REPORT 10-8054

Revision 0

Assessment of Proposed Rail Sidings

IPMG Printing Facility

23 Scrivener Street

Warwick Farm

PREPARED FOR

Independent Print Media Group Pty Ltd
IPMG
83 O'Riordan Street
ALEXANDRIA NSW 2015

29 JULY 2009

HEGGIES PTY LTD
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Assessment of Proposed Rail Sidings

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23 Scrivener Street

Warwick Farm

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1 INTRODUCTION

Heggies Pty Ltd (Heggies) has been engaged by Independent Print Media Group Pty Ltd (IPMG) to prepare an assessment of the noise and vibration impacts associated with the construction and operation of the proposed freight train rail sidings at the IPMG printing facilities.

This proposal acts as a modification to the Warwick Farm Printing Project which comprises of a conversion of the existing Kimberley Clark facilities by IMPG. This project has previously been assessed within Heggies Report 10-6970-R1 *'Proposed Printing Facility 23 Scrivener Street, Warwick Farm, DA Acoustical Assessment'*, dated 10 July 2008. The original Warwick Farm Printing Project was approved on 24 March 2009.

This report presents the results and findings of the noise and vibration assessment that will form part the Environmental Assessment for the rail siding upgrade project.

2 SITE LOCATION

The IPMG facilities are located at 23 Scrivener Street, Warwick Farm as shown in **Figure 1**. The site is situated at the northern end of an established industrial precinct and is bounded by RailCorp's Main South Railway Line to the west, Manning Street to the north, and Scrivener Street and industrial units to the east. Industrial premises and a car park for the Liverpool Hospital are located to the south.

Figure 1 Site Location

Image courtesy of Google Earth

The locality is currently exposed to rail generated noise through the operation of RailCorp's existing electrified passenger line. It is noteworthy that construction of the Southern Sydney Freight Line (SSFL) is currently being undertaken in the area.

The SSFL, which is located between RailCorp's passenger line and the IPMG site, will allow the unrestricted movement of freight rail traffic between Port Botany and Macarthur within a dedicated corridor.

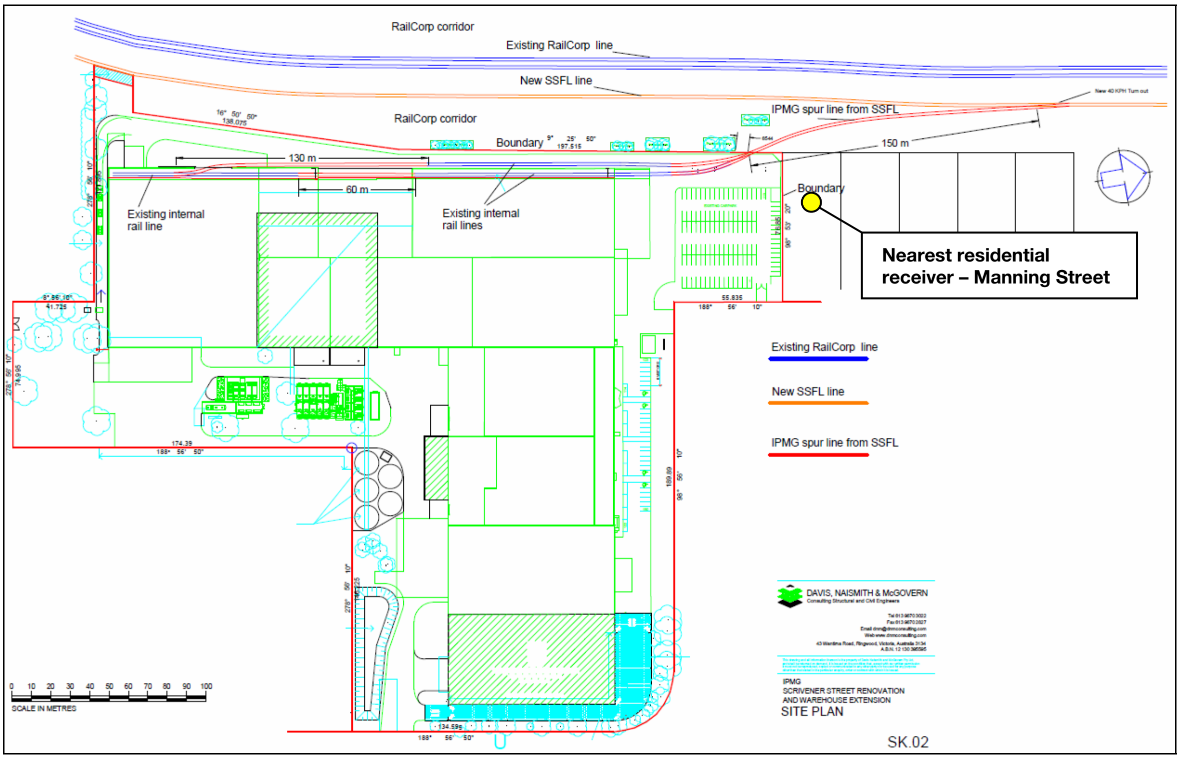
A number of large industrial and commercial operations are also currently operating in the area. These include Visy Australia, Sydney Water, Sleep Maker, Warwick Farm Racecourse (incorporating the associated stables and residential premises and ancillary buildings), numerous light industrial units, and also car parking facilities for Liverpool Hospital.

