.

Figure 7-1 Graph of Transient Vibration Guide Values for Cosmetic Damage



In addition to the British Standard, for the case of nearby heritage buildings and also typical residential construction, guidance for structural damage is derived from the German Standard DIN 4150 -3 “Structural Vibration Part 3 – Effects of Vibration on Structures. The following Table details these recommendations for heritage buildings.

Table 7-4 DIN 4150 recommend PPV vibration level for Heritage Buildings

Building	Guideline Values for Velocity – mm/s		
	1-10 Hz	10 to 15 Hz	40 to 50 Hz
Heritage	3	3 to 8	8-10
Residential	5	5 to 15	15 to 20

For the proposed construction works, it is unlikely that heritage buildings will be located close to vibration generating activities.

8 ROAD TRAFFIC NOISE EMISSION

8.1 Methodology of Assessing Traffic Noise Impact

The assessment of traffic noise impact during the operational phase of the M5 West Widening Project is based on guidance contained in NSW Department of Environment, Climate Change & Water (DECCW) *Environmental Criteria for Road Traffic Noise (ECRTN)*.

The *ECRTN* states that noise levels are to be assessed based on traffic volumes projected at a point in time 10 years after the opening of the Project. The proposed widening project is scheduled to open in 2013; therefore, the future assessment year applicable to this project is 2023. All calculations and modelling is based on the traffic forecasts prepared for this assessment by Halcrow.

Detailed noise calculations have been carried out for three different scenarios - Existing, Future Existing and Future Design.

- The Existing Scenario (Year 2009) has been modelled to allow for validation of the noise model against noise survey results recorded by Heggies during a survey conducted in year 2009.
- The Future Existing Scenario (Year 2013) represents noise levels modelled with the traffic forecast for year 2013, but without the proposed widening.
- The Future Design Scenario (Year 2023) represents noise levels modelled with traffic forecast 10 years post opening, with the road widening of the motorway incorporated.

The Future Design traffic volumes utilised for the modelling allow for natural growth in traffic and assume the operation of the proposed M5 East widening and link road.

The following factors are considered during the assessment process:

- traffic volume and likely proportions of heavy vehicles;
- topographical information along and surrounding the entire project corridor;
- land use surrounding the project;
- vehicle speed;
- different noise emission levels and source heights;
- location of the noise sources on the motorway;
- noise reduction from road surface materials;
- road gradient;
- noise reflections from barriers and existing dwellings; and
- noise attenuation from noise barriers (both natural and purpose built for the project).

8.2 Noise Modelling Procedures

Noise levels from both the existing and proposed road designs were calculated using procedures based on the *CoRTN (Calculation of Road Traffic Noise)* (UK Department of Transport, 1988) prediction algorithms. The standard prediction procedures were modified in the following ways.

- L_{Aeq} values were calculated from the L_{A10} values predicted by the *CoRTN* algorithms using the well-validated approximation $L_{Aeq,1hour} = L_{A10,1hr} - 3$. (NSW RTA, 2001).
- Noise source heights were set at 0.5m for cars, 1.5m for heavy vehicle engines and 3.6m for heavy vehicle exhausts, representing typical values for Australian vehicles. Noise from a heavy vehicle exhaust is 8dBA lower than the noise from the engine.
- Previous research in Australia has established a negative correction to the *CoRTN* predictions of -1.7dB for façade-corrected levels. Corrections for Australian conditions have been included in noise modelling for this project. (Samuels and Saunders, 1982)

The model was implemented using CadnaA software (Version 4). Road design information was based on data supplied by the RTA. Where there are no barriers present, ground was taken to be 50% soft ground. This has previously been found to give a good correlation with measured noise levels in similar situations. With barriers, hard ground is assumed, as required under the *CoRTN* procedures.

8.2.1 Traffic Data

While traffic modelling for the Traffic and Transport Working Paper reflects anticipated traffic numbers, the traffic data used for the noise modeling has been selected to ensure conservatism in the assessment and, therefore, in the identification of proposed mitigation measures.

Rather than use the average annual daily traffic (AADT) forecast based on a 7 day average and excluding the impact of the M5 East widening, which was adopted for the Traffic and Transport assessment, the noise and vibration assessment uses an average weekday traffic (AWT) forecast based on a 5 day average and includes the impact of the M5 East Duplication.

The combination of these results in a conservative assessment through “worst case” traffic numbers.

It should also be noted that the traffic and transport working paper uses modeled years at five year increments from the most recent journey to work data in 2006. As such, the years 2006, 2016, 2026 are used. The noise and environmental assessments, however, require traffic forecasts for scheme opening year and design year ten years from opening. In this case, years are 2013 and 2023 respectively. Traffic forecasts for 2013 and 2023 were derived through linear interpolation between explicitly modelled future years.

Road traffic modelling was undertaken by the Halcrow Group on behalf of the RTA. Road traffic volumes for the future existing situation in 2013 were modelled as “Scenario 1” in Halcrow’s road traffic modelling, and represent the traffic before widening of the M5 and prior to operation of the proposed M5 East Expansion.

Volumes for the future design year in 2023 were modelled in “Scenario 9” in Halcrow’s road traffic modelling. This model predicts the volumes in 2023 allowing for growth due to development affecting the region and also allowing for the M5 East Expansion proposal being in operation at the time.

