Appendix F Technical Working Paper: Noise and vibration assessment

Glenugie Upgrade
Upgrading the Pacific Highway

APPENDIX F TECHNICAL WORKING PAPER
NOISE AND VIBRATION ASSESSMENT

August 2009

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1. Introduction

The NSW Roads and Traffic Authority of (RTA) is proposing to upgrade a seven kilometre section of the Pacific Highway between Franklins Road and Eight Mile Lane at Glenugie on the mid-north coast of New South Wales (NSW). This is known as the Glenugie upgrade and is referred to in this report as ‘the project’.

The project is part of the Wells Crossing to Iluka Road Pacific Highway upgrade, which has been declared to be a project to which Part 3A of the NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act) applies. It has also been declared as critical infrastructure under the EP&A Act. The project, being part of the Wells Crossing to Iluka Road upgrade, therefore also falls within these declarations. A preliminary environmental assessment report has been prepared for the project under Part 3A of the EP&A Act (RTA, 2009b).

1.1. Objectives

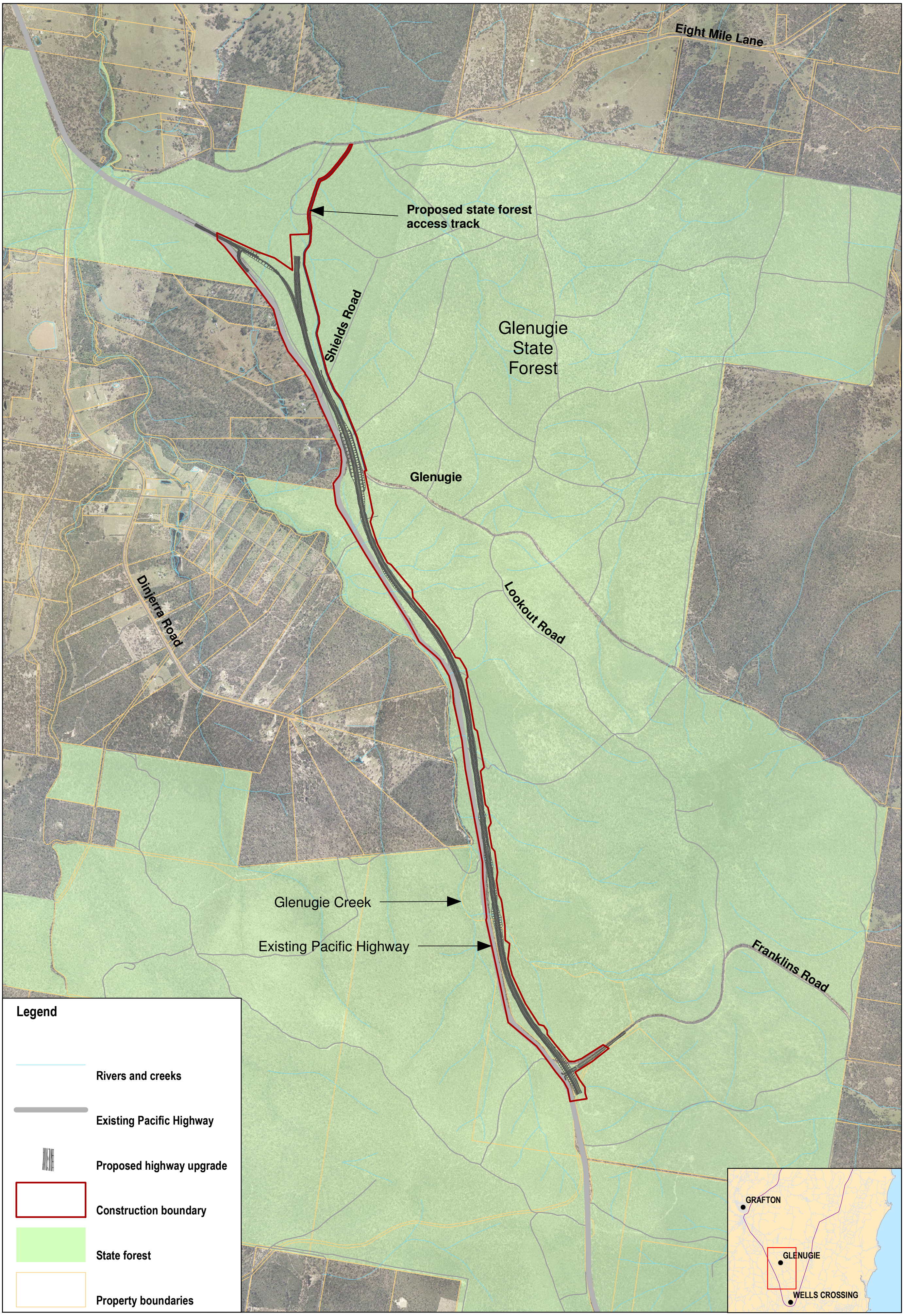
This report has been prepared to address the requirements for the Part 3A environmental assessment issued by the Director-General of the NSW Department of Planning. These requirements include assessment of the operational and construction noise impacts of the project.

The assessment of noise impacts presented in this report has been undertaken in consideration of the requirements of the Department of Environment and Climate Change’s *Environmental Criteria for Road Traffic Noise* (ECRTN) guideline (EPA, 1999) and the RTA’s *Environmental Noise Management Manual* (ENMM) (RTA, 2001). As part of the investigation of noise impacts, the tasks undertaken included:

- Identification of existing sensitive receivers.
- Determination of appropriate noise criteria for sensitive receivers.
- Determination of existing road traffic noise levels by conducting noise modelling and noise monitoring surveys.
- Prediction of the road traffic noise levels (operational noise) expected to result from the project and compare these to the relevant noise criteria.
- Recommendation of appropriate controls for any operational noise impacts.
- The assessment of potential construction noise impacts ad recommendations for noise minimisation measures where necessary.

1.2. The project

The preferred route for the Wells Crossing to Iluka Road upgrade was announced in September 2006 and is documented in the *Preferred Route Report* (RTA, 2006a). The route options development process is described in the *Route Options Development Report* (RTA, 2005). The concept design for the Wells Crossing to Iluka Road upgrade was announced in January 2009 and is documented in the *Wells Crossing to Iluka Road Concept Design Report* (RTA, 2009a). Further information on the Pacific Highway Upgrade Program and the Wells Crossing to Iluka Road upgrade is available on the RTA web site (RTA online). **Figure 1-1** shows the concept design for the project.



Data Sources
Topodata: Streetworks, LPI 2008
Aerial: 2007

Figure 1-1: The project

2. Existing noise environment

2.1. Noise sensitive receivers

Eight residences have been identified as potential noise sensitive receivers for the project. These residences are in a rural/rural residential community about 15 km south of Grafton. They were selected for assessment based on their proximity to both the existing highway and project highway alignment and their potential to experience changes in road traffic noise levels. The selection of individual residences has been undertaken using aerial photography and, where possible, visual identification during the monitoring survey. **Figure 2-1** shows the locations of the residences that have the potential to be impacted and the noise monitoring site.

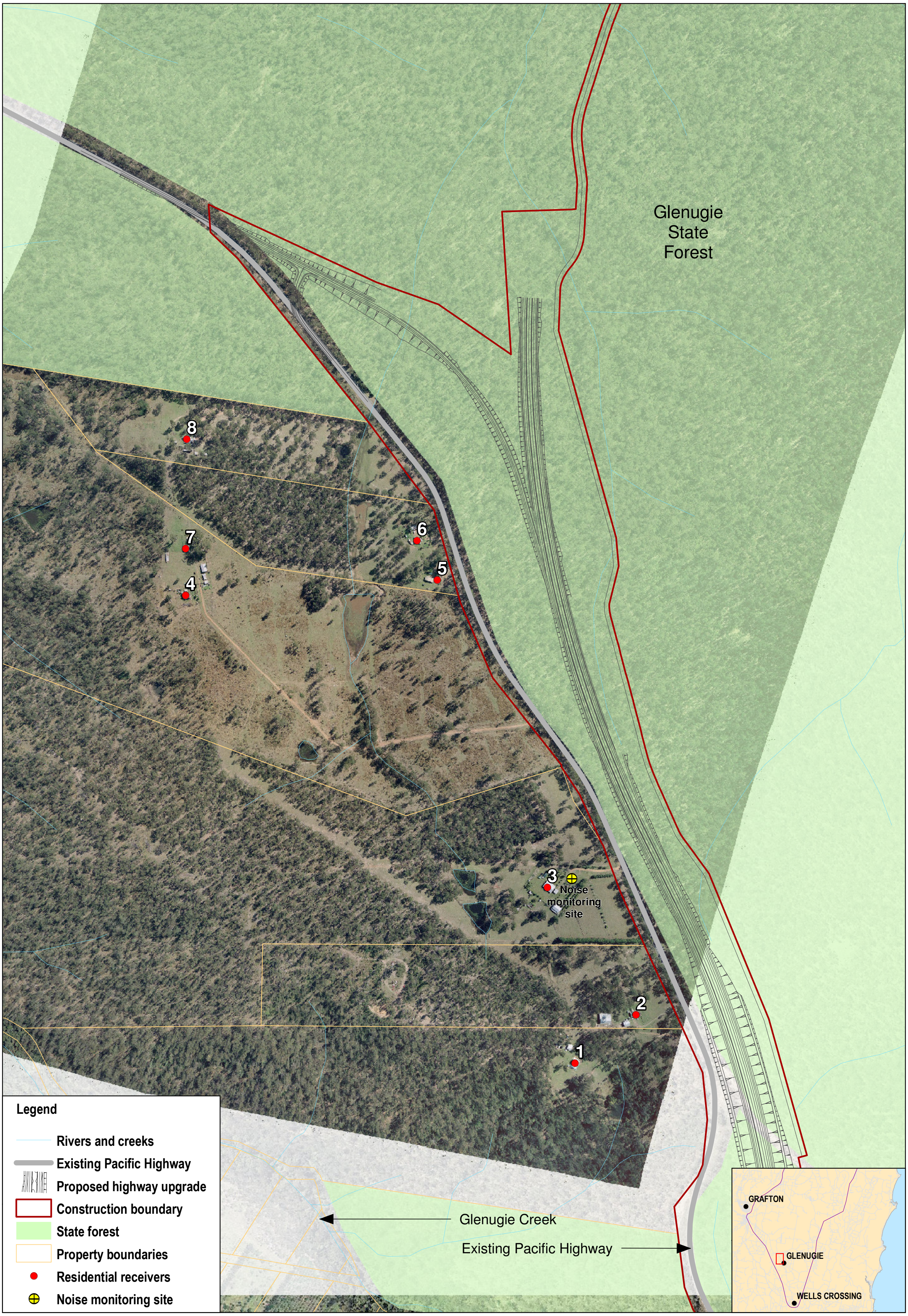
2.2. Background noise levels

To assist in the assessment of potential impacts for road projects, noise levels are measured at key locations along the existing highway. This monitoring data provides information on the current traffic noise levels, which is used to calibrate a road traffic noise model. This data is also used in the assessment of construction noise impacts.

Noise monitoring for the project was conducted over a one week period, between 11 and 18 May 2009, at a representative residential location about 100 m from the highway. The selected monitoring site is considered to be representative as it has good line of sight to the existing highway and is located mid-way along the group of sensitive residential receivers. There are no other residential dwellings in close proximity to either the existing highway or the project.

