WOOD & GRIEVE ENGINEERS

2/5 Dam - Construction Noise and Vibration Assessment

MMG Rosebery – Construction Noise & Vibration Addendum Report

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Revision

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0	31/07/2015	Issued for submission	**IK**
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Contents

1. Introduction

1.1 Background

Wood & Grieve Engineers (WGE) prepared a noise and vibration impact assessment report for MMG Rosebery in June 2015, which included a study of the potential impacts from construction and operations of the proposed 2/5 Dam located approximately 100 m east of residential areas in Rosebery, Tasmania.

The report provided a baseline study with measurements conducted at pre-identified noise sensitive receivers that could be negatively impacted by construction and operations of the dam. Noise criteria were set out and predictions were provided based on typical construction plant and equipment.

During the review process of the project to gain approval from the Regulators, the Tasmanian Environment Protection Agency (EPA) division provided comments with regards to the noise assessment and these shall be assessed to satisfaction of all relevant parties.

This Addendum Report is aimed to specifically address comments from EPA. Further details can be read in conjunction with the WGE report dated 26 June 2015.

1.2 Comments from EPA

Since the issuing of the Noise & Vibration impact assessment report by WGE dated 26 June 2015, Tasmania's Environment Protection Agency division has provided comments, which are to be addressed in this addendum report.

Table 1: Comments from EPA – Responses

EPA Item #	Comments – Noise	Response
5	*Table 28 (Plant Activity dB v's Distance of Source to Receiver) is inadequate and potentially misleading. Address the following points.* *1) Include noise levels for rock drills and mobile generators (if these will be used in construction).* *2) The total noise levels are probably meaningless, as the distance of construction machinery from receptors will vary widely, e.g. it is extremely unlikely that all types of machinery listed would be simultaneously located at 250 metres from a receptor.* *3) In any case, estimated total noise levels need to be compared with acceptable exposure levels, at representative receptors.*	To address this comment, additional noise modelling assessment has been conducted. The new assessment scenarios considered four key catchment areas of construction, the timeline and duration of activities to identify potential simultaneity of events and a full list of dominant noise-generating construction equipment. Details are presented in Sections 3 and 4 of this addendum report.
6	*In the operational phase, will there be any noise emissions from the equipment used to spread tailings? Will any pumps be operated? If so, provide an estimate of noise levels at nearby residences.*	There will be one pump operational; the proposed location of the pumps is approx. 400m from the nearest residents. Based on typical noise emissions from pumps of this type and distance attenuation over the abovementioned distance shall comply with the criteria.

7	*It is stated that the construction period is likely to be greater than 26 weeks, which means that noise emissions and impact on nearby residents would be treated as operational under the NSW ENCM. Tasmania's EPA Division concurs with this principle.* *An assessment is therefore required of whether construction activities will comply with the relevant noise criteria in section 3.3. Provide such an assessment.*	The additional assessment required for construction noise has been covered in this report. The assessment considered operational noise criteria for construction noise activities, as these will extend for over 26 weeks. Noise criteria are provided in Section 2 of this addendum report. There are a few construction activities which do not extend for more than 26 weeks, these activities are assessed against the *NSW Interim Construction Noise Guideline (ICNG July 2009)*

1.3 Scope of this report

The principal objective of this addendum report is to address the comments provided by EPA (Section 1.2) with regards to construction noise.

The following tasks have been undertaken to complete this noise assessment:

- Review of the existing noise and vibration assessment report;
- Setting of the applicable construction noise criteria;
- Identification of four key construction areas;
- Review of the construction schedule to identify simultaneous events;
- Compilation of relevant noise sources applicable to the indicated activities to take place within the key construction areas;
- Determination of construction noise assessment scenarios based on the information listed above; and
- A prediction using noise modelling software of the construction noise levels for comparison with the noise criteria.

1.4 Limitation

This report has been prepared for Pitt & Sherry. The purpose of this report is to provide an independent review of the noise impact of the new 2/5 Dam Tailings Facility at MMG Rosebery Mine within the greater Township of Rosebery, Tasmania.

It is not the intention of the assessment to cover every element of the acoustic environment, but rather to conduct the assessment with consideration to the prescribed work scope.

The findings of the noise assessment represent the findings apparent at the date and the time of the monitoring and the respective conditions. It is the nature of environmental assessments that all variations in environmental conditions cannot be assessed and all uncertainty concerning the conditions of the ambient noise environment cannot be eliminated. Professional judgment must be exercised in the investigation and interpretation of observations.
In conducting this assessment and preparing the report, current guidelines for noise were referred to. This work has been conducted in good faith with WGE's understanding of the client's requirements and future needs and the generally accepted consulting practice.

No other warranty, expressed or implied, is made as to the information and professional advice included in this report. It is not intended for any other parties or other use.

2. Noise Assessment Criteria

2.1 Construction Noise Criteria

In the absence of State specific noise requirements controlling construction noise, construction noise criteria applicable to the development have been referenced from chapter 171 of the Environmental Noise Control Manual (ENCM, originally developed by NSW EPA, 1994). The ENCM only considers construction periods of up to 26 weeks. Here a construction period is expected to be over 26 weeks; it is generally considered that the construction noise should be treated as operational noise in the assessment of noise impacts on the nearby residences.

It is anticipated the total construction period would be over 26 weeks. Therefore, the operational noise criteria applicable to the daytime period presented in Section 2.2 will also be applied to noise from construction activity.

It should be noted the ENCM construction noise guideline does not include any criteria to assess noise from traffic associated with construction. It is assumed that noise from traffic associated with the proposed construction is minimized as much as is practicably possible by limitations on construction hours, and Australia Design Rules which apply to road-registered vehicles.

Although the proposed construction is occurring for over 26 weeks, the construction is staged and only a part of construction works extend over 26 weeks. Details of construction activities, including the timeline is presented in section 3.1 & 3.2 respectively.