Traffic has been split between light vehicles and heavy vehicles based on the Austroads vehicle classification system. For the purpose of the noise model light vehicles are defined as Class 1 and Class 2 vehicles, while heavy vehicles are defined as Class 3 and above.

For the verification modelling presented in Section 8.3, the traffic volumes are based on existing volumes shown in the Halcrow report.

In each case, traffic volumes are divided into Day (7.00am-10.00pm) and Night (10.00pm-7.00am). Volumes adopted for each of the three models are shown in Table 8-1 to Table 8-3.

Table 8-1 Traffic Volumes, 2009

ID	Location	Period	Daily			
			Westbound		Eastbound	
			Light	Heavy	Light	Heavy
M-1	M5, N of M5 to M7 connection	Day	-	-	19721	2285
		Night	-	-	4484	663
M-2	M5, S of M7 to M5 connection	Day	22830	2804	29178	2572
		Night	3393	429	6634	746
M-3	M5, West of Hume Highway	Day	35758	5659	32942	4960
		Night	5315	865	7490	1439
M-4	M5, W of Moorebank	Day	50213	6052	45766	5431
		Night	7463	925	10406	1576
M-5	M5, W of Heathcote Road	Day	43677	4658	37893	3641
		Night	6491	712	8616	1056
M-6	Hammondville Toll Plaza	Day	38785	3969	32648	3178
		Night	5764	607	7423	922
M-7	M5, W of River Road (total)	Day	38617	4288	31874	3508
		Night	5739	655	7247	1018
M-8	M5, W of Fairford Road	Day	38684	5018	32887	3648
		Night	5749	767	7477	1059
M-9	M5, W of Belmore	Day	34544	4877	31591	3528
		Night	5106	745	7183	1024
M-10	M5, W of King Georges Road	Day	30645	4672	28438	3427
		Night	4555	714	6466	995

Table 8-2 Traffic Volumes, 2013

ID	Location	Period	Daily			
			Westbound		Eastbound	
			Light	Heavy	Light	Heavy
M-1	M5, N of M5 to M7 connection	Day	-	-	32215	3039
		Night	-	-	7325	882
M-2	M5, S of M7 to M5 connection	Day	24644	3356	22511	2711
		Night	3663	513	24644	3356
M-3	M5, West of Hume Highway	Day	37915	6089	35275	5318
		Night	5635	931	8020	1543
M-4	M5, W of Moorebank	Day	53018	6534	48685	5856
		Night	7880	999	11069	1699
M-5	M5, W of Heathcote Road	Day	46472	4918	39836	4210
		Night	6907	752	9058	1222
M-6	Hammondville Toll Plaza	Day	41233	4255	34409	3744
		Night	6128	650	7824	1086
M-7	M5, W of River Road (total)	Day	40793	4536	33463	4028
		Night	6063	693	7608	1169
M-8	M5, W of Fairford Road	Day	40959	5383	34682	4286
		Night	6087	823	7886	1244
M-9	M5, W of Belmore	Day	36824	5383	33258	4189
		Night	5473	823	7562	1215
M-10	M5, W of King Georges Road	Day	32884	5208	29950	4066
		Night	4887	796	6810	1180

Table 8-3 Traffic Volumes, 2023

ID	Location	Period	Daily			
			Westbound		Eastbound	
			Light	Heavy	Light	Heavy
M-1	M5, N of M5 to M7 connection	Day	-	-	28414	4427
		Night	-	-	6461	1285
M-2	M5, S of M7 to M5 connection	Day	32136	5448	42526	4905
		Night	4776	833	9669	1423
M-3	M5, West of Hume Highway	Day	49381	11395	47562	9971
		Night	7339	1742	10814	2894
M-4	M5, W of Moorebank	Day	65864	12248	61797	10845
		Night	9789	1872	14051	3147
M-5	M5, W of Heathcote Road	Day	57440	9617	51930	8258
		Night	8537	1470	11807	2396
M-6	Hammondville Toll Plaza	Day	56738	9145	49108	7927
		Night	8433	1398	11166	2300
M-7	M5, W of River Road (total)	Day	56083	9574	47919	8437
		Night	8335	1463	10895	2448
M-8	M5, W of Fairford Road	Day	57041	11186	50160	8925
		Night	8478	1710	11405	2590
M-9	M5, W of Belmore	Day	52106	11282	47676	8931
		Night	7744	1724	10840	2592
M-10	M5, W of King Georges Road	Day	47574	10958	43670	8664
		Night	7071	1675	9929	2514

8.2.2 Posted Traffic Speed

The posted traffic speeds used for the purpose of noise modelling are:

- **Main Carriageway:** King Georges Road to Georges River East Bridge (both east bound and west bound) – 110km/hr;
- **Main Carriageway:** Georges River East Bridge to 200 metres west of Hammondville Toll Plaza (both east bound and west bound) – 70km/hr;
- **Main Carriageway:** From 200 metres west of Hammondville Toll Plaza to Camden Valley Way (both east bound and west bound) – 100km/hr;
- **Entry and Exit Ramps**: All entry and exit ramps – 70 km/hr; and
- **Intersecting Roads:** All intersecting secondary roads – 70km/hr.