When measuring noise levels, the use of statistical descriptors is necessary to describe how variations in the noise environment occur over any given period. For road traffic noise, these descriptors are classified for daytime (7am - 10pm) and night time (10pm - 7am) periods. For environmental noise, the following assessment periods are used: daytime (7am - 6pm), evening (6pm – 10pm) and night time (10pm - 7am). Common noise descriptors used are as follows:

- L_{A10} – The noise level exceeded for 10 per cent of the measurement interval. This is commonly referred to as the average-maximum level.
- L_{A90} – The noise level exceeded for 90 per cent of the measurement interval. This is commonly referred to as the background noise level.
- L_{Aeq} – The noise level having the same energy as the time varying noise level over a 15 minute interval. For traffic noise, this descriptor is classified as $L_{Aeq\ 15\ Hr}$ and $L_{Aeq\ 9\ Hr}$ for the day and night time noise levels, respectively, and is commonly referred to as the ambient noise level.



Data Sources
Streetworks, LPI 2008
Aerial: 2007

Figure 2-1: Locations of residential receivers and noise monitoring

0 250
A4 1:10,000 Metres

- L_{Amax} – The maximum noise level measured at a given location over the measurement interval.
- RBL (Rating Background Level) - the overall single-figure background level, which is the 10th percentile of the L_{A90} values for each of the day, evening and night time periods over the whole monitoring period.

The statistical noise indices in this report were calculated from the monitored data, and include both road traffic noise and environmental noise parameters. The road traffic parameters are used to provide information on existing traffic noise levels for the noise modelling and the environmental noise statistics are used for the setting of construction noise criteria. The $L_{A10,18\ hour}$ and $L_{Aeq,15\ hour}$ and $L_{Aeq,9\ hour}$ road traffic noise indices and the L_{Amax} descriptors were calculated on a daily basis for these monitoring locations and are summarised as the median of the combined daily results. Because the L_{A10} and L_{Aeq} indices are not directly interchangeable, a correction factor is required to convert the modelled L_{A10} values to the L_{Aeq} criterion base. In this case, the difference between the $L_{A10,18\ hour}$ and $L_{Aeq,15\ hour}$ results is used to determine the correction factor that is applied to the results of the Calculation of Road Traffic Noise (CoRTN) noise modelling (see **Table 2-1**).

The daily traffic noise measurement profile for the monitoring location is shown graphically in Attachment A and summarised in **Table 2-1**. The weather conditions during the monitoring period were obtained for the Grafton region from the Bureau of Meteorology, and have been incorporated into the analysis of the measured noise levels. This is the closest weather station to the monitoring location and is considered representative of the meteorological conditions in the area. Monitoring data that are considered to be invalid due to adverse weather have been removed from the results. Adverse weather includes occasions where wind speeds exceed 5 metres per second or where rain affects any 15 minute monitoring period.

- **Table 2-1 Summary of traffic noise monitoring descriptors**

Monitoring Date	$L_{A10\ 18\ hour}$	L_{Aeq} 15 hour	L_{Aeq} 9 hour	L_{Amax} Day	L_{Amax} Night	Difference L_{A10} - L_{Aeq}
11-May-09 to 18-May-09	61 dB(A)	58 dB(A)	57 dB(A)	68 dB(A)	68 dB(A)	3 dB(A)

Observations during the site surveys identified road traffic noise on the existing highway as being the dominant noise source. Similarly the ambient night time noise environment is dominated by road traffic, which is confirmed by the noise levels measured during this time. Environmental noise parameters for each monitoring location are presented in **Table 2-2**. The maximum noise level recorded is noted as the L_{Amax}. The ambient L_{Aeq} noise level and the rating background level (RBL) are also presented for each monitoring period.

- **Table 2-2 Summary of unattended environmental noise monitoring descriptors**

Location	Day			Evening			Night		
	L_{Amax*}	L_{Aeq*}	RBL†	L_{Amax*}	L_{Aeq*}	RBL†	L_{Amax*}	L_{Aeq*}	RBL†
Location 1	67 dB(A)	56 dB(A)	44 dB(A)	69 dB(A)	59 dB(A)	41 dB(A)	68 dB(A)	57 dB(A)	33 dB(A)

*Note * L_{AMax} and L_{Aeq} – 50th Percentile; † L_{A90} 10th Percentile*

In **Table 2-2** the L_{Amax} and L_{Aeq} values have been reported as median values for each of the periods. These values are not used in the assessment of construction noise, however, they provide a reference to the existing environment when determining the potential level of impact expected from the construction of the project. The RBL monitoring data provide the basis for setting noise goals for the construction activity based on the appropriate construction noise guidelines.

3. Operational noise assessment

The noise criteria in this section of the report refer to operational noise impacts. Construction activities have also been assessed and are described in Section 4.

3.1. Assessment requirements

The Director General's requirements relating to operational noise and vibration include the following considerations for operational noise impacts:

- Assessment of the noise impacts of the project during operation, consistent with the guidance provided in Environmental Criteria for Road Traffic Noise (EPA, 1999).
- The assessment must include specific consideration of impacts to sensitive receivers (schools, hospitals, aged care facilities) and sensitive structures, as relevant.

3.2. Road traffic noise criteria

The noise criteria identified for the project are in accordance with the DECC Environmental Road Traffic Noise Criteria, (ECRTN) guideline. The appropriate noise goals for the upgrade of the highway are listed in **Table 3-1**. The assessment methodology and application of the noise criteria are taken from the RTA's Environmental Noise Management Manual (ENMM).

- **Table 3-1 Road traffic noise base criteria**

Road category	Daytime levels	Night-time levels
Redevelopment of an existing freeway	$L_{Aeq\ (15hour)}$ 60 dB(A)	$L_{Aeq\ (9hour)}$ 55 dB(A)

Due to the influence of the existing highway, the road category that is applicable for the identified noise sensitive receivers is that of a redevelopment of an existing arterial or freeway, defined by the ECRTN as:

> *"**Redevelop existing freeway/arterial** refers to an existing freeway, arterial or sub-arterial corridor where it is proposed to increase traffic-carrying capacity, change the traffic mix or change the road alignment through design or engineering changes. Redevelopment does not cover minor road works designed to improve safety, such as straightening curves, installing traffic control devices or making minor road alignments."*

The determination of the project criterion is supported by the RTA ENMM, Practice Note (I), which assists in identifying which noise level criteria should apply for new roads and road upgrades. The practice note takes into account the following points:

- Road traffic noise exposure from existing routes.

- Significant contribution to noise exposure from a road development or upgrade.
- New road traffic noise sources.
- The location of the existing route corridor alignments relative to proposed works.

Depending on the extent of impact of the current traffic noise environment at a receiver location, the base criteria for a redeveloped road may be modified. These modifying values are known as the allowance criteria. At a location where there is an existing road traffic noise impact the allowance criteria is used in assessing the appropriate forms of noise mitigation. While the base criteria in **Table 3-1** is applicable, where base criteria are already exceeded for a road redevelopment, the following allowance criteria is noted in the ECRTN:

> *"In all cases, the redevelopment should be designed so as not to increase existing noise levels by more than 2 dB."*

The ECRTN also states:

> *"Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In some instances this may be achievable only through long-term strategies such as improved planning, design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles; greater use of public transport; and alternative methods of freight haulage."*

This last statement initially refers to the implementation of noise barriers, architectural treatments and other traffic noise reducing strategies. The RTA ENMM provides further detail on which strategies would be most appropriate taking into account the factors affecting each sensitive receiver location.

3.3. Definition of new and upgrade sensitive receivers

Where there is the potential for an existing traffic noise exposure to have an impact on sensitive receivers, an assessment of this situation is required. The RTA ENMM defines an existing road traffic noise exposure in Practice Note (I) as follows:

> *"A site is defined as having an "existing road traffic noise exposure" if the prevailing noise level from the existing road alignment(s) under consideration is equal to or greater than 55 dB(A) L_{Aeq} (15hr) (day) or 50 dB(A) L_{Aeq} (9hr) (night). The noise level contours corresponding to these day and night noise levels define the "noise catchment" for an existing road. In areas outside these contours, road traffic is unlikely to be a significant noise source."*

Where the assignment of the road upgrade category at a receiver is not straightforward, the ENMM provides additional information for the redeveloped criteria application in Practice Note (I). Specifically, the redeveloped road criteria in the ECRTN apply at the exposed facades of a noise sensitive receiver for a road redevelopment that occurs outside an existing road corridor for the same road category if:

> *"The existing traffic noise level is equal to or greater than the criteria applying to "redeveloped roads" (when allowances are taken into account, these are effectively 58 dB(A) day and 53 dB(A) night, and the upgrading does not involve a new road traffic noise source".*

3.4. Assessment parameters

The types of influences that can be considered for a noise assessment are based on emissions that can be quantified by the traffic data or design of the road. Other noise sources that occur randomly or in different locations depending on the driver (e.g. use of exhaust brakes, horns etc), cannot be considered when modelling traffic noise. A list of factors that have known impacts have been incorporated into the noise model and are presented in **Table 3-2**. This table lists the variables that are used as inputs to the noise model and has a description of the effect of each variable on the overall noise emissions.

- **Table 3-2 Factors affecting road traffic noise**

Variable	Description
Traffic volumes and mix	The number of vehicles using the road as well as the proportion of heavy to light vehicles. A higher ratio of heavy vehicles increases the noise levels proportionally.
Traffic speed	An increase in traffic speed generally causes an increase in tyre noise.
Road surface types	Can be asphaltic concrete, low noise pavement or other types as applicable. Each surface type generates different levels of tyre noise.
Gradient of roadway	Noise level change as a result of traffic climbing or descending hills compared with traffic travelling along flat gradients.
Ground topography	Natural topographic features such as hills and valleys can shield residences from traffic noise.
Height of receivers	May be single or multiple storey residential dwellings. The height of the receiver would influence the exposure to traffic noise and the ability to mitigate adverse impacts.
Air and ground absorption	Noise levels reduce with increasing distance and ground vegetation.
Attenuation due to building structures	Existing buildings and structures may provide shielding of traffic noise to varying degrees.

3.5. Modelling of traffic noise impacts

Traffic noise at each identified receiver has been predicted for the project using the Calculation of Road Traffic Noise (CoRTN) method applied through the SoundPLAN noise modelling program. The CoRTN method predicts the $L_{A10,\ 18\ hour}$ and the $L_{A10,\ 1\ hour}$ noise levels at a receiver location based on the parameters listed in **Table 3-5**.

As previously discussed, **Table 2-1** indicates the difference between the $L_{A10\ (9hr)}$ and the $L_{Aeq\ (9hr)}$ measured noise levels at the monitoring location and is used to convert the output from the CoRTN method to the same parameters as the criteria outlined in the ECRTN (i.e. L_{A10} to L_{Aeq}). From the site data, a project specific conversion factor of 3 dB(A) has been adopted. The results of the CoRTN predictions from the SoundPLAN model are then modified by the relationship, $L_{A10,\ period} = L_{Aeq,\ period} + 3$ dB(A), to predict the $L_{Aeq,15hour}$ and $L_{Aeq,9hour}$ noise levels. A further correction of +2.5 dB(A) has been added to the $L_{Aeq,\ period}$ results to correct for facade reflections in accordance with the ENMM guidelines.

The CoRTN model sets the height of the traffic stream at 0.5 m above pavement height, irrespective of the heavy vehicle content within the traffic stream. To account for the large proportion of heavy vehicles in the traffic stream the CoRTN assessment has been modified to incorporate three different source heights. These three heights are 0.5 m for truck tyres and cars, 1.5 m for truck engines and 3.6 m for truck exhaust. Each of these sources has then been adjusted to account for the relative differences in the emission levels.