Construction activities occurring for more than 26 weeks are assessed against the daytime criteria presented in section 2.1. However, short term construction activities are compared to the construction noise criteria as per *NSW Interim Construction Noise Guideline (ICNG July 2009)* by the NSW Office of Environment and Heritage. The project specific criteria for short term construction activities are presented in Table 2. These values are adopted from the unattended background noise measurements.

Table 2: Construction Noise Criteria (residences)

Time of Day	Management Level $L_{Aeq,15min}$ *	How to Apply
Recommended Standard Hours: **Mon – Fri** **(7am – 6pm)** **Sat** **(7am – 4pm)** **No work on Sunday & Public Holidays**	Noise Affected 46 dB(A) *(Giblin Street)* 43dB(A) *(Alec Street)*	The noise affected level represents the point above which there may be some community reaction to noise. - Where the predicted or measured $L_{Aeq,15min}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. - The proponent should also inform all potentially impacted residences of the nature of works to be carried out, the expected noise levels and duration as well as contact details.
	Highly Noise Affected 75 dB(A)	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 relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur in, taking into account:

		- Times identified by the community when they are less sensitive to noise (such as before and after school, for works near schools, or mid-morning or mid-afternoon for works near residences) - If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside Recommended Standard Hours	36dB	- 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 5 dB(A) above the noise affected level, the proponent should negotiate with the community. - For guidance on negotiating agreements see section 7.2.2.

Other sensitive land uses, such as schools or hospitals, typically consider noise from construction to be disruptive when the properties are being used. Table 3 presents management levels for noise at other sensitive land uses based on the principle that the characteristic activities for each of these land uses should not be disturbed.

Table 3: NSW OEH ICNG Construction Noise Criteria (other sensitive land uses)

Land use	Management Level $L_{Aeq,15min}$ *
Hospital wards and operating theatres	Internal noise level 45dB(A)

Source: Chapter 4 (Table 3 Sec 4.1.1) of NSW OEH ICNG

2.2 Operational Noise Criteria

The criteria as detailed in the initial assessment report are presented in this section. Noise limits for residential properties have been calculated in accordance with the various applicable legislation and guidelines. The derived criteria based on the measured background noise levels are presented in Tables 4 to 7.

Table 4: N3/89 (SEPP N-1) Noise Limits

	Day	Evenings and Weekends	Night
Zoning Level, dBA	50	44	39
Background Noise Level dBA L_{90}	28	26	24
Background Classification	LOW	LOW	LOW
Noise Limit, calculation	0.5*(Zoning level + Bg level)+4.5, but not less than 45 dBA	0.5*(Zoning level + Bg level)+3 but not less than 37 dBA	0.5*(Zoning level + Bg level)+3 but not less than 32 dBA
Noise Limit, dBA	45	40	36

Noise Assessment Criteria

Table 5: Noise from Industry in Rural Victoria (NIRV) Noise Limits

	Day	Evenings and Weekends	Night
Applied Level, dBA	46	41	36
Background Noise Level, dBA L_{90}	28	26	24
Noise Limit, calculation	Applied level or background + 5 dBA, whichever is greater	Applied level or background + 5 dBA, whichever is greater	Applied level or background + 5 dBA, whichever is greater
Noise Limit, dBA	46	41	36

Table 6: INP Noise Limits

Location	Area Classification	Period	ANL[1] LAeq (period) dBA	RBL[2] LA90(15min) dBA	Criteria for New Sources	
					Intrusive LAeq(15min)	**Amenity LAeq(period)**
Residences	Rural	Day	50	33	38	50
		Evening	45	31	38	45
		Night	40	30	38	40

Note 1: ANL - Acceptable Noise Level

Note 2: RBL - Rating Background Level

The identified criteria are compared in Table 7.

Table 7: All noise criteria considered for Rosebery

	Day	Evening and Weekends	Night
N3/89 (SEPP N-1)	45	40	36
NIRV	46	41	36
INP	38	38	38

The construction activities from 2/5 Tailings Dam which occur for more than 26 weeks should comply with the operational noise criteria detailed in Table 7 for various times of the day depending upon the time of activity.

2.3 Vibration

Blast overpressure and vibration, inclusive of vibration impacts from construction activities has already been assessed in the previous report, therefore it has not been included in this report. Applicable criteria and assessment details are provided in the initial assessment report.

3. Construction Noise

3.1 Construction Catchment Areas

The locations of the construction stages are shown in Figure 1 and Figure 2 for construction catchment areas 1 and 2-4, respectively.