8.2.3 Road Surface

Table 8-4 presents a summary of two common road surface types and the associated noise reduction benefits.

Table 8-4 Road Surface Types and Benefits

Road Surface Type	Noise Reduction Benefit (dBA)
DGAC (Dense Graded Asphaltic Concrete)	0
OGAC (Open Graded Asphaltic Concrete)	-2.5

The existing motorway pavement surfacing is currently surfaced with Open Graded Asphaltic Concrete. However, with degradation over time and lack of surface maintenance, the surface is likely to have become clogged and behave more like Dense Graded Asphaltic Concrete. Some marginal residual noise reduction benefit may remain. It is proposed to re-surface the existing main carriageways with Open Graded Asphaltic Concrete as part of the upgrade. As a conservative measure however, the RTA has instructed that any acoustic benefit associated with OGAC on the existing pavement should not be incorporated into the future noise modelling. Therefore, as a conservative measure, the -2.5dBA pavement correction for OGAC has been confined only to new pavement even though existing pavement will also be re-surfaced.

8.2.4 Existing Noise Barriers

Traffic noise from the M5 West Motorway is currently mitigated with noise barriers of various heights along almost the entire length of the motorway. These typically range from approximately 2m to approximately 5m in height. The noise barriers are generally located either at the side of the carriageway or at the crest of cuttings, depending on which location provides the optimal noise benefit for the sensitive receivers situated behind.

The location and height of existing noise barriers was advised by the RTA, and these were included in all modelling scenarios. Locations of existing barriers are shown in Appendix C.

8.2.5 Receivers

The location of buildings along the route was determined from aerial photographs, and buildings were digitised to at least three rows back from the motorway. In general, all buildings were digitised, but in some cases commercial buildings that do not shield noise-sensitive buildings were not. The height of each building in storeys was determined by field inspection. This inspection also determined whether the building was a residence.

In each building, a receiver was located at 1.5m above the highest floor level.

8.2.6 Other Roads

Traffic noise from a number of other roads was also included in the total noise level. These are:

- Camden Valley Way
- Beech Road;
- Hume Highway;
- Moorebank Avenue;
- Heathcote Road;
- Nuwarra Road;
- Henry Lawson Drive;
- River Road;
- Belmore Road; and
- King Georges Road.

In each case, traffic volumes on these roads were provided by Halcrow. The modelled traffic speed was 70 km/h in all cases, and the road surface was dense graded asphaltic concrete.

8.3 Calibration of the Noise Model

Noise levels were calculated at each noise monitoring location using the existing traffic volumes as described above. A comparison between the predicted and measured noise levels is presented in Table 8-5 and Table 8-6 for the day and night periods respectively.

Table 8-5 Comparison of Predicted Daytime L_{Aeq} Noise Levels with Measured Noise Levels

NCA	Residence Location	Measured Daytime Noise Level $L_{Aeq,15hrs}$	Calculated Level L_{Aeq}	Predicted Difference (Predicted minus Measured)
BR_KGR_S	60 Parry Avenue	57.4	63.0	5.6
HR_FR_S	64 Tracey Street	59.6	64.7	5.1
HR_FR_S	23 Carrington Street	59.9	62.6	2.7
HR_FR_S	46 Louie Street	57.6	63.3	5.7
HR_HLD_N	80 Renton Avenue	56.7	61.6	4.9
MA_HLD_S	17 Fitzgerald Avenue	58.5	63.4	4.9
M7_HH_N	43 Acacia Avenue	58.5	63.9	5.4
CVW_HH_S	40A Ironbark Avenue	60	63.2	3.2
M7_HH_N	33 Mary Crescent	57.3	63.1	5.8
CVW_HH_S	55 Grove Street	60.2	63.8	3.6
HLD_HR_N	4 Meteren Close	58.2	64.2	6.0
HLD_HR_N	4 Flanders Avenue	56.7	62.6	5.9
QS_GA_N	32 Ely Street	60.3	63.2	2.9
FR_BR_N	24 Iris Avenue	56.6	62.8	6.2
BR_KGR_S	2/62 Kentucky Road	57.6	61.9	4.3
BR_KGR_S	41 Earls Avenue	54.9	58.8	3.9
BR_KGR_N	4 Arilla Avenue	62.8	64.5	1.7
M7_HH_N	15 Foveaux Avenue	60.5	62.5	2.0
MA_HLD_S	15 Barwon Court	62.4	63.8	1.4
Daytime Average Difference (Predicted – Measured) =				**4.3dBA**
Standard Deviation				**2.7dBA**

Note: 45 Incense Place excluded from the above analysis as it is considered to be more strongly affected by local road noise.