3.6. Modelled traffic values

The assessment of noise impacts considers four different scenarios of traffic flows:

- The current year, which considers the current road network and traffic conditions in assessing the level of existing impact at noise sensitive receiver locations. This scenario is also used to validate the noise model to provide an indication of the level of accuracy of the noise model based on known parameters.
- The future existing year, which considers traffic flows for a year equivalent to the year of opening of the project, but with no change to the existing road infrastructure (the “do nothing” option). This is 2012 for the purposes of modelling.
- The project opening year, which considers the proposed new road design and future traffic flows, incorporating normal growth, at the time of the project opening.
- The design year, which considers the proposed new road design and future traffic flows incorporating normal growth expected over a period of 10 years after the opening of the road project. The design year for the Glenugie upgrade is expected to be in 2022.

Table 3-3 and **Table 3-4** present the traffic numbers used in each of the above modelling scenarios showing the total traffic numbers for day and night time and the percentage of heavy vehicles. These data are used in the modelling of traffic noise impacts and are based on the average flows over the whole year. The traffic numbers used in the modelling represent the Annual Average Daily Traffic (AADT) flows and are calculated from SCATS data, RTA permanent counting stations and actual site measurements from tube counts.

3.7. Summary of project data

The operational noise impact assessment uses the results of the noise model predictions for the design year to provide details on the level of noise impact that is likely to result from the project. A summary of the parameters used in the noise modelling for the assessment of noise impacts is shown in **Table 3-5**.

To determine the predictive accuracy of the noise model it needs to be calibrated to a known operational scenario namely the current year of operations. This calibration process is known as the model validation, and is a process that is required by the DECC and RTA for each unique road project.

- **Table 3-3 Road traffic data input to noise model – south bound**

Assessment Period	Vehicle Classification	Future existing Year 2012		Project Year of Opening 2012		Design Year 2022	
		Volume	%	Volume	%	Volume	%
Day time (7am – 10pm)	Light	3100	78	3070	79	3966	70
	Heavy	875	22	839	21	1735	30
	Total	3975	100	3909	100	5700	100
Night time (10pm – 7am)	Light	236	45	232	45	351	47
	Heavy	289	55	285	55	403	53
	Total	526	100	517	100	754	100

- **Table 3-4 Road traffic data input to noise model – north bound**

Assessment Period	Vehicle Classification	Future existing Year 2012		Project Year of Opening 2012		Design Year 2022	
		Volume	%	Volume	%	Volume	%
Day time (7am – 10pm)	Light	3027	80	2998	81	3847	71
	Heavy	751	20	722	19	1571	29
	Total	3778	100	3719	100	5418	100
Night time (10pm – 7am)	Light	213	24	208	24	348	39
	Heavy	410	66	405	66	545	61
	Total	623	100	613	100	894	100

- **Table 3–5 Summary of modelling inputs**

Input variable	Data
Traffic numbers and mix	Traffic numbers forecast for the years 2012 and 2022 see **Section3.6**.
Ground topography	Obtained from aerial photogrammetry, 1 m increments
Gradient of roadway	Taken from a 3D model of the design alignment
Air and ground absorption	Ground absorption assumed 100% soft ground
Height of receivers	1.5 m above ground terrain
The acoustic properties of the road pavement surfaces	Tyned asphaltic concrete assumed for the whole alignment having a relative correction of +2.5 dB(A) compared to Dense Grade Asphalt
Traffic Speed	110 km/h throughout the project
Attenuation due to building structures	Building structures have not been included in the noise model due to the rural residential nature of the investigation area
Facade Reflection	+2.5 dB (A)
L_{A10} to L_{Aeq} conversion	3 dB (A) from L_{A10} to L_{Aeq} (See Table 2-1)

3.8. Validation of the noise model

In order to ensure the validity of the design year predictions, a noise model for the existing road traffic flows shown in **Table 3-3** was developed. The modelled output was compared to the measured noise levels that were recorded during the noise surveys along the existing road alignment (refer Section 2.2). **Table 3-6** presents the predicted noise levels from validation model scenario and the measured noise levels from the unattended monitoring. Where appropriate the modelled results are facade corrected and include the conversion from L_{A10} to L_{Aeq} noise levels.

- **Table 3-6 Comparison of measured and modelled road traffic noise levels**

Receiver Location	Noise Levels – Year 2007 Traffic Counts					
	Daytime (15hour)			Night-time (9hour)		
	Measured	Modelled*	Difference	Measured	Modelled*	Difference
Location 3	58	58	0	57	56	+1

Note * LA10 to LAeq difference of -3 dB(A) applied to modelled values

The predicted road traffic noise levels for the current year from the validation model indicate a variation of within 1 dB(A) of the measured value, which is within the tolerance of predictive accuracy that is required by the RTA for a model validation.

The results of the monitoring and modelling demonstrate that that the noise levels for the day time and the night time are similar for both periods. The ECRTN recognises the different needs for acoustic amenity during these times and provides for these differences by implementing a lower night time noise criteria. As noise levels from traffic on the highway approach the project noise criterion, the lower night time levels will be the first of the criteria to be met and/or exceeded. As a result, the $L_{Aeq\ 9hr}$ night time noise levels have been identified as being the critical assessment period and therefore will be adopted as the appropriate assessment criterion at each of the receiver locations.

3.9. Noise impact assessment for the project

The assessment of potential noise impacts from the project was calculated for the eight receivers adjacent to the existing highway for each scenario and compared to the relevant noise criteria at each location. Assessment of the year 2022 traffic data provides the expected future noise levels so that any mitigation measures required for the project would still provide a benefit for at least 10 years into the future. The initial predictions have been made without the inclusion of any noise mitigation measures and are based on the parameters for the modelling inputs in **Table 3-5** and the traffic data in **Table 3-3** and **Table 3-4**. For the modelling scenario, contributions from the existing highway were not included in the prediction of noise emissions.

3.10. Discussion of results

Normal traffic growth from the year of opening (2012) to the design year (2022) is however, expected to generate an increase of approximately 1.5 dB(A) in noise levels. For all residences, this increase in noise due to traffic growth over the period is offset to varying degrees by the realignment of the highway. Day time noise levels for the receivers in the north (locations 6,7 and 8) however, show either no change, or only a marginal increase, with a decrease in night time traffic noise levels. These residences experience a smaller attenuation of noise levels due to the relatively minor relocation of the alignment, where it rejoins the existing highway in the north.

For the design year, the modelling indicates that all residences would fall below the project specific noise level criterion. On this basis, there is no requirement for mitigation of operational noise levels resulting from the proposed highway upgrade. When the same years of operation are compared (project opening an future existing), all of the modelled receivers are predicted to experience a reduction in the existing noise levels, including maximum noise levels generated by heavy vehicles.

- **Table 3-7 Modelled road traffic noise levels**

Receiver number	Traffic noise levels						Base Criteria		Are target levels exceeded? Y/N		Change in noise levels (Design – future existing)		Are noise levels acute? Y/N		Change in noise levels (Design – future existing)
	Future existing (Year 2012)		Project opening (Year 2012)		Design year (Year 2022)										
	L_{Aeq} 15hr dB(A)	L_{Aeq} 9hr dB(A)	L_{Aeq} 15hr dB(A)	L_{Aeq} 9hr dB(A)	L_{Aeq} 15hr dB(A)	L_{Aeq} 9hr dB(A)	L_{Aeq} 15hr dB(A)	L_{Aeq} 9hr dB(A)	L_{Aeq} 15hr dB(A)	L_{Aeq} 9hr dB(A)	L_{Aeq} 15hr dB(A)	L_{Aeq} 9hr dB(A)	L_{Aeq} 15hr dB(A)	L_{Aeq} 9hr dB(A)	
1	60	57	55	52	57	53	60	55	N	N	-3	-4	N	N	N
2	63	60	57	53	58	55	60	55	N	N	-5	-5	N	N	N
3	59	57	56	53	58	54	60	55	N	N	-1	-3	N	N	N
4	65	63	57	53	58	55	60	55	N	N	-7	-8	N	N	N
5	66	64	57	54	59	55	60	55	N	N	-7	-9	N	N	N
6	55	53	54	50	55	52	60	55	N	N	0	-1	N	N	N
7	56	53	55	51	56	53	60	55	N	N	0	0	N	N	N
8	57	55	57	53	58	55	60	55	N	N	1	0	N	N	N

4. Construction noise and vibration

The Director General’s requirements for construction noise and vibration are as follows:

- Construction noise and vibration, including a considered approach to scheduling construction works having regard to the nature of construction activities (including transport, blasting and tonal or impulsive noise-generating works).
- The intensity and duration of noise and vibration impacts, the nature, sensitivity and impact to potentially-affected human receivers and structures.
- 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 or spoil management).
- The Environmental Assessment must also present a strategy for monitoring and mitigating construction noise and vibration, with a particular focus placed on those activities identified as having the greatest potential for adverse noise or vibration impacts, and a broader, more generic approach developed for lower-risk activities.

4.1. Construction noise assessment

During the construction phase, heavy machinery and other equipment used in the road making process has the potential to provide a source of unwanted noise emissions at residential locations. The DECC provides guidance for the assessment of these noise sources to assist in the determination of the potential level of impact. An assessment of noise levels generated by the construction activities is used to balance the expected noise levels with mitigation measures to reduce the severity of any impacts. In general, the noise level that is acceptable within the community is controlled by the time of day/night, the emergence of the noise above the existing background, and the duration of the works.

Noise level objectives outlined in *Chapter 171 Construction Site Noise* of the DECC *Environmental Noise Control Manual 1994* (ENCM) (DECC 1994) offer the goals that project works are assessed against. These goals apply at the nearest residential dwellings and have been outlined in **Table 4-1**.

Given that project works are to take longer than 26 weeks to complete, and with reference to the objectives in **Table 4-1**, the project specific L_{A10} construction noise level should not exceed a background noise level by more than 5 dB(A).

- **Table 4-1 Construction noise objectives**

Construction period	Noise objective
Up to 4 weeks	The L_{A10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 20 dB(A).
From 4 to 26 weeks	The L_{A10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 10dB(A).
Greater than 26 weeks	The L_{A10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 5dB(A).

4.2. Construction hours

In accordance with the ENCM, construction works are typically restricted to the hours of:

- 7am and 6pm Monday to Friday.
- 8am to 1pm Saturday.
- No work on Sundays or public holidays.

Restricting works to these hours is intended to minimise the potential for noise to impact on sensitive receivers during the quietest periods of the day. Where noise emission from construction activities are not expected to affect sensitive receivers due to either the type of activity or the distance to a receiver location, restricting works to these hours would not be necessary.

For much of the Glenugie upgrade project, the large distances from the upgrade alignment to the nearest receiver locations would provide substantial attenuation of noise from any out of hours activities. Considering the distances to the nearest receivers along the length of the project alignment, the proposed construction hours for the project are as follows:

- Construction will normally be limited to the following hours:
  - Between 6am and 6pm Monday to Friday.
  - Between 7am and 4pm Saturday.
- There will be no works on Sundays or public holidays except:
  a) Works that do not cause construction noise to be audible at any sensitive receivers.
  b) For the delivery of materials required outside these hours by the Police or other authorities for safety reasons.
  c) Where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm.

d) Any other work as agreed through negotiations between the RTA and potentially affected sensitive receivers. Any such agreement must be recorded in writing and a copy kept on site for the duration of the works.

e) Where the work is identified in the Construction Noise and Vibration Management Plan (CNVMP) and approved as part of the Construction Environmental Management Plan.

f) As agreed by the DECC.

Local residents and the DECC must be informed of the timing and duration of work approved under items (d) and (e) at least 48 hours before that work commences.

Hours of work would be addressed in the CNVMP for the project. The CNVMP would be finalised in consultation with the Department of Planning and DECC.

By commencing works for the project at 6am each weekday, an additional hour of work would be achieved for daytime activities in comparison to the standard construction work start time of 7am. The extra hour of work in the morning allows for a number of essential pre-start activities such as mechanical pre-start, minor maintenance and refuelling, equipment establishment and setup, and minor preparation works. These activities generally have low noise levels.