The nearest potentially sensitive receivers to the IPMG rail siding are located to the immediate north of the site on Manning Street. This area forms part of 'The Stables' residential area.

3 PROJECT DESCRIPTION

The proposal involves the modification of the existing rail sidings at the site. The existing sidings are proposed to be connected to the new Southern Sydney Freight Line (SSFL) to allow freight train access to the IPMG site for the delivery of goods. The proposed layout of the new sidings is shown in **Figure 2**.

Figure 2 Proposed Sidings



The train would follow the follow sequence of movements in order to enter the site, offload goods, turnback and leave the site (refer to **Figure 2** when reading the operational procedure):

- The freight train would access the IPMG rail line at approximately 15 kph via a turnout on the SSFL, situated approximately 150 m south of Warwick Farm Station.
- The train would then enter the IPMG site at the north-west corner through a sliding gate at a speed of 5 kph.
- The train would then proceed onto the existing IPMG siding and enter the building via a sliding door at the north-west corner.
- The train would then proceed south and stop approximately 55 m from the southern end of the building where the locomotive would be uncoupled from the wagons and allowed to proceed over a turnout (located internally).
- The southern sliding door of the building would then be opened to allow the locomotive to turnback onto the western rail line and proceed out of the building in a northerly direction.
- The locomotive would then stop, turnback and crossover onto the eastern rail line in order to be re-coupled with the opposite end of the wagons.
- The locomotive would then shunt the remainder of wagon consist (four wagons) into the building.
- The locomotive would remain attached to the wagons, but with the engine off, until the unloading phase is completed.
- Once the unloading phase is complete and notification has been received that the SSFL northbound is available, the locomotive's engine would then be started (and idle for 40 minutes) before departing the site through the boundary gate at 5 kph.

The existing sidings are noted as being internal to the IPMG building and as such, noise associated with the unloading of wagons is not anticipated to have an adverse impact on the surrounding sensitive receivers.

It is also noted that IPMG's rail operator will develop a site train handling procedure reflecting specific site requirements (ie including noise minimisation, site speed restrictions, etc).

A single freight train is proposed to access the site each day. The train would arrive at approximately 7 am and depart at around 3 pm, Monday to Friday.

Train operations on site will be conducted in a way that ensures train force noise is minimised.