Table 8-6 Comparison of Predicted Night time L_{Aeq} Noise Levels with Measured Noise Levels

NCA	Residence Location	Measured Night time Noise Level $L_{Aeq,9hrs}$	Calculated Level L_{Aeq}	Predicted Difference (Predicted minus Measured)
BR_KGR_S	60 Parry Avenue	55.1	58.2	3.1
HR_FR_S	64 Tracey Street	56.3	59.9	3.6
HR_FR_S	23 Carrington Street	57.1	57.8	0.7
HR_FR_S	46 Louie Street	54.5	58.5	4.0
HR_HLD_N	80 Renton Avenue	54	57.1	3.1
MA_HLD_S	17 Fitzgerald Avenue	54.7	58.3	3.6
M7_HH_N	43 Acacia Avenue	54.1	59.2	5.1
CVW_HH_S	40A Ironbark Avenue	56	58.5	2.5
M7_HH_N	33 Mary Crescent	53.3	58.6	5.3
CVW_HH_S	55 Grove Street	57	59.2	2.2
HLD_HR_N	4 Meteren Close	54.5	59.4	4.9
HLD_HR_N	4 Flanders Avenue	54.1	57.9	3.8
QS_GA_N	32 Ely Street	57.1	58.8	1.7
FR_BR_N	24 Iris Avenue	53.9	58.0	4.1
BR_KGR_S	2/62 Kentucky Road	54.9	57.2	2.3
BR_KGR_S	41 Earls Avenue	51.6	54.0	2.4
BR_KGR_N	4 Arilla Avenue	59.6	59.7	0.1
M7_HH_N	15 Foveaux Avenue	55.6	57.9	2.3
MA_HLD_S	15 Barwon Court	58.2	58.8	0.6
Night time Average Difference (Predicted – Measured) =				**2.9dBA**
Standard Deviation				**2.2dBA**

Note: 45 Incense Place excluded from the above analysis as it is considered to be more strongly affected by local road noise.

Table 8-5 and Table 8-6 indicate a consistent over-prediction in the modelling, to the extent of typically 3dBA to 6dBA. A review of traffic speed modelling, undertaken by Halcrow and made available by the RTA for the project, indicates severe congestion through most of the day, and for a number of hours during the early morning. This is considered to be the fundamental reason for the over-prediction. The average of peak hour and inter-peak hour speed during the daytime is approximately 62km/h, well below the posted speeds used in the modelling. Furthermore, in 2023, the average speed is only marginally higher at 65km/h. Accordingly the noise modelling will be calibrated by subtracting the average prediction differences. The calibration factor has been determined to be 4.3dBA in the day and 2.9dBA at night, based on the average over prediction values for the relevant time periods.

8.4 Results

For the Future Existing and Future Design scenarios, façade noise levels were calculated at each building facade along the route. The CadnaA program incorporates a procedure to determine the most-affected location on a façade, and this was used in each case.

Appendix D shows results for the Future Existing scenario. The figures show each residential receiver, with the noise level at the most-exposed location on the highest floor being indicated by colour. Appendix E shows the same information for the Future Design scenario.

Appendix D indicates that in the Future Existing scenario many residential dwellings along the route of the motorway will already be subjected to noise levels exceeding *ECRTN* base criteria. The Future Design scenario shown in Appendix E indicates an increase in this number.

In a number of cases the noise levels shown are a result of noise from roads other than the Motorway. In the case of the Future Design scenario at night (which is the most critical time period), buildings for which the noise level at the most-affected façade is dominated by noise from a road other than the M5 Motorway are indicated by a "cloud".

8.5 Noise Mitigation - Residences

Consideration of architectural treatment would be in accordance with the guidelines of the *ENMM*, which indicates that such treatment would not be "feasible and reasonable" unless:

- the increase in noise level between the Future Existing and Future Design scenarios exceeds the "allowance criterion" of 2dBA; or
- the noise level in the Future Design scenario is acute (65dBA $L_{Aeq,15hr}$ or 60dBA $L_{Aeq,9hr}$).

It is also considered that mitigation would not be considered "reasonable and feasible" where an acute noise level in the Future Design scenario is due largely to noise from traffic on roads other than the M5.

The noise mitigation that could be considered for the project are:

- roadside noise barriers; and
- architectural treatment of exposed residential dwellings.

Noise barriers represent the preferred noise mitigation measure, as all sensitive receivers behind a particular noise barrier benefit from the resulting reduction in noise. However, if noise barriers are not considered reasonable and feasible, architectural property treatment may then be utilised to mitigate noise in accordance with the requirements of the *ENMM*.

In this project, most of the residences identified as requiring mitigation under the above guidelines do so because their noise level in the Future Design scenario is acute. Night-time levels are more significant than day-time levels in this regard – any residence predicted to experience day-time noise levels above 65dBA also experiences night-time levels above 60dBA.

From the plots shown in Appendices D and E, a total of 286 residential buildings are identified as either exceeding the "allowance criterion" or are subjected to acute noise levels. These are identified in Table 8-7. The identified residences do not include those within "clouds" in Appendix E, where the total traffic noise level at the worst-affected façade is dominated by noise from other roads.