4.3. Project-specific construction noise objectives

Based on the measured noise levels described in Section 2 the project-specific noise objectives for each residential location have been generalised based on the data from the monitoring location (**Table 4-2**). It is expected that the nominated background noise levels will be marginally conservative for the residences set closer to the road than the monitoring location. This difference however, is not expected to be significant and therefore will provide an acceptable basis for the construction noise limits.

- **Table 4-2 Project-specific construction noise objectives**

Range of receiver distance to upgraded road centreline (m)	RBL dB(A)	Noise objective dB(A)
700-150	44	49

4.4. Construction noise predictions

4.4.1. Construction activities

Although a detailed program of construction has not yet been determined, based on previous road construction projects, the specific construction stages described in **Table 4-3** may be expected. The noise impacts of each of these activities have been considered separately and cumulatively in this section.

- **Table 4-3 Summary of road construction stages and associated activities**

Activity	Description
Clearing and grubbing	Felling of trees and shrubs as well as removal of manmade structures; removing stumps, roots and general vegetation.
Earthworks	Bulk earthworks including topsoil stripping, cut and fill, excavation of culverts and basins, construction of batters and landscaping
	Culvert construction, drainage, diversion drains to sedimentation basins
Bridgeworks	Casting and formwork, piling, concrete pouring, pre-cast element installation and demolition as required
Paving and asphalting	Application of road surface pavement to road base slab including pouring of concrete base and sub-base, supplication of sprayed bitumen seals; laying of asphalt, finishing open drains and installation of road furniture and medians.

Activities associated with the construction project are likely to include:

- Concrete batching - A temporary concrete batching plant may be required to supply concrete to the project. This would involve deliveries of aggregate and cement/fly ash as well as generate significant truck movements for concrete delivery.
- Blasting - It may be necessary to clear hard rock from cuttings by blasting.
- Site compound and workshop - An administrative and maintenance area is likely to be required.
- Deliveries - Deliveries to site may include heavy machinery, construction materials and other consumables.

Table 4-4 summarises the likely equipment to be utilised across the project and the achievable source sound power levels for plant items based on the most recent available data from current similar projects elsewhere in NSW.

- **Table 4-4 Expected construction activities and associated noise levels**

Typical activity description	Plant noise source	L_{A10} Sound power level re: 1pW, dB(A)
Clearing and grubbing	30t Excavator	103
	Rigid trucks	107
	Bulldozer	110
	Chainsaws	114
	Tub grinder	109
Drainage and earthworks	Excavator	105
	D11 bulldozer	114
	D9 bulldozer	113
	Compactor	112
	Grader	111
	Water cart	107
	Haul truck	112
	Dump truck	110
	651 scraper	108
	637 scraper	107
	Backhoe	110
	Vibrating / compaction roller	113
	Front end loader	114
Bridgeworks	Impact piling rig	121
	Bored piling rig	114
	Pneumatic hammer	113
	Excavator	112
	Haul truck	112
	Generator	111
	Mobile crane	110
	Concrete truck	110
	Concrete pump	107
	Compressor	105
Paving and asphalting	Generator	111
	Backhoe	110
	Asphalt paver	111
	Concrete paver	111
	Pneumatic-tyred roller	111
	Concrete truck	110
	Concrete vibrator	105
	Concrete saw	109
	Concrete batch plant	111

4.4.2. Predicted noise levels

The magnitude and nature of the noise level likely to be experienced at identified sensitive receivers is primarily dependent on the equipment in use and the proximity to the sensitive receiver. Intervening factors such as topography and meteorology will also have an influence on the predicted value.

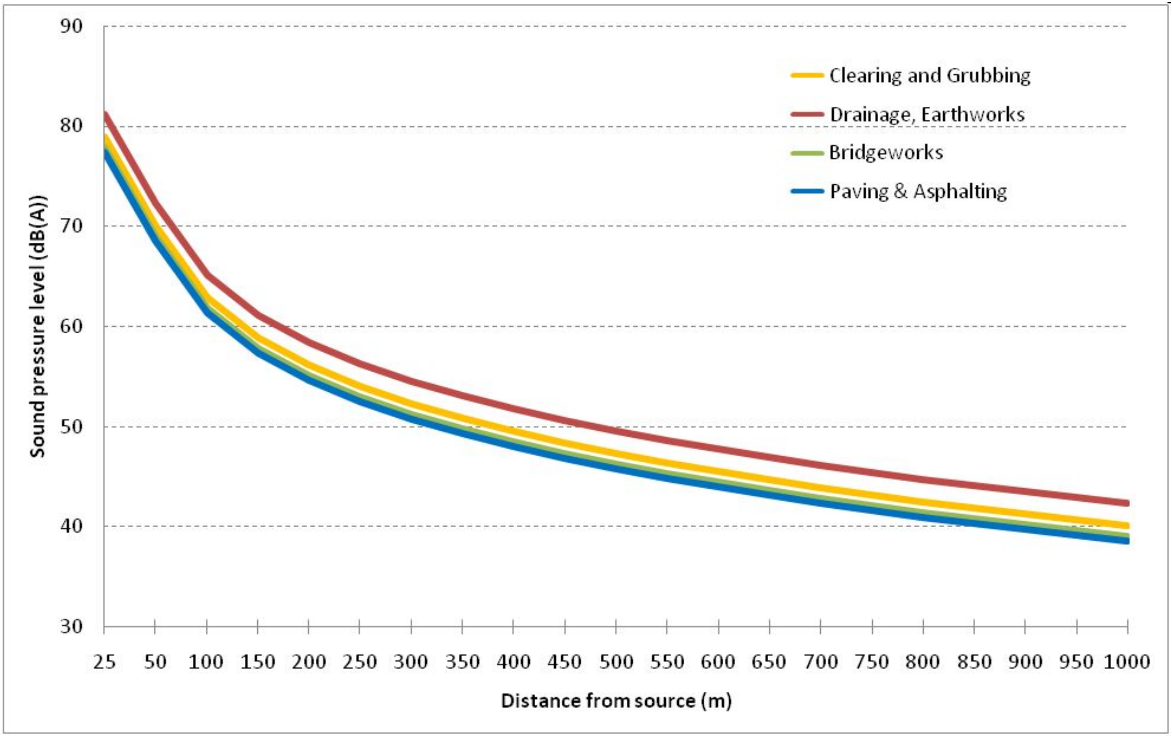
The L_{A10} sound pressure levels at various distances from the construction sources have been predicted based on four possible scenarios, representing each stage of construction, at any location on the construction corridor, as follows:

- Clearing and grubbing - 1 x 30 t truck, 1 x excavator and 1 x chainsaw.
- Drainage and earthworks - 2 x CAT 651 scrapers, 1 x compactor, 1 x D11 bulldozer.
- Bridgeworks - 1 x mobile crane, 1 x concrete truck, 1 x concrete pump.
- Paving and asphalting - 1 x concrete paver, 1 x open-topped haul truck.

Although the equipment types and numbers will vary in practice, these scenarios provide a suitable indication of the likely magnitude of construction noise impacts. Based on the above scenarios and sound power levels listed in **Table 4-4**, and incorporating estimated attenuation due to distance as well as ground and atmospheric absorption, predicted L_{A10} sound pressure levels for increasing distance from the construction sources are presented graphically in **Figure 4-1**.

It may be inferred, based on the noise management levels determined previously (refer **Table 4-2**), that at distances less that about 300m, daytime construction noise levels may be exceeded. For evening and night time periods, the distances would increase to 500m and 1000m although this would only apply to paving and batch plant activities. Based on the outcome of these predictions, the construction contractor should apply all feasible and reasonable work practices to minimise noise. On this basis, a selection of recommended mitigation measures is provided in **Section 4.10**.

- **Figure 4-1 Estimated reduction of construction noise with distance from the source.**



4.5. Batching plants

4.5.1. Batching noise assessment criteria

Batching requirements for the project have not yet been determined. However, it is expected that either a concrete or asphalt batching plant (or both) would be required for producing paving material and may be located within or adjacent to the road construction corridor. Since any batching plant would operate in the same location on a semi-continuous basis during the project, it is considered to be similar to operational facilities rather than construction noise sources.

The absence of noise sensitive receivers along the Project alignment will provide substantial opportunities for the location of the batching plant. Given a batching plant is likely to operate during all periods, the assessment criteria would apply to the day (7am to 6pm), evening (6pm to 10pm) and night (10pm to 7am) periods. When considering potential locations for the plant, buffer distances of at least 1000 m from residential dwellings should be maintained where possible to minimise noise impacts.

Since the location of the batching plant site is not known at this stage, appropriate criteria cannot be determined in this assessment. As a guide, presuming a rural/residential setting, a planning noise level of approximately L_{Aeq} 50 dB(A) would be anticipated during the day, based on the INP (DECC 2000). At night time, this would be a lower criterion based on the pre existing background noise level.

4.5.2. Batching noise levels

For the purpose of this assessment, a concrete batching plant has been used to predict the potential noise impact on sensitive receivers. The predicted impacts from a concrete plant should be representative of those from an asphalt batching plant. However, during detailed design, the actual batching facility selected would require further assessment.

The concrete batching process generally involves loading of aggregate, cement, water and fly-ash into the batching plant, in which it is mixed and the concrete loaded into waiting open-topped tip-trucks. Previous experience has identified an operational noise emission from this type of process as having sound power of approximately 110 dB(A) – 112 dB(A). **Table 4-5** summarises some of the potentially dominant noise sources at an operational batching plant, based on observations at other batching plants.