Figure 1: Construction Catchment Area 1

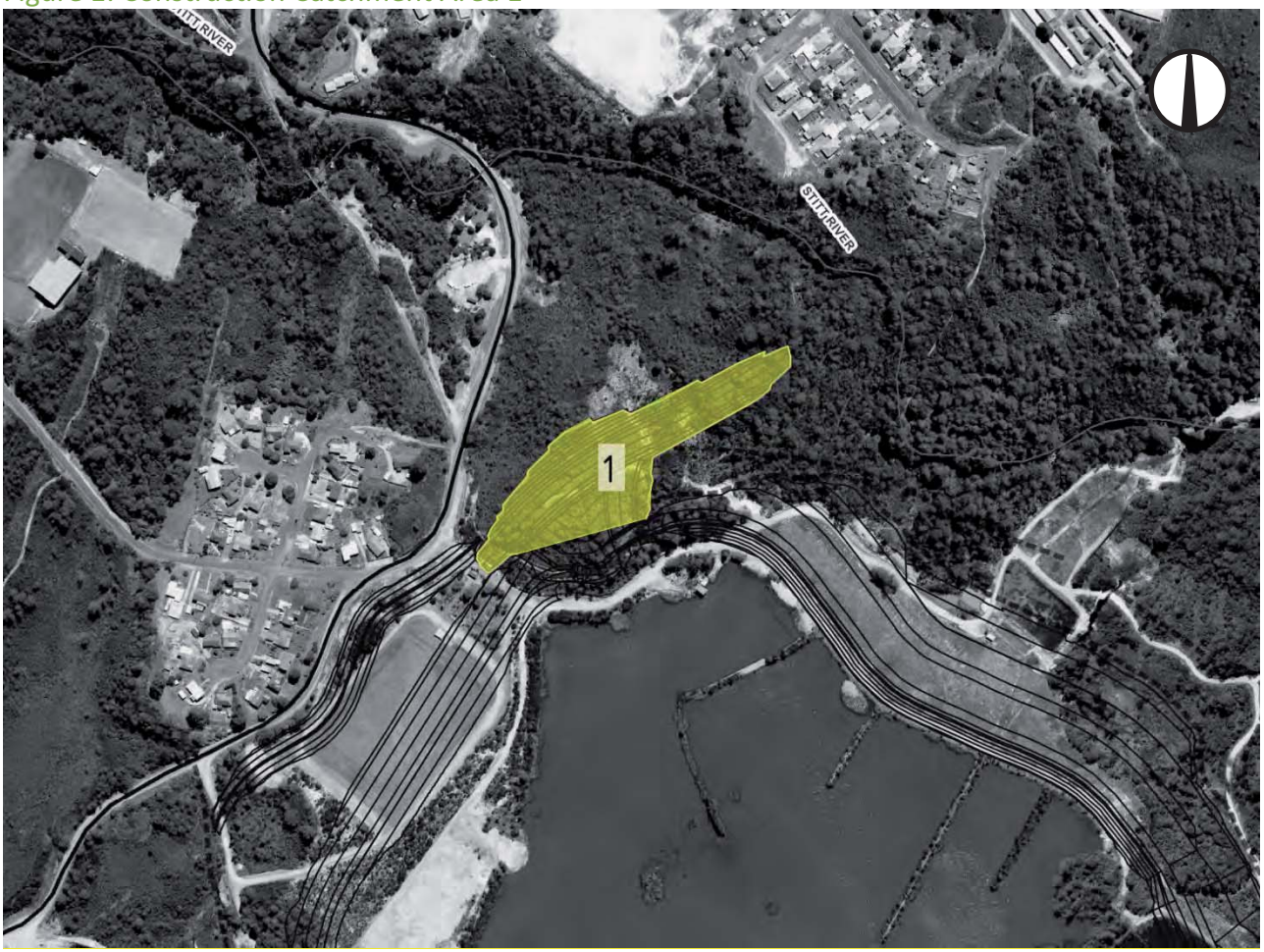
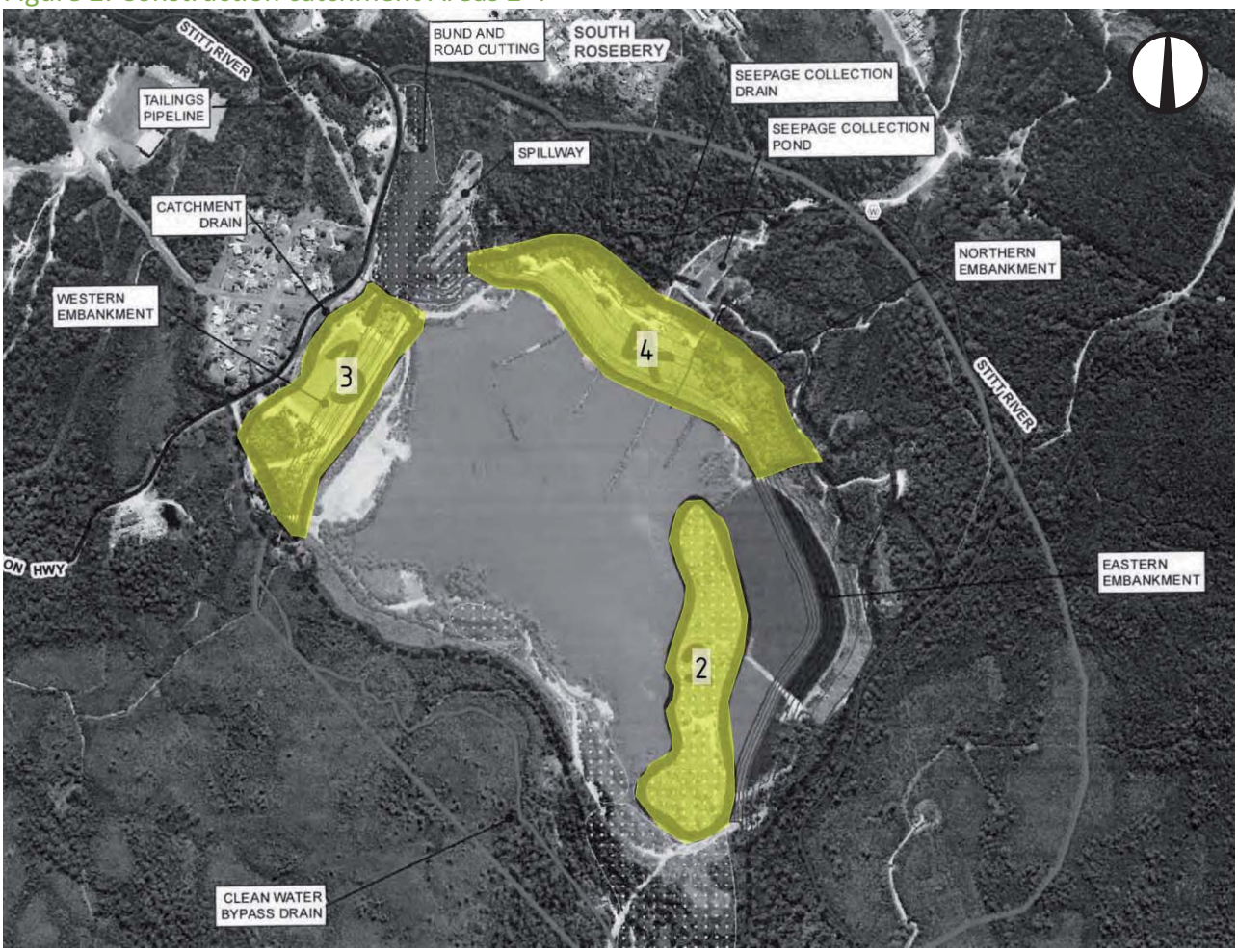


Figure 2: Construction catchment Areas 2-4



3.2 Construction activities and equipment

Table 8 presents a summary of the identified a timeline of the dominating noise-generating construction activities and a spatial reference with regards to the four construction noise catchment areas identified in Section 3.1.