Table 8-7 Residences Requiring Consideration for Noise Mitigation

No. of Dwellings	Location	Reason for Noise Mitigation
	CVW_M7_W	
-	-	-
	CVW_HH_S	
3	5 Pecan Place & 2 new developments	Acute Noise
16	817-823 Flame Tree Street & new developments	Acute Noise
3	Flame Tree Street new developments	Acute Noise
3	37, 39 & 41 Guise Avenue - Townhouse	Acute Noise
1	9 Doomben Close - Townhouse	Acute Noise
1	14 Sandown Close	Acute Noise
1	43 Verbena Avenue	Acute Noise
1	30 Verbena Avenue	Acute Noise
1	42-44 Verbena Avenue - Townhouses	Acute Noise
1	13 Carnation Avenue - Townhouse	Acute Noise
2	5-7 Carnation Avenue - Townhouses	Acute Noise
2	13, 17 Grove Street	Acute Noise
1	431 Hume Highway	Acute Noise
1	26 Pensacola Place	Acute Noise
11	1, 5, 7, 11 & 35-23 Phoenix Crescent	Acute Noise
1	18 Lakewood Crescent	Acute Noise
	MA_HLD_S	
4	22, 24, 53 & 55 Wombeyan Ct	Acute Noise
1	23 Todd Ct	Acute Noise
1	15 Warrego Ct	Acute Noise
1	23 Timbara Ct	Acute Noise
1	56 Colo Ct	Acute Noise
1	7 Fitzgerald Avenue	Acute Noise
31	23-71, 75 & 77 Whitfield Parade	Allowance Goal / Acute Noise
	HR_FR_S	
1	230 Horsley Road	Acute Noise
5	15-19, 27 & 29 Toby Crescent	Acute Noise
2	165 & 126 Beaconsfield Street	Acute Noise
3	66, 64 & 60 Tracey Street	Acute Noise
3	5, 17 & 41 Alliance Avenue	Acute Noise
33	66-100 & 51-75 Carrington Street	Acute Noise
1	36 Ely Street	Acute Noise
3	29, 40 & 42 Sherwood Street	Acute Noise
2	40 & 47 Carrington Street	Acute Noise
1	37A Victoria Street	Acute Noise
1	31 Mackenzie Street	Acute Noise
8	44A, 44B, 40A,40, 36, 26A, 26B, & 20 Louie Street	Allowance Goal / Acute Noise
7	32 30, 28, 24, 18, 16 & 14 Louie Street	Allowance Goal
2	79 & 100 Gibson Avenue	Acute Noise
2	8-10 Bryant Street	Acute Noise
	BR_KGR_S	
2	67 - 65 Graham Road - Apartments	Acute Noise
3	109, 105 & 90 Penshurst Road - Townhouses	Acute Noise

No. of Dwellings	Location	Reason for Noise Mitigation
7	56-64 & 78 Parry Avenue	Acute Noise
1	37 Welfare Avenue	Acute Noise
1	42 Welfare Avenue	Acute Noise
	M7_HH_N	
1	42 Cedar Road	Acute Noise
2	3-5 Acacia Avenue	Acute Noise
1	28 Jarrah Avenue	Acute Noise
1	34 Jarrah Avenue	Acute Noise
1	7 Robinson Close	Acute Noise
15	35-65 Foveaux Avenue	Acute Noise
1	114 Graham Avenue - Townhouse	Acute Noise
3	50, 54-56 Tully Avenue	Acute Noise
1	42 Monteclair Avenue	Acute Noise
3	2-6 Doral Place	Acute Noise
3	50-54 Congressional Drive	Acute Noise
11	43-65 Congressional Drive	Acute Noise
2	20, 20A Lakewood Crescent	Acute Noise
1	11 Lakewood Crescent	Acute Noise
4	New subdivision within M7_HH_N Macadamia Street	Acute Noise
	HR_HLD_N	
2	108 & 104 Renton Avenue	Acute Noise
2	2&4 Clyde Avenue	Acute Noise
1	2 Jaqueline Place	Acute Noise
	HLD_HR_N	
3	6, 8 & 12 Prescot Parade	Acute Noise
3	4, 5 & 6 Meteren Close	Acute Noise
2	17 & 9 Maygar Close	Acute Noise
4	48, 42, 40 & 36 Flanders Avenue	Acute Noise
	QS_GA_N	
1	6 Gordon Parker Street	Acute Noise
1	23 Sherwood Street	Acute Noise
1	28 Sherwood Street	Acute Noise
1	20 Albert Street	Acute Noise
2	19 & 19A Gordon Parker Street	Acute Noise
2	18 & 19 Victoria Street	Acute Noise
1	5 Wolaroi Crescent	Acute Noise
2	9 Turvey Street - Townhouses	Acute Noise
	FR_BR_N	
2	24 & 10 Iris Avenue	Acute Noise
1	35 Belgium Street	Acute Noise
3	4, 6 & 16 Sofala Street	Acute Noise
	BR_KGR_N	
6	16-14, 10, 6, 4 & 2 Arilla Avenue	Acute Noise
2	28 & 2 Baralga Crescent	Acute Noise
1	59 Karne Street	Acute Noise
11	12-16, 6-8, 18, 28-32, 38B & 46-48 Grove Avenue	Acute Noise
1	93 Penshurst Road	Acute Noise
1	26 Welfare Avenue	Acute Noise

No. of Dwellings	Location	Reason for Noise Mitigation
2	13 & 13A Warne Crescent	Acute Noise
1	323 King Georges Road	Acute Noise

8.6 Noise Mitigation for Residences

The M5 West Upgrade widening does not currently require alterations to any of the existing noise barriers along the route of the motorway.