- **Table 4-5 Potential noise sources at an operational batching plant**

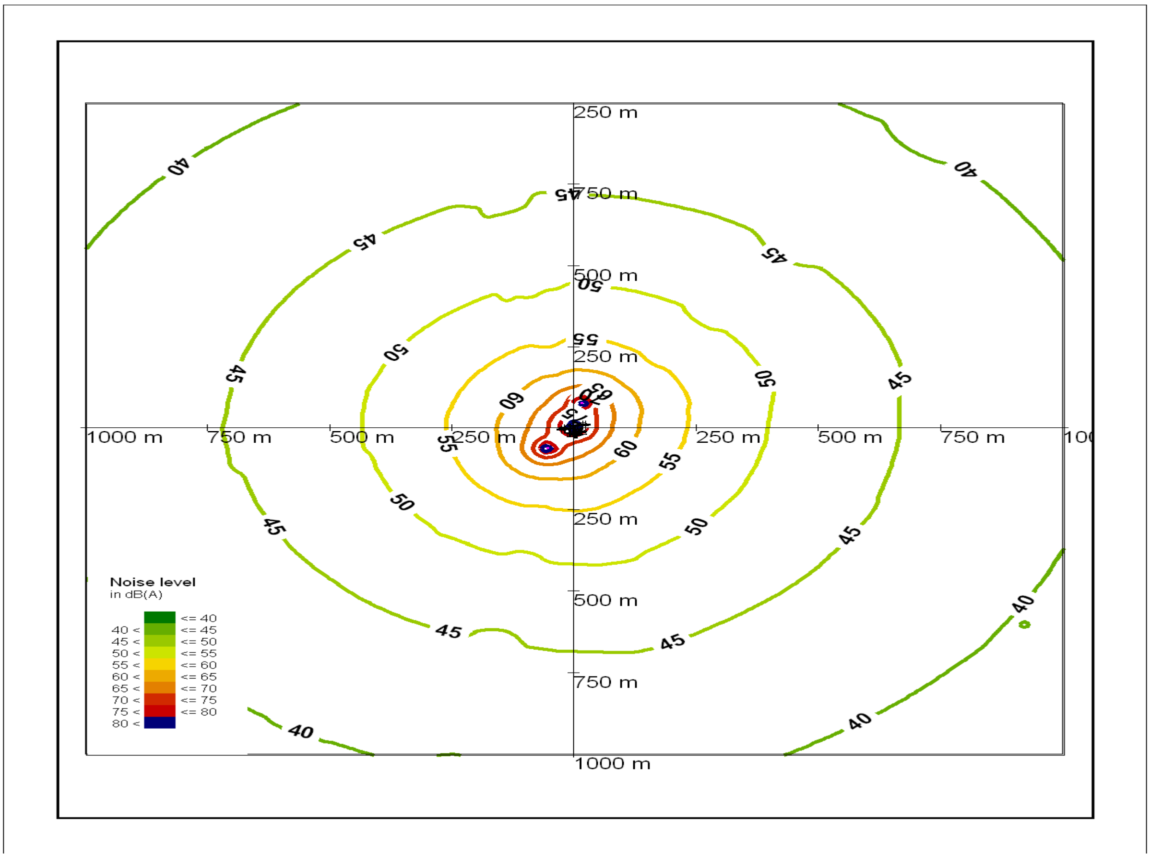
Noise source	Process description
▪ Aggregate loading	A front end loader (FEL) used to load aggregate and sand from the stockpiles into the hoppers.
▪ Aggregate hopper gates	The aggregate may be loaded onto the conveyors via gates which are controlled by compressed-air power rams, which generate a significant air release each time gates are opened.
▪ Aggregate conveyor	The aggregate is loaded to the mixing drum via a conveyor. The conveyor is driven by an electric motor and runs on rollers, which may squeal if not properly lubricated.
▪ Dust extraction fan	Externally mounted fans for controlling dust in cement and fly-ash silo
▪ Vibratory aggregate hopper cleaner	May be associated with the aggregate hopper and activates each batch to ensure all product has been loaded - emits a mid-frequency hum
▪ Mixing drum	Rotation by hydraulic or electric drive
▪ Truck movements	Trucks are a significant noise source for a batching plant, with a high number of movements and rapid turnaround time Other truck movements include aggregate and cement deliveries at a lower frequency of movement
▪ Compressor	Used to operate gates, externally mounted
▪ Generator	Where the site is not connected to 3-phase power a generator would be required to power the plant. Even with power, a generator may be installed for emergency use
▪ Cement loading	Cement is pneumatically loaded to the silo using a blower on the silo.
▪ Reverse beepers	Trucks are typically required to reverse into the loading bay

4.5.3. Predicted noise levels

Based on the estimated noise emissions from a batching plant the L_{Aeq} sound pressure levels have been predicted using a SoundPLAN model at nominal distances from the plant. The prediction is generic and does not account for attenuation due to topographical or structural barriers and assumes worst-case meteorological conditions, i.e. stable atmosphere and light breeze from source to receiver.

The noise contours are presented in **Figure 4-2** and demonstrate that within 250 m of the plant, noise levels are likely to be approximately 55 dB(A), whilst at 500 m, the L_{Aeq} noise levels is expected to be approximately 48 dB(A); and at 1000 m, the predicted noise level is 41 dB(A). A more through assessment of potential impacts would be undertaken at the detail design stage when batching plant types and locations are finalised.

- **Figure 4-2 Predicted noise levels with increasing distance from the batching plant**



4.6. Blasting impact assessment

4.6.1. Blasting guidelines

Chapter 154 of the ENCM (DECC 1994) provides guidance on times of day, airblast overpressure noise level and ground vibration peak particle velocity limits for operations which involve the repeated use of explosives, such as quarrying and bulk earthworks.

Blasting operations are recommended to be confined to the periods Mondays to Saturdays, 9am to 3pm and blasting outside these times should be approved only where blasting during the recommended times is impractical. Blasting at night should be avoided unless absolutely necessary.

Table 4-6 shows the limiting over-pressure and ground vibration levels during blasting at the nearest sensitive receiver.

- **Table 4-6 Limiting criteria for the control of blasting impact at residences**

Blast over pressure level, dB (linear)*	Ground vibration, peak particle velocity, (mm/sec)**
115	5

*Any exceedance above a blast over pressure of 115dB (linear) should be limited to not more than 5% of the total number of blasts. On these infrequent occasions a maximum limit of 120dB (linear) should not be exceeded at any time over a 12 month period.

**Ground vibrations above 5 mm/sec should also be limited to not more than 5% of the total number of blasts. On these infrequent occasions a maximum limit of 10 mm/sec should not be exceeded at any time over a 12 month period.

4.6.2. Blasting prediction

Blasting activities produce ground-borne vibration and air blast overpressure, both of which can cause discomfort and, at higher vibration levels, potential damage to property. Potential impacts are primarily dependent upon the effective mass of explosive charge per hole and the distance to the receiver.

At the environmental assessment stage, blasting and seismic details for the project are unknown and it will be necessary to carry out noise and vibration predictions later once the proposed charge and blast configuration information becomes available. However, it is important that the actual buffer zone associated with this site be identified and appropriate measures taken to limit over-pressure and vibration to acceptable levels at critical locations.

The distance estimates relating to vibration have been determined using Australian Standard 2187.2-1993, applicable to free face blasting in ‘average field conditions’:

$$V = 1140\left(\frac{R}{Q^{1/2}}\right)^{-1.6}$$

where

- V = ground vibration as peak particle velocity in mm/s.
- R = distance between charge and point of measurement in metres.
- Q = effective charge mass per delay or maximum instantaneous charge in kilograms.

The distance estimates relating to over-pressure are determined from the results of a regression analysis of noise data obtained from a number of mine sites in the Hunter Valley. The distance per Maximum Instantaneous Charge (MIC) may vary significantly depending on the geological conditions, local shielding and meteorological factors at the site but provide an appropriate indication of over-pressure magnitude.

In the absence of specific blasting information and seismic details of the site, **Table 4-7** provides general guidance for estimating the likely minimum distance from blasting that may be required to meet over-pressure and vibration criteria described above, for a range of MIC values.

- **Table 4-7 Minimum distances to comply with blasting vibration and over-pressure limits for various MIC values.**

Maximum instantaneous charge (MIC)	Minimum distance Limits (metres)	
	Vibration	Over pressure
5	70	290
10	100	350
20	140	430
50	220	560
100	300	670
200	430	750

The above distances are estimates and should only be referred to for guidance, however, it is evident that the degree of impact is strongly dependent on the size of the blast and that a greater separation distance is required to comply with the over-pressure limit than the vibration limit. Therefore, in terms of buffer distances, the over-pressure limit is more stringent than the vibration limit and therefore would become the limiting blast criterion for the project. As there are a number of cuttings on the project it is expected that blasting may be required during the earthworks phase. Where blasting is necessary within the minimum buffer distances, additional management strategies would be required.

The blast charge configuration should be selected to ensure that DECC goals are not exceeded. Before blasting can commence at a site, critical locations should be identified and appropriate measures taken to limit over pressure and vibration to acceptable levels. Blasts should be monitored initially at these locations to ensure that predicted over-pressure and vibration levels are not exceeded.

4.7. Site compound and deliveries

The impact of noise from the establishment and operation of the site compound on nearby sensitive receivers is not likely to be significant however should be considered. The locations of any compounds would be confirmed at the detail design stage.

During establishment of the site, anticipated activities would include clearing and grading and the installation of pre-fabricated portable site offices and a maintenance workshop area. Sources of noise during this time, although typically relatively noisy, are anticipated to be of limited duration. They include mobile machinery (e.g. scrapers, graders compactors and mobile cranes) and stationary plant (e.g. generators, compressors). Vibration sources are not likely to be significant and would be rapidly attenuated with distance.

Operation of the site compound will be required to support construction activities and the predominant noise source will likely be vehicle movements (e.g. staff transport and delivery of construction supplies). It has been assumed that the location of the construction compounds would be near transport facilities for delivery and access reasons and therefore the additional vehicle movements are not likely to present a significant noise or vibration impact on sensitive receivers.

The use of hand tools during vehicle maintenance may result in audible noise at sensitive receivers; however their use would reflect the existing rural land use and will not be a continual noise source. Any noise and vibration generated during the operation of the site compound should be managed under a specific Noise and Vibration Management Plan, which includes monitoring, noise mitigation and community consultation as a minimum as well as measures to identify and mitigate any unforeseen significant noise sources from the sites.

4.8. Construction vibration

4.8.1. Assessment criteria – human comfort

The DECC document *'Assessing Vibration; a technical guideline'*, published in February 2006 provides guidance on disturbance to human occupants of buildings as a result of vibration. This document provides criteria which are based on the British Standard BS 6472-1992, *'Evaluation of human exposure to vibration in buildings (1-80Hz)'*. Vibration sources are defined as C*ontinuous, Impulsive or Intermittent.* Section 2 of the technical guideline defines each type of vibration as follows:

- 'Continuous vibration' continues uninterrupted for a defined period (usually throughout the day-time and/or night-time).
- Impulsive vibration is a rapid build up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds.
- Intermittent vibration can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude'.

The criteria are applied to a single weighted root mean square (rms) acceleration source level in each orthogonal axis, as required in the guideline. Preferred and maximum values for continuous and impulsive vibration are defined in **Table 4-8**.

- **Table 4-8 Preferred and maximum weighted rms values for continuous and impulsive vibration acceleration (m/s^2) 1-80Hz**

Location	Assessment period	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous Vibration					
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or Night-time	0.020	0.014	0.040	0.028
Workshops	Day or Night-time	0.04	0.029	0.080	0.058
Impulsive Vibration					
Residences	Daytime	0.30	0.21	0.60	0.42
	Nighttime	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day or Night-time	0.64	0.46	1.28	0.92
Workshops	Day or Night-time	0.64	0.46	1.28	0.92
Note:	Daytime is 7am to 10pm and night-time is 10pm to 7am				

Intermittent vibration is to be assessed using vibration dose values (VDV). The VDV method is more sensitive to peaks in the acceleration waveform and makes corrections to the criteria based on the duration of the source's operation. The VDV can be calculated using the overall weighted rms acceleration of the vibrating source in each orthogonal axis and the total period during which the vibration may occur. Weighting curves are provided in each orthogonal axis in the DECC guideline. Preferred and maximum VDV's are defined in Table 2.4 of the DECC guideline and are reproduced in **Table 4-9**.

- **Table 4-9 Acceptable VDV for intermittent vibration ($m/s^{1.75}$) impacts**

Location	Daytime		Night-time	
	Preferred values	Maximum values	Preferred values	Maximum values
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

Note: Daytime is 7am to 10pm and night-time is 10pm to 7am

4.8.2. Assessment criteria – structural damage

Currently no Australian Standard exists for guidance on structural damage caused by vibration and therefore the British standard for this type of impact will be referred to in this report. The British Standard 7385: Part 2 "Evaluation and measurement of vibration in buildings", can be used as a guide to assess the likelihood of building damage from ground vibration including piling, compaction, construction equipment, road and rail traffic. BS 7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur.

BS 7385 recommends that the peak particle velocity is used to quantify vibration and specifies damage criteria for frequencies within the 4Hz to 250Hz range usually encountered in buildings. At frequencies below four Hz, a maximum displacement value is recommended. The levels from the standard are given in **Table 4-10**.

- **Table 4-2 BS 7385 structural damage criteria**

Group	Type of structure	Peak component particle velocity, mm/s		
		4 to 15 Hz	15 to 40 Hz	40 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	15 to 20	20 to 50	50

The levels set by this standard are considered ‘safe limits’ up to which no damage due to vibration effects has been observed for certain particular types of buildings. These values relate to intermittent vibrations. Continuous vibration can give rise to magnifications due to resonances and may need to be reduced by up to 50 per cent.