Table 8: Construction activities and duration

Location reference (Figures 1 and 2)	Task Name / equipment	Weeks																											
		15/02/2016	22/02/2016	29/02/2016	7/03/2016	14/03/2016	21/03/2016	28/03/2016	4/04/2016	11/04/2016	18/04/2016	25/04/2016	2/05/2016	9/05/2016	16/05/2016	23/05/2016	30/05/2016	6/06/2016	13/06/2016	20/06/2016	27/06/2016	4/07/2016	11/07/2016	18/07/2016	25/07/2016	1/08/2016	8/08/2016		
1	**Excavate rock on Western wall and place 1 m of rockfill over the Eastern Wall**																												
	Excavator																												
	4 - 6 x ADTs																												
	Water cart																												
	Clearing and grubbing																												
	2 x Excavators																												
	2 x Tree fallers with chain saws																												
2	**Blasting and crushing**																												
	1 - 2 x Drill rigs																											Continues for 32 more weeks	
	1 - 2 x Blasts a week																												
	Crusher																												
	Screen																												
	Loader																												
	Bulldozer with ripper as required																												
	Excavator with ripper as required																												
	Excavator																												
3																													
	Strip borrow pit and Construction screening bund																												
	Excavator																												
	2x ADT																												
	Bulldozer																												
	Water cart																												
4	**Rockfill placement over the Eastern embankment**																												
	2 x Excavators																												
	3 - 4 x ADTs																												
	Bulldozer																												
	Water cart																												
	Roller																												

It should be noted that the construction activities during Stage 1, 3 & 4 are for short-term only and Stage 2 occurs for an extended period exceeding 26 weeks. As detailed in the criteria section, noise emissions from construction activities in stages 1, 3&4 are assessed against the criteria detailed in section *NSW Interim Construction Noise Guideline (ICNG July 2009).*

Stage 2 construction activities exceed the time period of over 26 weeks, and therefore the noise emissions from these activities are compared against the operational noise criteria.

Blast overpressure and vibration, inclusive of vibration impacts from construction activities has already been assessed in the previous report, therefore it has not been included in this report.

4. Noise Prediction

4.1 Methodology

Acoustics modelling software has been used to predict construction noise levels at sensitive receptors. The noise model was constructed to enable the prediction of noise levels from the various construction activities and phases. This was achieved by combining the contribution from each noise source. The noise model takes into account:

- sound power levels of each source;
- receptor locations;
- meteorological effects and attenuation due to distance; and
- ground and atmospheric absorption.

Table 9 lists the key model parameters that have been chosen to provide a conservative representation of actual conditions. Only worst case metrological conditions based on the location of construction activities have been modelled.

Table 9: Noise modelling parameters

Parameter	Setting
Software	CadnaA
Sound Propagation Algorithm	Concawe
Temperature / humidity	20 degrees C / 70% humidity
Stability Class (worst case north / worst case west)	F / F
Wind direction (worst case north / worst case west)	190 degrees / 45 degrees
Wind speed (worst case north / worst case west)	0 m/s (neutral) / 4 m/s (north) / 2 m/s (west)[1]
Parameter	$L_{Aeq(15\ min)}$
Receiver height	1.5 m

1. *Based on average yearly data.*

The location of noise sources in the acoustics model have been selected to represent the minimum separation distances from the project site to the noise sensitive receptors. Since there are a number of noise-sensitive receptors at multiple locations, and several noise sources, the modelling has included a series of variants to cover all situations; the results in some instances showing a range of construction noise levels.

4.2 Sensitive Receivers

Figure 3 shows an aerial map of the location of the proposed dam in relation to the Rosebery Township.

The residential properties potentially most affected by the construction activities from the proposed dam are located to the north and west of the dam location. The receivers to the north are named as Alec street residents and to the west are named as Giblin street residents for the purposes of this modelling.Figure 4 shows the location of residents.