At all residences listed in Table 8-7, new or increased height noise barriers have been considered where there are more than three such residences in a group. Where the residences do not form a group of at least three, then in accordance with the *ENMM*, noise barriers are not considered a reasonable approach and architectural treatment of these residences would be considered.

Where barriers are considered, the *ENMM* provides guidance on reasonable and feasible measures and optimisation of the barrier height. The cost-effective and reasonableness procedures defined within the *ENMM* guidelines also state the following requirements:

- noise barriers less than 5 m in height should generally achieve a minimum of 5dBA reduction at the ground floor level to be considered cost-effective;
- noise barriers 5m and above should generally achieve a minimum of 10 dBA noise reduction at the ground floor level to be considered cost-effective; and
- noise barriers more than 8m high are generally considered visually unacceptable and therefore not feasible.

8.7 New Noise Barriers

In a number of cases, high predicted noise levels are a result of gaps in the existing extent of noise barriers and/or earth mounds, namely:

- Northside - PB1 – 4.5m – East of Kurrajong Road – 275m;
- Southside – PB2 – 6.0m – West of Box Road – 400m;
- Northside – PB3 – 4.5m – Infill barrier between Hume Highway and railway – 240m;
- Southside – PB7 – 4.0m – Between Horsley Road and Panania North Public School – 510m; and
- Southside – PB8 – 4.0m – Infill barrier behind Parry Avenue – 155m.

In each case above, the trigger for consideration of noise barriers was predicted acute noise levels. The approach taken in relation to these new noise barriers was to determine the height of the additional noise barrier for which the *ECRTN* target noise level at the worst-affected residence was achieved, where this was feasible. In the case of PB8 however, the infill noise barrier is relatively short and the area behind is significantly affected by noise propagating over the adjacent sections of existing barrier on either side. Here the approach taken was to match the adjacent noise barrier sections in height. It is of little benefit here to install a greater height noise barrier due to the strong flanking noise contribution over the adjacent existing noise barrier sections.

The locations of proposed new noise barriers are shown in Appendix G. More detailed information on the impact of different height noise barriers is contained in Appendix H.

8.8 Increasing Height of Existing Noise Barriers

In situations where there is a group of at least three dwellings that will be subjected to acute noise levels in 2023, and where these are located behind an existing noise barrier, consideration has been given to increase the height of these barriers.

In all cases, apart from EB29, the analysis rejected construction of new noise barriers of greater height because of the very small additional noise benefit (much less than 5 dB) which is provided by increased height noise barriers relative to the existing noise barriers, and the significant cost that would be incurred to obtain marginal benefit.

The EB29 noise barrier is proposed to be increased to 5m between Beaconsfield Street and Queens Street. The replacement barrier, PB7a, would be approximately 950m long and is shown in Appendix G.

8.9 Architectural Treatment

Architectural treatment for mitigation of noise usually depends on the level of exceedance over the target noise criteria. Typically the level of treatment is:

- 1-10dBA exceedance - offer fresh air ventilation, sealing of wall vents and check window and door seals and replace where necessary;
- >10dBA exceedance - offer fresh air ventilation, sealing of wall vents and check window and door seals and replace where necessary. Offer (residences in suitable condition/fabric) to upgrade glazing and doors (if required) that are exposed to highway noise from the new highway.

Predicted noise levels in the study area are all in the first category. The budget for architectural treatment is typically $15,000 to $20,000 per residence.

After the installation of the new barriers shown in Appendix G, the 180 residences listed in Table 8-8 require consideration of architectural treatment

Table 8-8 Residences Requiring Consideration for Architectural Treatment

No. of Dwellings	Location	Reason for Noise Mitigation	Predicted $L_{Aeq,9hr}$ Levels (dBA)
	CVW_M7_W		
-	-	-	
	CVW_HH_S		
3	37, 39 & 41 Guise Avenue - Townhouse	Acute Noise	61-63
1	9 Doomben Close - Townhouse	Acute Noise	62
1	14 Sandown Close	Acute Noise	61
1	43 Verbena Avenue	Acute Noise	60
1	30 Verbena Avenue	Acute Noise	61
1	42-44 Verbena Avenue - Townhouses	Acute Noise	60