4 DIRECTOR-GENERAL'S REQUIREMENTS

A Project Application for the proposed modifications to the Warwick Farm Printing Project was lodged with the Department of Planning on 5 May 2009. Following receipt of the Project Application, Director-General's Requirements (DGRs) were issued for the Environmental Assessment on 22 June 2009. The DGRs pertaining specifically to noise and vibration are reproduced below:

*"**Noise***

There are three areas of potential noise impact that need to be assessed as part of the project:

- *Construction noise impacts*
- *The operational noise impacts of the spur line*
- *The increase in the noise impact of the rail network (including the Southern Sydney Freight Line) as a result of additional rail traffic generated by the project.*

Construction Noise Impacts

The assessment of construction noise and vibration should:

1. *Identify the source, nature and scope of construction noise and vibration impacts;*
2. *Outline project details including project duration and proposed construction hours.*

   Please note, it is the Department's preference that construction works be undertaken during standard construction hours, being: Monday to Friday – 7 am to 6 pm and Saturday – 8 am to 1 pm. If works are required to be undertaken outside of these standard construction hours, the assessment will need to provide adequate justification. If necessary, out of hours works should be scheduled in the following order of preference: Saturday afternoon, Sunday, Public Holidays, weekday evenings (6 pm – 10 pm) and then night times (10 pm – 7 am weekdays and 10 pm – 8 am Saturday, Sunday and Public Holidays).
3. *Assess predicted construction noise impacts against the construction noise guidance on the Department's website, accessible at:*
   http://www.environment.nsw.gov.au/noise/constructnoise.htm
4. *Identify feasible and reasonable noise and vibration mitigation measures for construction including consideration of respite periods or curfew times for works involving high noise or vibration impacts.*
5. *The assessment should include commitments to noise and vibration monitoring during construction and to the preparation and implementation of a community consultation and notification process for the project including for 'out of hours' works.*

Operational noise impacts of the spur line:

A rail noise assessment should be undertaken in accordance with the Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects (Department of Environment and Climate Change 2007) to determine the operational noise impact of the proposed spur line. This interim guideline is designed to ensure that potential noise impacts associated with the ongoing expansion of rail developments are assessed in a consistent and transparent manner.

The assessment should include:

1. *Assess the predicted operational noise and vibration impacts on noise sensitive receivers;*
2. *Identify any reasonable and feasible noise and vibration mitigation measures;*
3. *Explain what mitigation measures will be implemented. If any measures identified under criteria 2 will not be implemented, justification for this approach is required.*

4. *Include a commitment to post-construction noise monitoring to verify that the noise level conditions applicable to the project are not being exceeded, and a commitment to implementation of feasible and reasonable noise mitigation measures should post-construction noise monitoring identify that the appropriate levels are being exceeded.*

5. *Include an assessment of any stationary noise sources such as train idling and shunting under the NSW Industrial Noise Policy (Environment Protection Authority 2000).*

Rail Traffic Generating Development

The Environmental Assessment should also include an assessment of the increase in noise impact of the rail network as a result of additional rail traffic generated by the proposal, if the project related noise increase is greater than 0.5 dB LAeq. If the project related noise increase does not exceed 0.5 dB LAeq, the following assessment is not required. The Department understands that the rail traffic generated from this project has not been considered in the Environmental Assessment for the Southern Sydney Freight Line. If required, the assessment should include:

- *The typical offset distance/s of sensitive receivers from the rail line/s likely to be affected by increased rail movements should be identified;*
- *The existing level of rail noise at the offset distance/s identified in point one above should be quantified using the noise descriptors LAeq,24hr and LAmax (95th percentile) dB(A);*
- *The cumulative rail noise level (i.e. from existing plus proposed rail movements) should be predicted using a calibrated noise model (based on predicted increased rail movements) at the offset distances identified above;*
- *The cumulative noise level should be compared against the following rail noise assessment trigger levels: LAeq,24hr 60 dB(A) and LAmax (95th percentile) 85 dB(A);*
- *Where the cumulative noise level exceeds the noise assessment trigger levels, and project related noise increase are predicted, all feasible and reasonable noise mitigation measures should be implemented. As a general principle, where the reduction of existing noise levels can be achieved through feasible and reasonable measures, a reduction in noise levels to meet the noise assessment trigger levels in the primary objective. In all cases where the LAeq noise level increases are more than 2 dB(A), strong justification should be provided as to why it is not feasible or reasonable to reduce the increase.*

NOTES:

(1) *A project related noise increase is an increase of more than 0.5 dB.*

(2) *Ideally, the geographical extent of the rail noise assessment should be to where project related rail noise increase are less than 0.5 dB. The roughly equates to where project related rail traffic represents less than 10% of total line/corridor rail traffic.*