4.8.3. Vibration impact assessment

This section provides guidance on the magnitude of vibration that may be expected from the construction activities of each scenario. **Table 4-11** summarises the anticipated level of vibration for each stage of construction. It can be inferred that activities such as compaction and rolling, as well as ripping would be the dominant sources of vibration during the project.

- **Table 4-3 Summary of anticipated vibration levels for various construction activities.**

Stage	Activity	Vibration guidance
Clearing and grubbing	Clearing of vegetation, trunk and root removal, processing of timber waste	In general, the activities carried out during this stage of works generate low levels of vibration and areas close to residences are generally already cleared. Vibration impact is considered unlikely.
Earthworks	Bulldozers ripping	1 mm/s to 2 mm/s at distances of approximately 5 m. At distances greater than 20 m, vibration is usually below 0.2 mm/s.
	Compactors	20 mm/s at distances of approximately 5 m, 2 mm/s at distances of 15 m. At distances greater than 30 m, vibration is usually below 0.3mm/s.
	Vibratory rollers	Up to 1.5 mm/s at distances of 25 m. Higher levels could occur at closer distances, however, no damage would be expected for any building at distances greater than approximately 12 m (for a medium to heavy roller).
	Truck traffic (on normal smooth road)	0.01 mm/s to 0.2 mm/s at the footings of buildings located 10 m-20 m from a roadway. (Very large surface irregularities can cause levels up to five to ten times higher).
Bridgeworks	Impact piling	The typical levels of ground vibration from pile driving range from 1 mm/s to 3 mm/s at distances of 25 m to 50 m, depending on ground conditions and the energy of the pile driving hammer
Paving and asphalting typical operations	Paver, concrete cutter	None of the construction plant used during paving and asphalting will be major sources of ground vibration

Most of the works will not be within 100 m of residential locations however, vibration levels generated by construction plant has been estimated at various distances and expected vibration impacts are shown in **Table 4-12**. These results indicate that vibration impacts are not likely to be an issue for the Project.

- **Table 4-4 Potential vibration impacts**

Approximate distance	Comment on potential vibration impact
Earthworks	
50 – 100 m	Reduction in human comfort as a result of ripping is possible. Structural damage is unlikely.
100m+	Low probability of reduction in human comfort for all activities
Bridgeworks	
50 -100 m	Reduction in human comfort as a result of piling is possible. Structural damage is unlikely.
100 m+	Low probability of reduction in human comfort from piling activities

4.9. Construction noise and vibration mitigation measures

Based on the distance of the nearest receivers to the project alignment and specific activities such as bridgeworks, the construction noise and vibration impact assessment has determined that the potential for adverse impacts on sensitive receivers is minimal. Feasible and reasonable mitigation measures should however, be implemented to ensure these impacts are maintained at their practical minimum.

The measures that should be incorporated in a Construction Noise and Vibration Management Plan (CNVMP) to systematically address and manage known and unidentified construction noise and vibration impacts on sensitive receivers are listed below.

Administrative measures

- Ensure compliance with approved construction hours. This requirement to be communicated to all staff through inductions and toolbox meetings.
- Prepare an out-of-hours works procedure to minimise the impact of any necessary works outside normal hours
- Provide an induction to site personnel (including s/c) addressing the requirements of this CNVMP and their responsibilities with regard to noise and vibration management.
- Keep the local community informed of progress and construction activity.
- Provide continuous education of supervisors, operators and sub-contractors on the need to minimise noise through Toolbox meetings and on-site coaching.
- A protocol should be developed for handling noise complaints that includes recording, reporting and acting on complaints.

On-site activities

- Select the location of construction compounds and design these facilities to minimise noise exposure and impacts at noise receivers (i.e. consider buffer zones, access, storage and maintenance areas, barriers/shielding etc)
- Select quieter alternatives to noisy activities if practical/feasible , i.e. use bored piling where practical
- Select appropriate sized vibratory compactors and other rock excavation equipment and design procedures for their use in order to comply with vibration emission limits.
- Ensure equipment is operated in the correct manner including replacement of engine covers, repair of defective silencing equipment, tightening of rattling components, repair of leakages in compressed air lines and shutting down equipment not in use.
- Position plant on site to reduce emission of noise to the surrounding neighbourhood.
- Select site access points and haul road locations away from sensitive receivers.
- Keep horn signals between drivers to a minimum.
- Regularly grade access roads to reduce noise from trucks rattling.
- During clearing and grubbing, select ‘quiet’ plant and fit residential grade mufflers where required. Since excavators are much quieter than chainsaws, excavators with grabs and rake attachments should be used in lieu of chainsaws wherever possible.
- Where possible tub grinding should not occur within 500 m of sensitive receivers
- Topsoil will be stockpiled, where practicable within the width of easement, in noise sensitive areas to provide shielding to residences.
- Ensure equipment and diesel combustion engines (including delivery and disposal trucks) are turned off when not in use. (this also has sustainability implication).
- Ensure machinery used is appropriately sized to prevent overloading and associated over-revving.
- Where possible, locate construction equipment in a position that provides the most acoustic shielding from buildings and topography.
- Ensure traffic movement is kept to a minimum, e.g. ensure trucks are fully loaded so that the volume of each delivery is maximised and the number of trips is therefore minimised.
- Ensure plant and equipment is adequately maintained.

Monitoring

- Monitor construction noise levels at construction commencement to verify compliance with the Noise and Vibration Management plan and noise impact statements.
- Undertake monitoring of noise levels from fixed and mobile plant every six months and ensure that levels are not degraded by lack of maintenance and comply with respective Australian Standards (Refer AS 2436 -1981).
- Undertake regular monitoring of overall noise levels at sensitive receivers to check for compliance.
- Undertake vibration monitoring when blasting has the potential for inducing vibration at sensitive receiver locations.

Blasting

- Develop a blast management strategy to ensure compliance with vibration and over-pressure limits.

5. Conclusion

An operational noise assessment for the Pacific Highway, Glenugie Upgrade project has identified the potential noise sensitive receivers in the investigation area and undertaken an impact analysis against the Department of Environment and Climate Change, Environmental Criteria for Road Traffic Noise and the RTA, Environmental Noise Management Manual.

In accordance with these guidelines, measurements of the existing noise environment were made to provide information for the validation of the noise model as well as providing additional details used in the assessment of potential construction noise impacts. Based on the measurement of the existing traffic noise and the predicted traffic profile for the project, the night time noise levels were identified as being the critical assessment values for the project.

The noise levels at all receiver locations were predicted using noise modelling software, which identified potential exceedances of the noise criteria. The majority of the assessed noise sensitive receivers were predicted to be at or lower than the base noise criterion and also experienced a reduction in both daytime and night time noise levels. On this basis the assessment indicates that there is no additional noise mitigation required at sensitive receiver locations.

A construction noise and vibration assessment has also been undertaken providing consideration of the scheduling of construction works and the associated activities with respect to noise emissions. The assessment of these activities indicates that the potential for noise impacts will be greatest within about 300 m of the works however noise management measures should be incorporated into the construction management plan to assist with the minimisation of impacts.

6. References

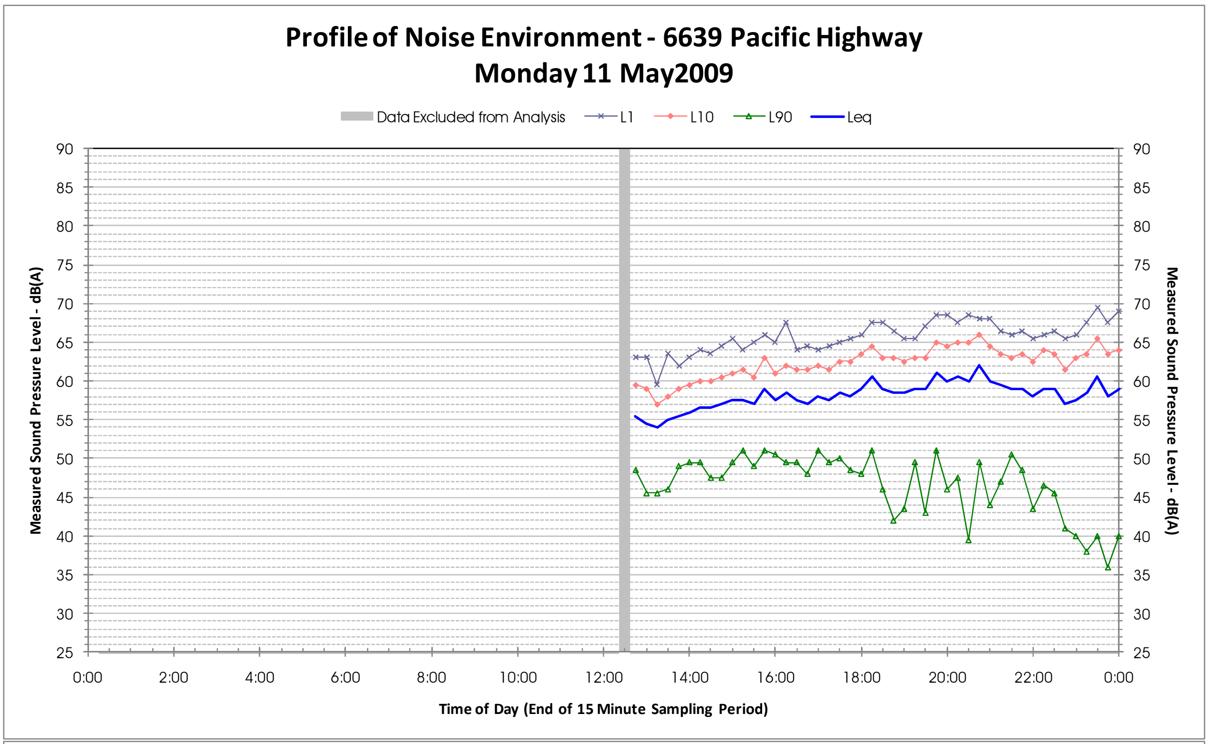
Environment Protection Authority 1999, *Environmental Criteria for Road Traffic Noise*, (Department of Environment and Climate Change, Sydney.

Roads and Traffic Authority 2001, *Environmental Noise Management Manual,* RTA, Sydney.

German standard DIN 4150: Part 3 – 1999 *Effects of Vibration on Structures.*

British Standard BS 6472: - 1992 Evaluation of Human Exposure to Vibration in Buildings.