No. of Dwellings	Location	Reason for Noise Mitigation	Predicted $L_{Aeq,9hr}$ Levels (dBA)
1	13 Carnation Avenue - Townhouse	Acute Noise	60
2	5-7 Carnation Avenue - Townhouses	Acute Noise	60
2	13, 17 Grove Street	Acute Noise	62-63
1	431 Hume Highway	Acute Noise	62
1	26 Pensacola Place	Acute Noise	63
11	1, 5, 7, 11 & 35-23 Phoenix Crescent	Acute Noise	60-63
1	18 Lakewood Crescent	Acute Noise	61
	MA_HLD_S		
4	22, 24, 53 & 55 Wombeyan Ct	Acute Noise	60-61
1	23 Todd Ct	Allowance Goal	58
1	15 Warrego Ct	Acute Noise	63
1	23 Timbara Ct	Acute Noise	65
1	56 Colo Ct	Acute Noise	62
1	7 Fitzgerald Avenue	Acute Noise	64
31	23-71, 75 & 77 Whitfield Parade	Allowance Goal / Acute Noise	59-63
	HR_FR_S		
2	165 & 126 Beaconsfield Street	Acute Noise	60-72
1	36 Ely Street	Acute Noise	62
3	29, 40 & 42 Sherwood Street	Acute Noise	61
1	40 Carrington Street	Acute Noise	61
3	51, 53, 47 Carrington Street	Acute Noise	61-63
1	37A Victoria Street	Acute Noise	63
1	31 Mackenzie Street	Acute Noise	60
8	44A, 44B, 40A, 40, 36, 26A, 26B, & 20 Louie Street	Allowance Goal / Acute Noise	60-64
7	32, 30, 28, 24, 18, 16 & 14 Louie Street	Allowance Goal	58-60
2	79 & 100 Gibson Avenue	Acute Noise	61
2	8-10 Bryant Street	Acute Noise	60-64
	BR_KGR_S		
2	67 - 65 Graham Road - Apartments	Acute Noise	61
3	109, 105 & 90 Penshurst Road- Townhouses	Acute Noise	60-61
1	37 Welfare Avenue	Acute Noise	64
1	42 Welfare Avenue	Acute Noise	62
	M7_HH_N		
1	42 Cedar Road	Acute Noise	64
2	3-5 Acacia Avenue	Acute Noise	60-61
1	28 Jarrah Avenue	Acute Noise	60
1	34 Jarrah Avenue	Acute Noise	60
1	7 Robinson Close	Acute Noise	61
1	114 Graham Avenue - Townhouse	Acute Noise	63
3	50, 54-56 Tully Avenue	Acute Noise	61-66
3	50-54 Congressional Drive	Acute Noise	60-61

No. of Dwellings	Location	Reason for Noise Mitigation	Predicted $L_{Aeq,9hr}$ Levels (dBA)
2	20, 20A Lakeview Crescent	Acute Noise	62
1	11 Lakewood Crescent	Acute Noise	66
	HR_HLD_N		
2	108 & 104 Renton Avenue	Acute Noise	60
2	2&4 Clyde Avenue	Acute Noise	62-63
1	2 Jaqueline Place	Acute Noise	61
	HLD_HR_N		
3	6, 8 & 12 Prescot Parade	Acute Noise	60
3	4, 5 & 6 Meteren Close	Acute Noise	61-63
2	17 & 9 Maygar Close	Acute Noise	60
4	48, 42, 40 & 36 Flanders Avenue	Acute Noise	60-63
	QS_GA_N		
1	6 Gordon Parker Street	Acute Noise	62
1	23 Sherwood Street	Acute Noise	62
1	28 Sherwood Street	Acute Noise	60
1	20 Albert Street	Acute Noise	61
2	19 & 19A Gordon Parker Street	Acute Noise	61-65
2	18 & 19 Victoria Street	Acute Noise	62-65
1	5 Wolaroi Crescent	Acute Noise	62
2	9 Turvey Street - Townhouses	Acute Noise	60
	FR_BR_N		
2	24 & 10 Iris Avenue	Acute Noise	60
1	35 Belgium Street	Acute Noise	61
3	4, 6 & 16 Sofala Street	Acute Noise	61-64
	BR_KGR_N		
6	16-14, 10, 6, 4 & 2 Arilla Avenue	Acute Noise	60-61
2	28 & 2 Baralga Crescent	Acute Noise	60
1	59 Karne Street	Acute Noise	60
11	12-16, 6-8, 18, 28-32, 38B & 46-48 Grove Avenue	Acute Noise	60-63
1	93 Penshurst Road	Acute Noise	62
1	26 Welfare Avenue	Acute Noise	61
2	13 & 13A Warne Crescent	Acute Noise	62-63
1	323 King Georges Road	Acute Noise	68

8.10 Other Sensitive Land Uses

Table 8-9 presents calculated noise levels within parks and recreation areas. In the case of parks, golf courses and reserves, noise was calculated approximately 10% into the area, or at a location within the area considered most likely to be used by patrons, whichever distance was the greater.

Table 8-9 Noise Levels in Outdoor Recreation Areas

Location	Noise Criterion, $L_{Aeq(15hr)}$ (dBA)	Future Existing Noise Level, $L_{Aeq(15hr)}$ (dBA)	Future Noise Level, $L_{Aeq(15hr)}$ (dBA)	Future Noise Level Exceeds Target? (Yes/No)	Increase in Noise Level, (dBA)	Increase Exceeds Allowance criteria (>2dBA)? (Yes/No)
Sir Roden Cutler VC Rest Area	55	55	54	No	0	No
Daruk Park	55	57	58	Yes	1	No
New Brighton Golf Club	60	61	64	Yes	3	Yes
Mclaughlin Oval	60	65	66	Yes	1	No
Rotary Park	55	62	63	Yes	1	No
Wise Reserve	55	63	65	Yes	2	No
Deepwater Regional Park	55	63	65	Yes	1	No
Riverlands Golf Club	60	61	63	Yes	2	No
Uni of Western Sydney Tennis Court	60	56	58	No	2	No
University of Western Sydney Oval	60	57	59	No	2	No
Canterbury Bankstown Tennis and Bowling Club	60	58	59	No	2	No
Salt Pan Creek Reserve	55	64	65	Yes	1	No
Lance Hutchinson Oval	60	59	60	No	2	No
John Mountford Reserve	55	59	60	No	2	No