(3) *General guidance on the concept of 'feasible and reasonable' can be obtained by reference to the Department's guidelines: 'Industrial Noise Policy' and 'Environmental Criteria for Road Traffic Noise'. However, in the context of rail noise, consideration of feasible and reasonable noise mitigation measures should extend, but not necessarily be limited to:*

    - *The use of best practice rolling stock including only locomotives that have received an approval to operate on the NSW rail network in accordance with the noise limits L6.1 to L6.4 in RailCorp and ARTC Environmental Protection Licences or a Pollution Control Approval issued pursuant to the former Pollution Control Act 1970.*
    - *Movement scheduling to limit movements during more sensitive times to the extent practicable*
    - *Using noise barriers and acoustic treatments."*

5 EXISTING ACOUSTIC ENVIRONMENT

5.1 Surrounding Receivers

The nearest potentially sensitive receiver locations in relation to the proposed rail siding are the Manning Street residences to the immediate north of the IPMG development. The nearest residence is approximately 15 m from the proposed location of the rail siding (refer **Figure 2** and **Figure 3**).

It is noted that the residences on Manning Street form part of 'The Stables' residential area which is associated with Warwick Farm Racecourse. To occupy a house in this area the resident must own and train horses at the racecourse. Each residence therefore has its own on-site stables.

When considering the nearest affected houses on Manning Street, it was noted during the on-site survey that all the buildings which face directly on to the railway corridor are stables and as such, are not of residential use.

Furthermore, it is noted that the daily routine of residents in 'The Stables' includes early morning training sessions with their horses, which typically begin at around 3:30 am.

During the onsite inspection it was observed that construction works were being performed on the nearest affected residential plot to the IPMG site, as is shown in **Figure 3** (by the red line) and in **Figure 4**.