Attachment A Existing noise profiles at the project monitoring site


Profile of Noise Environment - 6639 Pacific Highway
Monday 11 May2009
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)
90
85
80
75
70
65
60
55
50
45
40
35
30
25
0:00
2:00
4:00
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8:00
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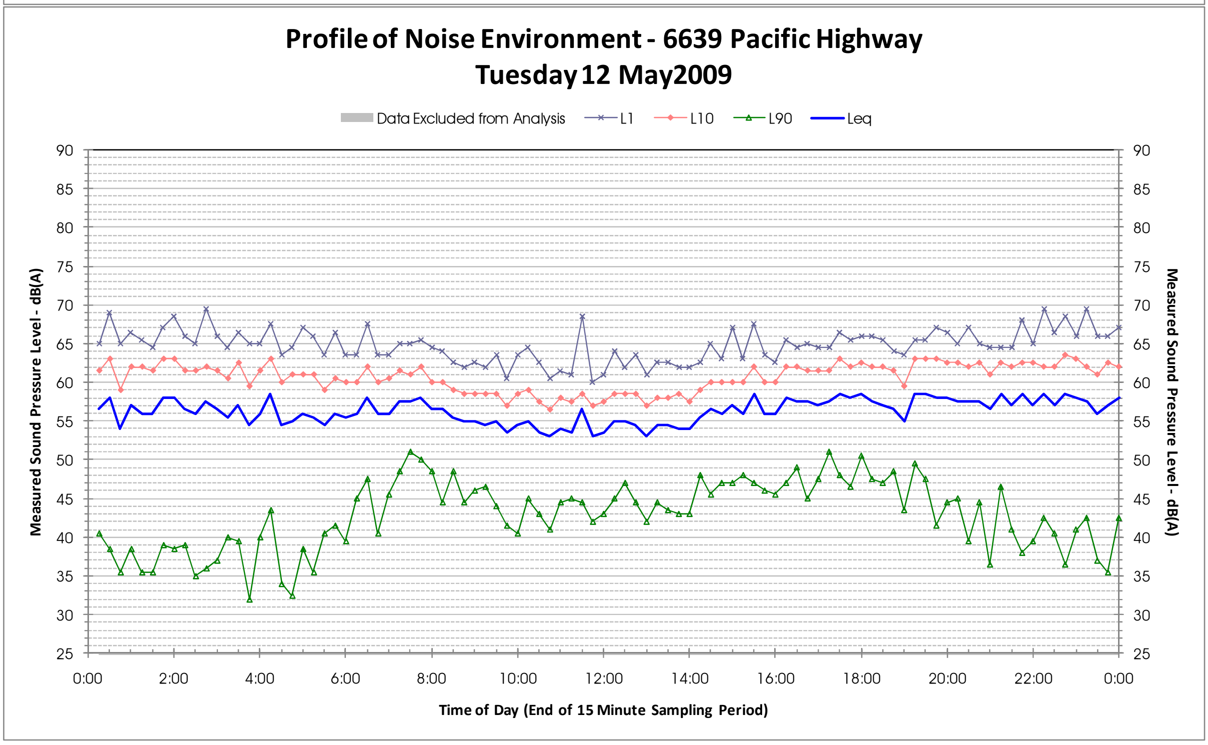
Profile of Noise Environment - 6639 Pacific Highway
Tuesday 12 May2009
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)
90
85
80
75
70
65
60
55
50
45
40
35
30
25
0:00
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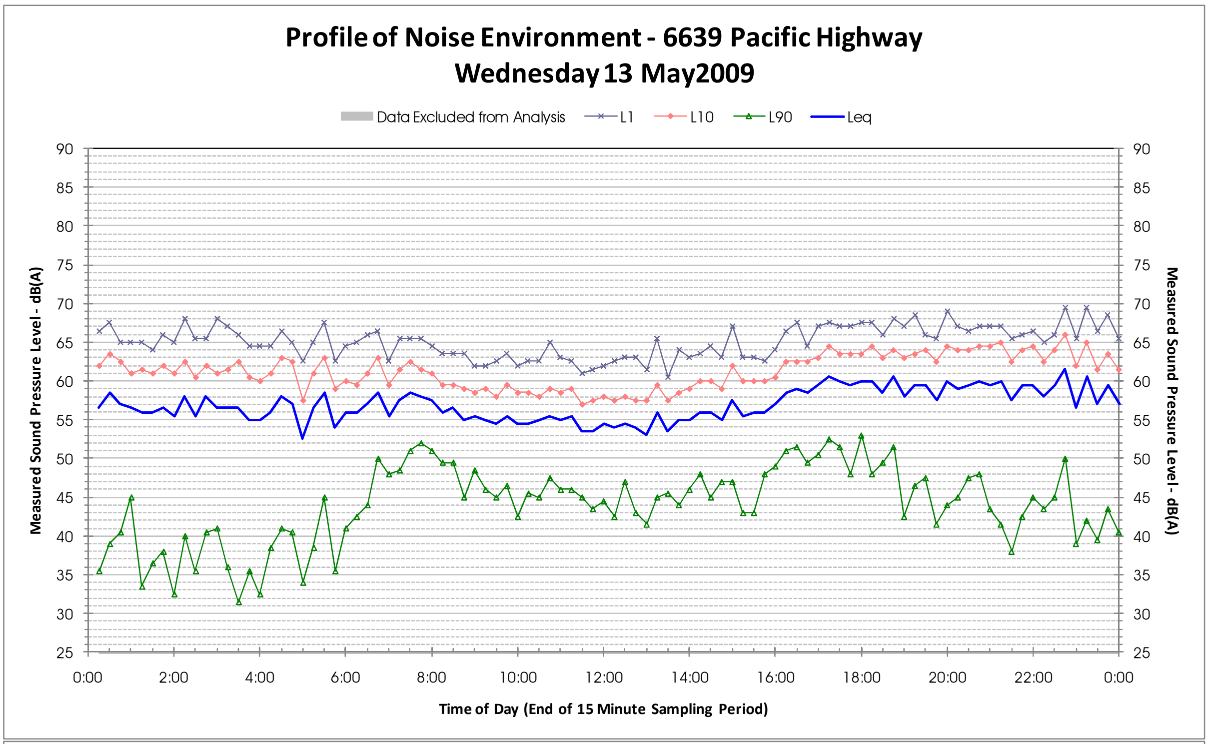
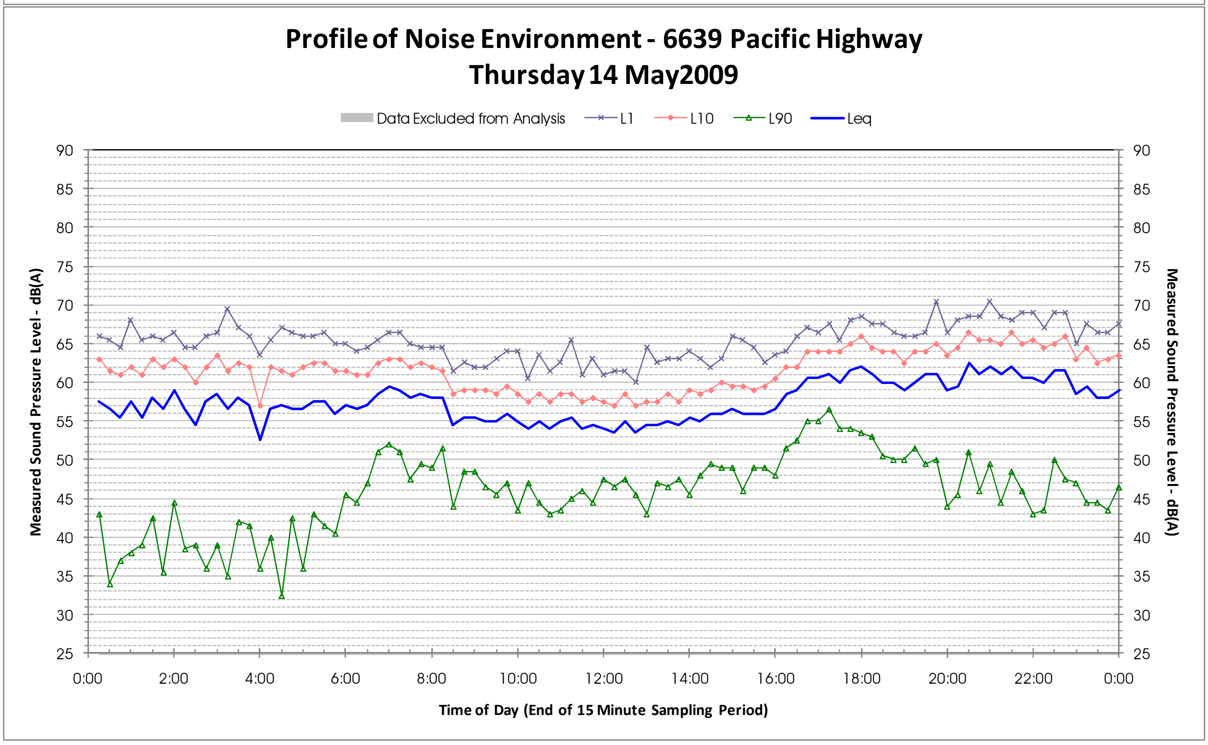
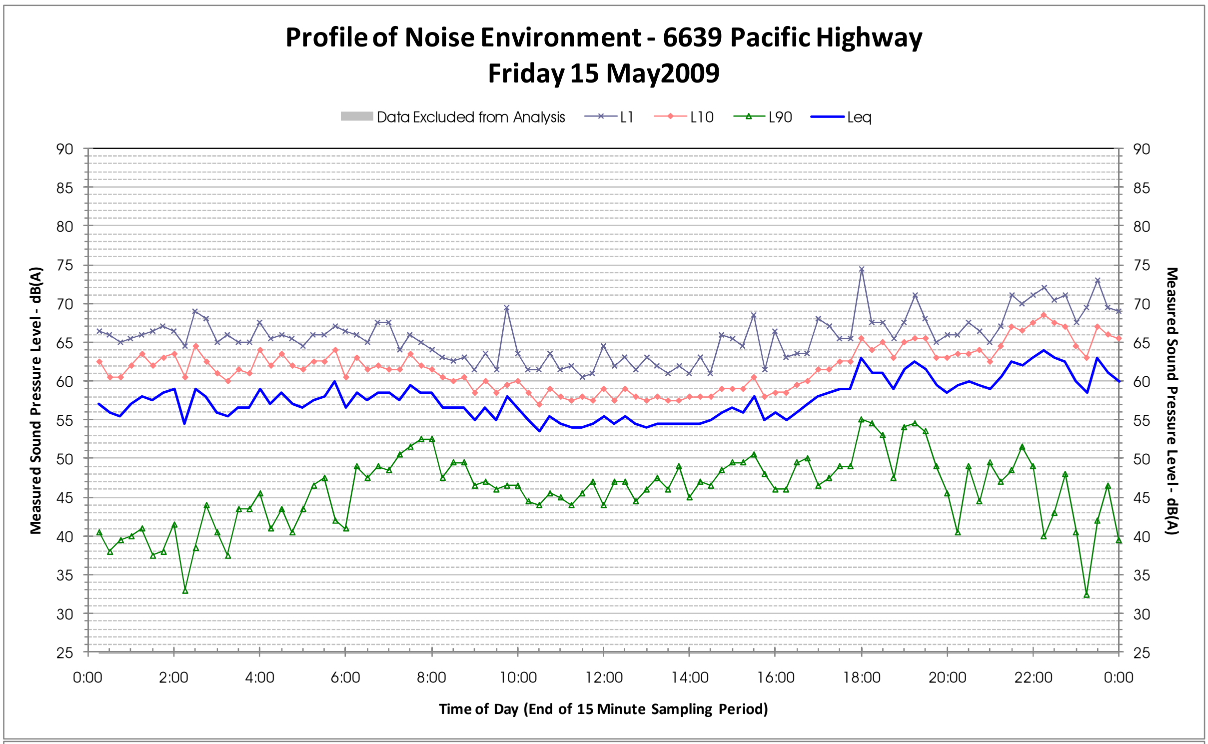
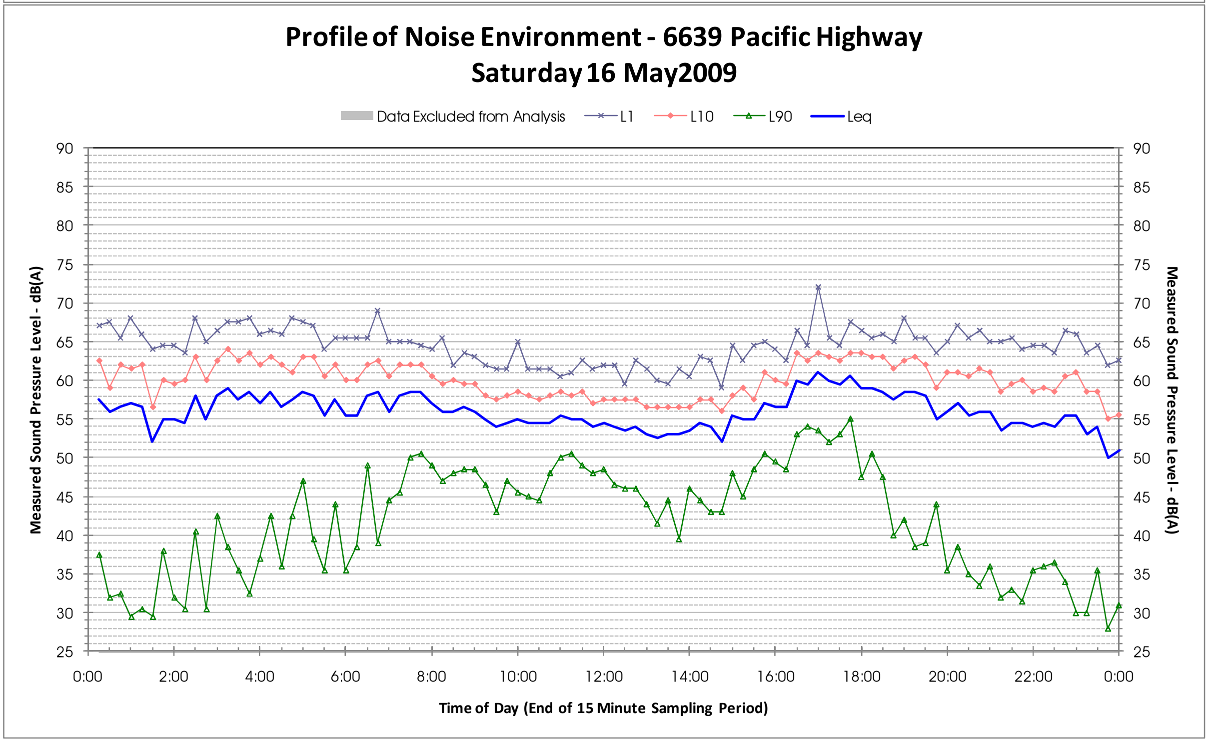
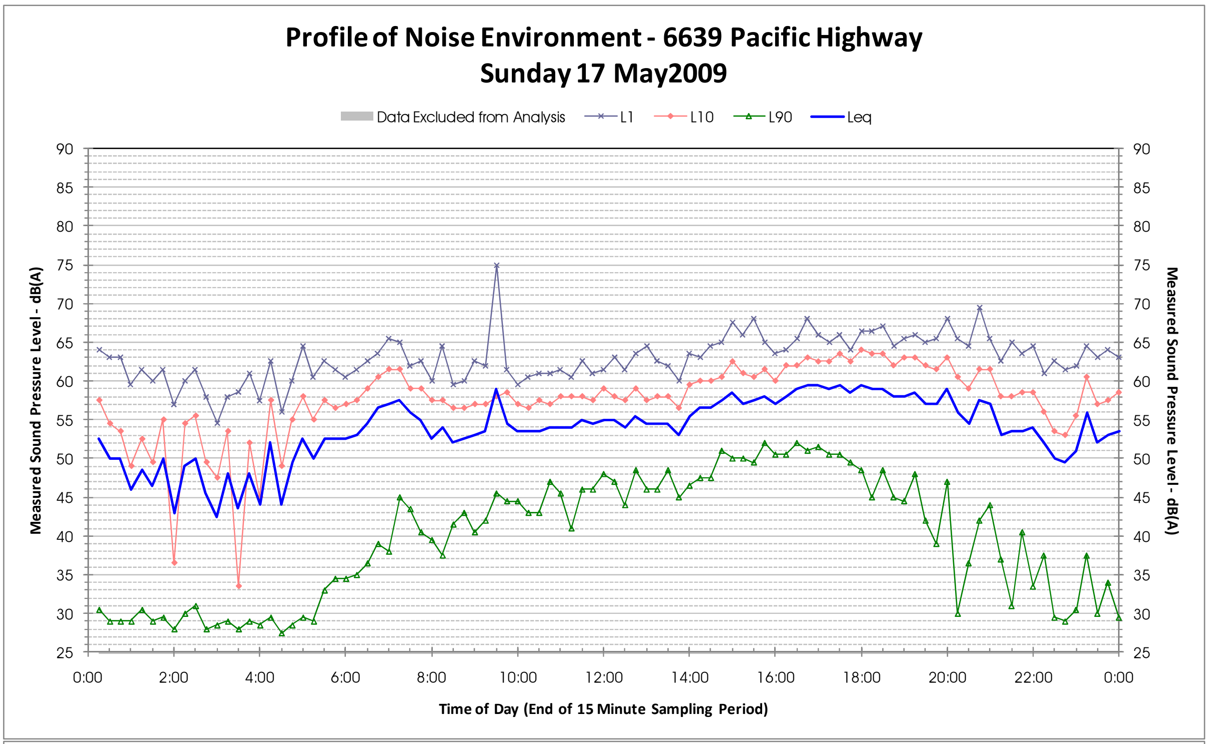
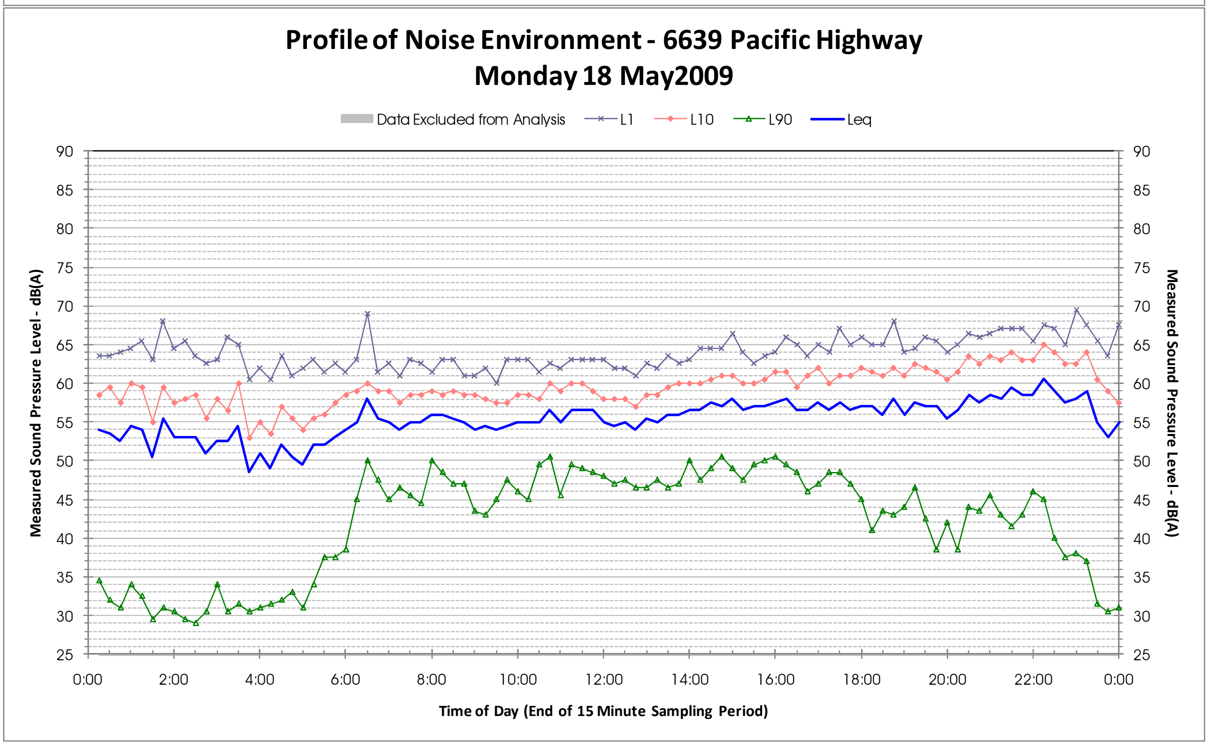