Figure 3: Aerial photo of the project site and surrounds

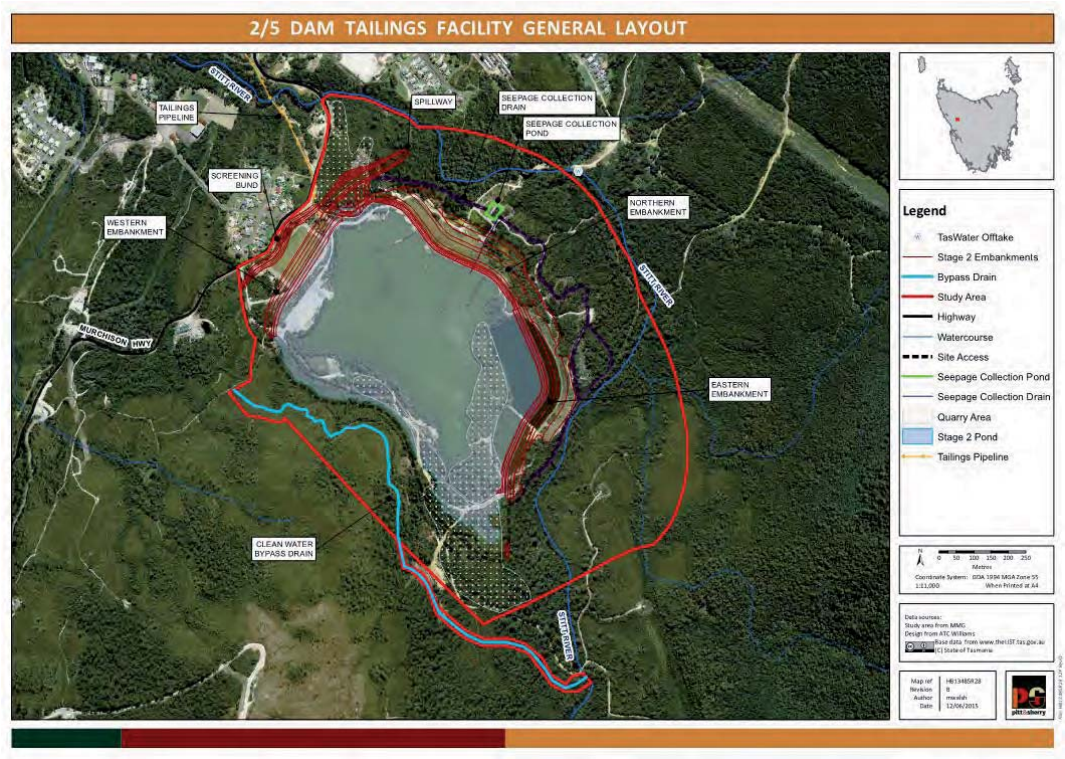


Figure 4: Aerial photo of the noise sensitive receivers in vicinity of the 2/5 dam

4.3 Construction noise modelling scenarios

Based on construction activities provided in Table 8 , worst case scenarios of activities have been identified for assessment of construction noise. Table 10 presents the identified modelling scenarios based on the proposed works description and the engineering details as confirmed as confirmed by MMG's dam design engineers.

The scenarios assume that all plant operates at the same time, at nominal loads and constantly for the 15-minute assessment period.

The modelling has focused on representing the construction works, potential overlapping of activities and locations of those activities. It has aimed to test the sensitivity of the receptors to worst-case noise generating scenarios. As such, it assumes the operation of all the equipment that would be required for the activities forming the assessment scenario. For this reason the modelling is conservative in its output.

Table 10: Construction noise scenarios

Scenario No	Activities	Noise Source	Qty
1	**Area 1:** - Rock excavation on western wall + rockfill over eastern wall	Excavator	1
		ADT	4
		Water cart	1
2	**Area 1:** - Rock excavation on western wall + rockfill over eastern wall - Clearing and grubbing	Excavator	3
		ADT	4
		Water cart	1
		Tree fallers/chain saw	2
3	**Area 1:** - Rock excavation on western wall + rockfill over eastern wall - Clearing and grubbing **Area 2:** - Blasting and crushing	Excavator	5
		ADT	4
		Water cart	1
		Tree fallers/chain saw	2
		Drill rig	2
		Blasting	2
		Crusher	1
		Screen	1
		Loader	1
		Bulldozer	1
4	**Area 1:** - Rock excavation on western wall + rockfill over eastern wall **Area 2:** - Blasting and crushing	Excavator	4
		ADT	6
		Water cart	1
		Drill rig	2
		Blasting (events a week)	2

Noise Prediction

Scenario No	Activities	Noise Source	Qty
		Crusher	1
		Screen	1
		Loader	2
		Bulldozer	1
5	**Area 2:** - Blasting and crushing **Area 3:** - Strip borrow pit and construction screening bund	Drill rig	2
		Blasting (events a week)	2
		Crusher	1
		Screen	1
		Loader	2
		Bulldozer	2
		Excavator	4
		ADT	4
		Water cart	1
6	**Area 2:** - Blasting and crushing **Area 4:** - Rockfill placement over the eastern embankment	Drill rig	2
		Blasting (events a week)	2
		Crusher	1
		Screen	1
		Loader	2
		Bulldozer	1
		Excavator	3
		ADT	2

The noise model assumes all equipment listed in each scenario will be continuously operating in a 15 minute interval period.

4.4 Equipment sound power

Typical sound power levels of the proposed equipment are based on information contained within Appendix A of Australian Standard AS 2436—2010 and WGE data base. The sound power level of equipment used in the model is presented in Table 11.

Table 11: Sound power level of equipment

Equipment	Sound Power Levels – dB(A)
Excavator	113
Dump Truck	108
Water Cart	109
Tree fallers /Chain Saw	100
Drill Rig	115
Crusher	117
Screen	114
Loader	116
Bulldozer	118

5. Results

The predicted noise levels at the Giblin Street receivers and Alec Street receivers are summarised in Table 12, for the day time activities only. It has been assumed that beeping or movement alarms of mobile plant or vehicles would not be used during these activities.

The predicted results for various construction scenarios are assessed to the nominated criteria. Scenarios 1 & 2 due to the construction activity being only up to 8 weeks is assessed to the *NSW Interim Construction Noise Guideline (ICNG July 2009).* All other scenarios are assessed to operational noise criteria as the construction activity extends to more than 26 weeks.

Table 12: Predicted Noise Levels

Scenario	Predicted construction noise levels $L_{Aeq,15min}$		Noise Criteria			
			Criteria as per NSW ICNG (less than 26 weeks)		Operational Noise Criteria as per NSW INP (more than 26 weeks)	
	Giblin Street Residents	Alec Street Residents	Giblin Street Residents	Alec Street Residents	Giblin Street Residents	Alec Street Residents
1	36-44	27-38	46	43	-	-
2	43-46	34-37	46	43	-	-
3	38-47	38-43	-	-	38	38
4	41-52	37-42	-	-	38	38
5	40-50	42-44	-	-	38	38
6	41-50	37-44	-	-	38	38

5.1 Discussion & Recommendations

The predicted noise levels for scenario 1 & 2 comply with the nominated construction noise criteria as per NSW INCG. Exceedances to the operational noise criteria *(NSW INP)* are predicted for scenarios 3, 4, 5 & 6. The predicted exceedances are mainly due the use of multiple equipment (>4) with in the same construction area at any given assessment time period of 15 minutes.

The noise modelling considers the worst case scenario with all the nominated equipment operational in the assessment period of 15 minutes and with worst case meteorological conditions. In practice this may not be the case, however it is difficult to accurately determine the equipment which may be operational at any given time for each scenario. It could be generally expected the predicted noise levels may be slightly lower due to some of the equipment being not used in the assessment interval of 15 minutes.