Figure 3 Residences under Construction

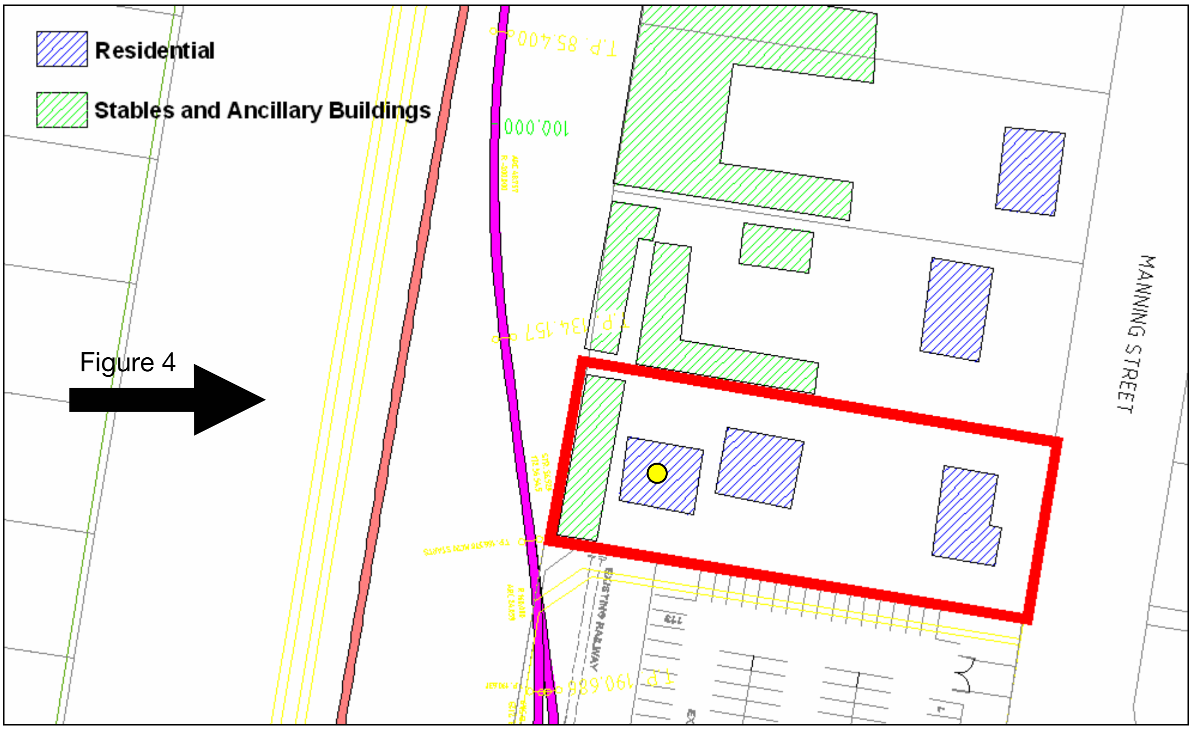


Figure 4 Residences under Construction

Three 2-storey houses are currently being built on the plot, with a building (approximately 4 m in height) on the western boundary of the site for stabling horses. The horse stabling building would act as an effective noise barrier for rail generated noise.

5.2 Ambient Noise Survey

5.2.1 Ambient Noise Monitoring

A survey to quantify and characterise the existing ambient noise environment immediately surrounding the site was carried out at two locations, as shown in **Figure 1**.

The two locations selected were:

- Location 1 – South-western corner of the site. Noise levels at this location included contributions from plant noise emissions from on-site construction works, from the ancillary hospital buildings to the south and from rail movements on the Main South railway line.
- Location 2 – Manning Street. Noise levels at this location were dominated by road traffic on Manning Street, vehicle movements from the ARTC construction compound located at the northern car park and general industrial noise from the surrounding area.

The measurements were carried out using ARL Environmental Noise Loggers Type EL 316 between Monday 26 May and Tuesday 3 June 2008. The noise loggers continuously sampled levels over the entire measurement duration, and calculated relevant statistical indices for each 15 minute period. The noise logger serial numbers are included in **Table 1**. The noise loggers carry current manufacturers' calibration certification.

Table 1 Acoustic Instrumentation Schedule

Location	Description	Type or Class	Serial Number
1	ARL 316 Environmental Noise Logger	Type 1	16-207-042
2	ARL 316 Environmental Noise Logger	Type 1	16-207-046

5.2.2 Survey Results

The results of the noise monitoring have been processed with reference to the procedures contained in the NSW Government's *'Industrial Noise Policy'* (Jan 2000) (INP), which is administered by the Department of Environment and Climate Change (DECC). The results establish noise levels which are representative of receiver locations relevant to the proposed development.

The Rating Background Noise Level (RBL) is the background noise level used for assessment purposes at the nearest potentially affected receiver (see **Appendix A** for a description of the acoustic terminology). It is the median of the daily background noise levels during each assessment period, being daytime, evening and night-time. RBL levels ($L_{A90(15minute)}$) and L_{Aeq} noise levels are presented in **Table 2** and also illustrated in **Appendix B**.

Table 2 Measured Ambient Noise Levels

Location	Noise Level - dBA re 20 µPa					
	Daytime 7.00 am – 6.00pm		Evening 6.00 pm – 10.00 pm		Night-time 10.00 pm – 7.00 am	
	RBL	L_{Aeq}	RBL	L_{Aeq}	RBL	L_{Aeq}
1	45	62	48	63	46	63
2	43	65	41	61	37	59

6 CONSTRUCTION NOISE ASSESSMENT

The two primary noise metrics used to describe construction noise emissions in the modelling and assessments are:

$L_{A10(15\ minute)}$ the 'Average Maximum Noise Level' during construction activities. This parameter is used to assess the construction noise impacts.

L_{A90} the 'Background Noise Level' in the absence of construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods respectively. The $L_{A10(15\ minute)}$ construction noise goals are based on the L_{A90} background noise levels.

The subscript 'A' indicates that the noise levels are filtered to match normal human hearing characteristics (i.e. A-weighted).

6.1 Construction Noise Goals

The DECC's '*Environmental Noise Control Manual'* provides guidelines for assessing the noise impact from construction sites. The DECC's general approach to the control of noise from construction sites involves the following:

- **Limiting hours of operation for 'noisy' construction work** - The DECC normally limits construction works to the following time periods: 7.00 am to 6.00 pm from Monday to Friday, 8.00 am to 1.00 pm on Saturdays and no work on Sundays and Public Holidays.
- **Use of silenced equipment** - All practical measures should be used to silence equipment, particularly in instances where extended hours of operation are required.