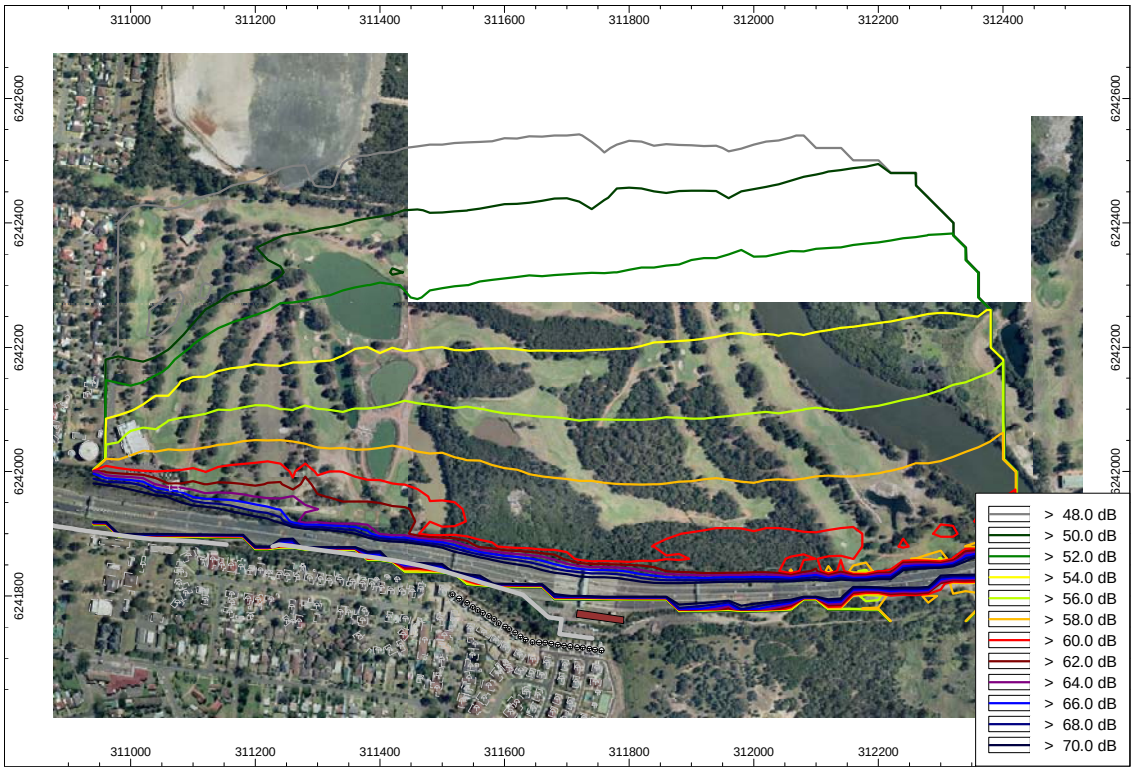
Note: Increase in noise level has been calculated to one decimal place and then rounded to the nearest whole number.

Based on Table 8-7, predicted noise levels within eight of the parks, reserves and active recreation areas exceed the relevant *ECRTN* target noise level in 2023. However, in most cases the increase in noise level is within the 2dBA allowance goal. No further treatment by way of noise barriers is considered reasonable in these circumstances.

At New Brighton Golf Club, both the allowance goal and the target noise level are exceeded at the nearest point within the area likely to be frequented. Noise mitigation here would require consideration of two sections of noise barrier, nominated as PB5 and PB6, along the boundary. These would be in the order of 3m to 4m in height and total approximately 850m in length.

However, Figure 8-1 shows that less than a nominal area of approximately 15% of the playable area of the golf course lies above the *ECRTN* target noise level (represented by the red contour). It is not considered reasonable to construct 850m of noise barriers given that the affected zone is minimal.

Figure 8-1 New Brighton Golf Course Noise Levels



Noise levels at churches and schools are presented in Table 8-10. Noise levels have been calculated at the façade of the noise sensitive buildings. With windows partially open for ventilation purposes, the typical external to internal noise reduction is between 10dBA and 15dBA. For this project, internal noise levels were conservatively estimated by subtracting 10dBA from the calculated façade noise levels.

Table 8-10 Internal Noise Levels at Non-Residential Noise Sensitive Receivers

Location	Noise Criterion, $L_{Aeq(1hr)}$ (dBA)	Future Existing Noise Level, $L_{Aeq(1hr)}$ (dBA)	Future Noise Level, $L_{Aeq(1hr)}$ (dBA)	Future Noise Level Exceeds Target?	Increase in Noise Level, (dBA)
Hammondville Public School North Build	45	49	51	Yes	2
Hammondville Public School South Build	45	45	48	Yes	3
Panania North Public School	45	46	47	Yes	2
Sir Joseph Banks Public School West	45	47	49	Yes	2
Sir Joseph Banks Public	45	47	48	Yes	2