As detailed in *NSW Interim Construction Noise Guideline (ICNG July 2009),* where the predicted levels are greater than noise affected level ($L_{Aeq,15min}$ 46dB(A), Giblin St. & $L_{Aeq,15min}$ 43dB(A), Alec St.), the proponent should apply all feasible and reasonable work practices to meet the noise affected level.

Additionally the guideline also suggests the proponent should also inform all potentially impacted residences of the nature of works to be carried out, the expected noise levels and duration as well as contact details. Details of generic mitigation measures and construction noise management have been provided in the report.

Results

It is also noted that the predicted noise levels in all scenarios did not exceed the highly affected noise levels of 75dB(A). Therefore no further mitigations detailed in the *ICNG* are required.

It is recommended the following site specific management controls are use where possible:

- Where possible, the operation of multiple equipment (>4) shall be limited to a minimum particularly for construction area 3.
- Screening and crushing plant shall be located as far away as possible from the residences.
- Refer to the distance source to receiver attenuation detailed in Table 13. Where possible equipment shall be moved as far away as possible from the residences. Some general equipment sound power level and sound pressure levels at various distances are included in the table for reference purposes.
- Construction activities are carried out only during day time or normal hours.

Table 13: Predicted Plant Item Noise Levels dB(A)

Plant Activity/dB(A) L_w	Distance of Source to Receiver (m)							
	50	**250**	**500**	**750**	**1000**	**2000**	**4000**	**8000**
Crane 110	68	54	48	45	42	36	30	24
Backhoe 108	66	52	46	43	40	34	28	22
Compressor 100	58	44	38	35	32	26	20	14
Concrete Pump 109	67	53	47	44	41	35	29	23
Dump Truck 108	66	52	46	43	40	34	28	22
Water Tanker 109	67	53	47	44	41	35	29	23
Compactor 110	68	54	48	45	42	36	30	24
Front End Loader 116	74	60	54	51	48	42	36	30
Rock breaker 120	78	64	58	55	52	46	40	34
Excavator 113	71	57	51	48	45	39	33	27
Dozer 118	76	62	56	53	50	44	38	32
Compressor 100	58	44	38	35	32	26	20	14
On-road Truck & Dog 103	61	47	41	38	35	29	23	17

The proposed construction schedule only nominates the expected activities for a period of time, but this does not necessarily require all the nominated plant in each stage to be operational continuously for an extended period of time. However, where noisy construction activities are expected to occur for longer intervals it is recommended to notify the residents with the details of proposed noisy activities, duration of the work and a contact name, phone number and email address provided for the resident to address any complaint.

6. Construction Noise and Vibration Management

6.1 Management Plan

The construction works carried out during Scenario 4, 5 & 6 are predicted to produce the highest noise levels of all of the construction phases. The most impacted residences are Giblin Street residents.

Sporadic attended and unattended monitoring may be conducted during these stages of construction which represent the highest risk in terms of noise and vibration exposure for the surrounding community. This monitoring would typically include 15 minute measurements using a type 1 sound level meter, vibration analyzer and noise and vibration loggers. Any noise and vibration level exceedances will be reported to MMG or construction manager, which will be logged in their construction register and will be monitored until compliant noise and vibration levels are achieved through various noise and vibration mitigation measures and site management procedures.

The following flow chart (See Figure 5) can be used to assist with noise mitigation and management measures in order to comply with the standards as aforementioned.

6.1.1 Mitigation Measures (Generic)

According to AS 2436 – 2010 *"Guide to noise and vibration control on construction, demolition and maintenance sites"* the following techniques could be applied to minimize noise and vibrations exposure of the potential most affected receivers.

NOISE

If noisy processes cannot be avoided, then the amount of noise reaching the receiver should be minimized. There are two ways of achieving this, either in increasing the distance between the noise source and the receiver or in introducing noise reduction measures such as screens.

Physical methods to reduce the transmission of noise between the site works and residences, or other sensitive land uses, are generally suited to works where there is longer-term exposure to the noise. Practices that will reduce noise from the site include:

(a) Increasing the distance between noise sources and sensitive receivers.
(b) Reducing the line-of-sight noise transmission to residences or other sensitive land uses using temporary barriers (stockpiles, shipping containers and site office transportables can be effective barriers).
(c) Constructing barriers that are part of the project design early in the project to provide mitigation against site noise.
(d) Installing purpose built noise barriers, acoustic sheds and enclosures.

Screening

On sites where distance source-receiver is limited, the screening of noise may be of benefit and this should be taken into account at the planning stage.

If structures such as stores, site offices and other temporary buildings are situated between the noisiest part of the site and the nearest dwellings, some of the noise emission from the site can be reduced. If these buildings are occupied, then sound insulation measures may be necessary to protect workers occupying them.

A hoarding that includes a site office on an elevated structure offers a superior noise reduction when compared with a standard (simple) hoarding. This performance is further enhanced when the hoarding is a continuous barrier.

Storage of building materials or the placement of shipping containers between the noise source and any noise-sensitive area may also provide useful screening and the same is true of partially completed or demolished buildings. Noisy stationary plant can be put in a basement, the shell of which has been completed, provided reverberant noise can be controlled. Where compressors or generators are used in closed areas, it is necessary to ensure that the exhaust gases are discharged directly to the outside air and that there is good cross-ventilation to prevent the build-up of poisonous carbon monoxide fumes and to allow an adequate air supply to maintain efficient running.

Where such noise barriers are not practicable, a worthwhile reduction in noise can be obtained by siting the plant behind and as close as possible to mounds of earth, which may effectively screen the plant from any noise-sensitive areas. These can often be designed into the construction schedule or site arrangement for future landscaping.

Water pumps, fans and other plant and equipment that operate on a 24-hour basis may not be a source of noise nuisance by day but can create problems at night. They should therefore be effectively screened either by being sited behind a noise barrier or by being positioned in a trench or a hollow in the ground provided this does not generate reverberant noise. In such cases, however, adequate ventilation should also be ensured. Long, temporary earth embankments can provide quite effective noise screen for mobile equipment moving, for example, on a haulage road. When the earthworks are complete, the earth mounds should be removed if possible with smaller, quieter excavators. A noise barrier may be a more reliable method of noise control than the imposition of restrictions on throttle settings.