Profile of Noise Environment - 6639 Pacific Highway
Wednesday 13 May2009
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)


Profile of Noise Environment - 6639 Pacific Highway
Thursday 14 May2009
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)


Profile of Noise Environment - 6639 Pacific Highway
Friday 15 May2009
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)


Profile of Noise Environment - 6639 Pacific Highway
Saturday 16 May2009
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)


Profile of Noise Environment - 6639 Pacific Highway
Sunday 17 May2009
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
25
30
35
40
45
50
55
60
65
70
75
80
85
90


Profile of Noise Environment - 6639 Pacific Highway
Monday 18 May2009
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
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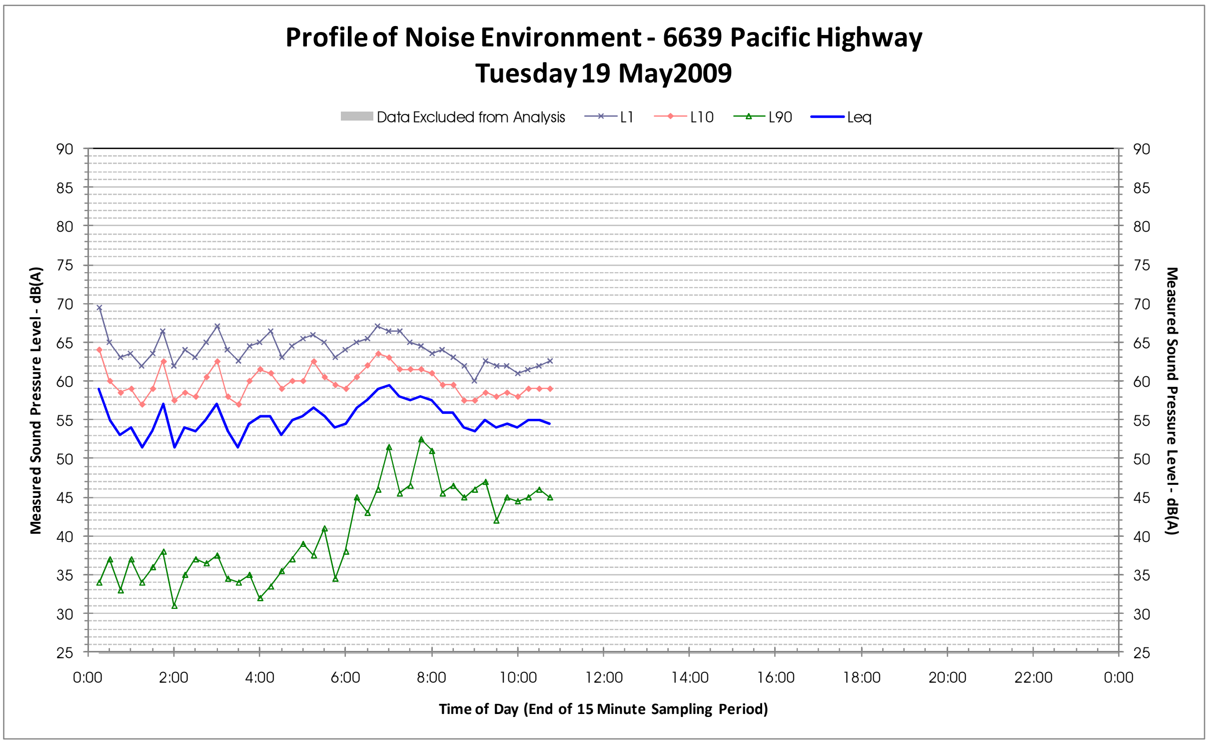
70
75
80
85
90


Profile of Noise Environment - 6639 Pacific Highway
Tuesday 19 May2009
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)