In many cases it will not be practicable to screen earthmoving operations effectively, but it may be possible to partially shield construction plant or to build-in at the early stages protective features ultimately required to screen traffic noise.

Where earth noise barriers are not a practical proposition because of lack of space, consideration should be given to the possibility of constructing temporary screens from wood or any of the materials suggested in Appendix D of AS2436:2010 “Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites”.

The usefulness of a noise barrier will depend upon its length, its height, its position relative to the source and to the listener, and the material from which it is made. A barrier designed to reduce noise from a moving source should extend beyond the last property to be protected to a distance of not less than ten times the shortest measurement from the property to the barrier. A barrier designed to reduce noise from a stationary source should, where possible, extend to a distance beyond the direct line between the noise source and the receiver to a distance equal to ten times the effective barrier height, which is the height above the direct line between source and receiver.

Reversing and warning alarms

Community complaints often involve the intrusive noise of alarms commonly used to provide a safe system of work for vehicles operating on a site. Beeper reversing alarm noise is generally tonal and may cause annoyance at significant distances from the work site.

There are alternatives capable of providing a safe system of work that are equal to or better than the traditional ‘beeper’, while also reducing environmental noise impacts. The following alternatives should be considered for use on construction sites as appropriate:

(a) Broadband audible alarms incorporating a wide range of sound frequencies (as opposed to the tonal-frequency ‘beep’) are less intrusive when heard in the neighbourhood.
(b) Variable-level alarms reduce the emitted noise levels by detecting the background noise level and adjusting the alarm level accordingly.

(c) Non-audible warning systems (e.g. flashing lights, reversing cameras) may also be employed, providing safety considerations, are not compromised.
(d) Proximity alarms that use sensors to determine the distance from objects, such as people or structures, and generate an audible alarm in cabin for the driver.
(e) Spotters or observers.

The above methods should be combined, where appropriate.

VIBRATIONS

Vibration can be more difficult to control than noise, and there are few generalizations that can be made about its control. It should be kept in mind that vibration may cause disturbance by causing structures to vibrate and radiate noise in addition to perceptible movement. Impulsive vibration can, in some cases, provide a trigger mechanism that could result in the failure of some building component that had previously been in a stable state.

It can also trigger annoyance being elevated into action by occupants of exposed buildings, and should therefore be included in planning of communication with impacted communities. It should be remembered that failures, sometimes catastrophic, can occur as a result of conditions not directly connected with the transmission of vibrations, e.g. the removal of supports from retaining structures to facilitate site access. BS 7385-2 provides information on managing ground borne vibration and its potential effects on buildings.

Where site activities may affect existing structures, a thorough engineering appraisal should be made at the planning stage.

General principles of seeking minimal vibration at receiving structures should be followed in the first instance. Predictions of vibration levels likely to occur at sensitive receivers is recommended when these are relatively close, depending on the magnitude of source of the vibration or the distance involved. Relatively simple prediction methods are available in texts, codes of practice or other standards, however it is preferable to measure and assess site transmission and propagation characteristics between source and receiver locations.

Comparison of predicted levels of vibration with preferred or regulatory levels will indicate when either more detailed predictions are required or mitigation of transmitted vibration is advisable or necessary. Guidance in measures available for mitigation of vibration transmitted can be sought in more detailed standards, such as BS 5228-2 or policy documents, such as the NSW DEC Assessing Vibration: A technical guideline.

Identifying the strategy best suited to controlling vibration follows a similar approach to that of noise—of avoidance, control at the source, control along the propagation path, control at the receiver, or a combination of these. It is noted that vibration sources can include stationary plant (pumps and compressors), portable plant (jackhammers and pavement vibrators), mobile plant, pile-drivers, tunneling machines and activities, and blasting, amongst others. Unusual ground conditions, such as a high water-table, can also cause a difference to expected or predicted results.

Figure 5: Noise Mitigation Management Flow Chart

6.2 Complaint Handling Procedures and Community Liaison

It is recommended that the contractor directly contact adjacent noise sensitive receivers and provide them with the following information:

a. The contact details for a nominated representative in order to make noise / vibration complaints.
b. Explain the timeframe for the works
c. Notify the noise sensitive receivers and the EPA in a timely manner should there need be any extension to the proposed arrangements.

To assist in the management of noise and vibration complaints various procedures are to be followed, these include:

- Clearly visible signage identifying any key personnel along with their contact details is to be erected along the perimeter of the building site including;
    - A 24 hour contact name, phone number and email address provided for the resident to address any complaint. The signage will declare; “For any enquiry, complaint or emergency relating to this site at any time please contact…”
- Give complaints a fair hearing
- Have a documented complaints process, including an escalation procedure so that if a complaint is not satisfied there is a clear path to follow
- Call back as soon as possible to keep people informed of action to be taken to address noise problems. Call back at night time only if requested by the complainant to avoid further disturbance
- Implement all feasible and reasonable measures to address the source of the complaint
- A register is to be kept by the contractor to keep a record of complaints and detail any information associated with them. The contents of the register will include:
    - The name and the address of the complaint
    - Time and date of the complaint
    - The nature of the complaint (Noise/Vibration)
    - Subsequent details
    - Remedial action undertaken

The contents of the register will be maintained and updated with any new complaint without delay.

6.3 Monitoring

6.3.1 Noise Monitoring

The following procedures will be followed by personnel suitably qualified and experienced in undertaking acoustic measurements.

Where noise monitoring is occurring due to works adjacent receiver locations or in response to a complaint, the monitoring will be undertaken at the nearest relevant sensitive receiver. If monitoring is not able to be undertaken at the receiver, a suitable representative location will be selected.

Noise monitoring shall be in accordance with Section 5 – Methods of Noise and Vibration Measurement of AS 2436-2010.

Noise monitoring will be undertaken with the microphone at a height of 1.2 to 1.5 metres from the ground, unless noise measurements are taken from a balcony or veranda, in which case the same microphone height will apply above the floor. Conditions such as wind velocity, wind direction, temperature, relative humidity and cloud cover will also be recorded during short-term noise monitoring.

All attended short-term noise monitoring will be recorded over 15 minute sample intervals. Noise levels will be recorded at a minimum rate of 8 samples per second. The following minimum A-weighted noise metrics will be reported: L_{A90}, L_{Aeq}, L_{A10}, L_{A1} and L_{Amax}. In addition to measuring and reporting overall A-weighted noise levels, statistical L_{A90}, L_{Aeq}, L_{A10} and L_{A1} noise levels will also be measured and reported in octave band centre frequencies from 31.5 Hz to 8 kHz. Where the noise monitoring is conducted within 3.5 metres of large walls or a building facade, then a reflection correction of up to -2.5 dB(A) will be applied to remove the effect of increased noise due to sound reflections from such structures.

The monitoring results will be analyzed to determine if there is any adjustment required to the extent of noise mitigation.

6.3.2 Vibration

Monitoring of construction vibration levels (if required) will be undertaken in the following situations:

- where significant vibration generating plant or equipment is operating adjacent sensitive receivers
- in response to a complaint where this is considered an appropriate response.

The following vibration monitoring procedures will be followed by personnel suitably qualified and experienced in undertaking vibration measurements. Vibration measurements shall be carried out in accordance with *Section 5 – Methods of Noise and Vibration Measurement* of *AS 2436-2010*.

Vibration monitoring at structures will be conducted at the nearest location to the works that is adjacent to the foundations of the relevant sensitive structure. If monitoring is not able to be undertaken adjacent to the structure, a suitable location at a representative location from the works will be selected.

Vibration monitoring may also be undertaken at specific setback distances from significant vibration generating plant to determine appropriate buffer distances from the plant to structures. Any vibration monitoring conducted in this manner will be undertaken on the project site such that it is representative of the actual site conditions within the project area.

Vibration monitors will include tri-axial vibration sensors measuring over a frequency range from 1 to 500 Hz, in accordance with German Standard *DIN 4150: 1999 – Part 3, Structural vibration in buildings – Effects on structures* (DIN 4150). The sensors will be mounted in general accordance with Australian Standard *AS 2775-2004 Mechanical vibration and shock – Mechanical mounting of accelerometers*. We note that there is no specific Australian Standard referring to structural vibration in buildings, the available international standard for structural vibration is DIN 4150.

7. Conclusion

This report is an addendum report to the Wood & Grieve Engineers (WGE) prepared a noise and vibration impact assessment report for MMG Rosebery in June 2015, which included a study of the potential impacts from construction and operations of the proposed 2/5 Dam located approximately 100 m east of residential areas in Rosebery, Tasmania.

This report addresses the noise impacts from the construction activities as per the request from EPA following the review of WGE noise and vibration impact assessment report for MMG Rosebery in June 2015.

The predicted noise levels presented in this report show that the residential receivers will be noise affected. These receivers will have some reaction to the construction noise as per the classifications in the NSW ICNG. Therefore, feasible and reasonable measures may be implemented to control noise emission from the site to these residential receivers as documented within the report.

The noise modelling considers the worst case scenario with all the nominated equipment operational in the assessment period of 15 minutes and with worst case meteorological conditions. In practice this may not be the case, however it is difficult to accurately determine the equipment which may be operational at any given time for each scenario. It could be generally expected the predicted noise levels may be slightly lower due to some of the equipment being not used in the assessment internal of 15 minutes.

The predicted noise levels at residential receivers in all scenarios did not exceed the highly affected noise levels of 75dB (A). Therefore no mitigation detailed in the *ICNG* are required.

Details of general and site specific mitigations and general mitigation, and noise management measures are provided in the report.

Appendix 1 - Glossary of Acoustic Terms

NOISE	
Acceptable Noise Level:	The acceptable LAeq noise level from industrial sources, recommended by the EPA (Table 2.1, INP). Note that this noise level refers to all industrial sources at the receiver location, and not only noise due to a specific project under consideration.
Adverse Weather:	Weather conditions that affect noise (wind and temperature inversions) that occur at a particular site for a significant period of time. The previous conditions are for wind occurring more than 30% of the time in any assessment period in any season and/or for temperature inversions occurring more than 30% of the nights in winter).
Acoustic Barrier:	Solid walls or partitions, solid fences, earth mounds, earth berms, buildings, etc. used to reduce noise.
Ambient Noise:	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment Period:	The period in a day over which assessments are made.
Assessment Location	The position at which noise measurements are undertaken or estimated.
Background Noise:	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level.
Decibel [dB]:	The units of sound pressure level.
dB(A):	A-weighted decibels. Noise measured using the A filter.
Extraneous Noise:	Noise resulting from activities that are not typical of the area. Atypical activities include construction, and traffic generated by holidays period and by special events such as concert or sporting events. Normal daily traffic is not considered to be extraneous.
Free Field:	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground
Frequency:	Frequency is synonymous to pitch. Frequency or pitch can be measured on a scale in units of Hertz (Hz).
Impulsive Noise:	Noise having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.

Appendix 1 - Glossary of Acoustic Terms

Intermittent Noise:	Level that drops to the background noise level several times during the period of observation.
LAmax	The maximum A-weighted sound pressure level measured over a period.
LAmin	The minimum A-weighted sound pressure level measured over a period.
LA1	The A-weighted sound pressure level that is exceeded for 1% of the time for which the sound is measured.
LA10	The A-weighted sound pressure level that is exceeded for 10% of the time for which the sound is measured.
LA90	The A-weighted level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
LAeq	The A-weighted "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
LAeqT	The constant A-weighted sound which has the same energy as the fluctuating sound of the traffic, averaged over time T.
Reflection:	Sound wave changed in direction of propagation due to a solid object met on its path.
R-w:	The Sound Insulation Rating R-w is a measure of the noise reduction performance of the partition.
SEL:	Sound Exposure Level is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound Absorption:	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter:	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level:	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level:	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise:	Containing a prominent frequency and characterised by a definite pitch.