- **Compliance with noise emission objectives**:
  - For a construction period of up to 4 weeks duration, the L_{A10} noise level when measured over a period of not less than 15 minutes should not exceed the L_{A90} background noise level by more than 20 dBA.
  - For a construction period of between 4 and 26 weeks, the L_{A10} noise level should not exceed the L_{A90} background noise level by more than 10 dBA.
  - For a construction period of greater than 26 weeks, the L_{A10} noise level should not exceed the L_{A90} background noise level by more than 5 dBA.

As the overall duration of the proposed construction program is anticipated as being 5 weeks, the L_{A90} background + 10 dBA noise goal is applicable to the residential receiver locations. The $L_{A10(15\ minute)}$ construction noise goal is based on the local L_{A90} background noise level during the relevant time period.

Unattended background noise monitoring was undertaken during June 2008 in the vicinity of the proposed construction works. The noise monitoring undertaken at Location 2 is considered most representative of the noise environment at the nearest residential receivers (located on Manning Street). **Table 3** presents the relevant L_{A10} construction noise objective for the receivers together with the unattended noise logging results on which the construction noise objective was based.

Noise objectives are only presented for the daytime period as construction works are proposed to be restricted to 7 am to 5 pm, Monday to Friday.

Table 3 Summary of LA10 Construction Noise Objectives

Receiver Location	Typical Distance to Site (m)	LA90 Noise Level (dBA)	Daytime LA10 Construction Noise Objective (dBA)
Nearest receiver on Manning Street	20	43	53

6.2 Description of Noise Intensive Construction Works and Modelling

6.2.1 General Approach to Noise Modelling

Calculations have been performed in order to assess the potential impact of construction noise at the nearest residential receiver on Manning Street. The calculations consider the local ground topography, location of buildings and representative noise sources as discussed below. At the relatively small distances between construction sites and receivers, weather effects have little influence on noise propagation and hence neutral meteorological conditions were assumed.

The calculated construction noise levels will inevitably depend on the number of plant items and equipment operating at any one time and their precise location relative to the receiver of interest. Noise levels have been calculated for both ‘typical’ construction activities and ‘worst case’ activities, assuming plant operating in the area closest to the respective receivers.

6.2.2 Typical Sound Pressure Levels

Sound pressure levels for typical items of plant required to carry out the works are listed in **Table 4**. These noise levels are representative of modern plant operating with noise control measures in good condition.

Table 4 Sound Pressure Levels for Plant Items

Item	Typical Plant Type	Noise Level at 7 m (dBA)	
		Typical Maximum Level	Noise Level for Modelling (L_{A10})
Heavy Rockbreaker	On excavator KATO 750	103	98
Excavator KATO	KATO 750 (14 tonne)	86	83
Bobcat Skidsteer	-	85	82
Backhoe/FE Loader	Wheeled	86	82
Dump Truck	15 tonne	83	82
Product Truck	12-15 tonne	83	82
Generator	Diesel	79	78
Concrete Saw	-	95	92
Jackhammer/Breaker	Hand held	88	84
Concrete Truck	-	88	85
Core Drill	-	77	74
Twin Drum Roller	2.5 tonne	82	80

6.2.3 Construction Noise Modelling Scenarios

On the basis of the proposed construction methodology it is anticipated that the following scenarios would be apparent:

Scenario 1 - Excavation and Breaking Concrete

- Front End Loader
- 14 Tonne Excavator w/ Hammer
- Excavator
- Bobcat Skidsteer
- Concrete Saw
- Medium Breaker
- Core Drill

Scenario 2 - Compaction/Capping Layer Preparation

- 2.5 tonne Twin Drum Roller
- Light Rigid Truck
- Bobcar Skidsteet

Scenario 3 - Track Laying/Installation and Concrete Works

- Rigid Dump Truck
- Concrete Truck

6.3 Construction Noise Assessment

6.3.1 Construction Site Noise

The predicted typical and worst-case construction noise levels at the nearest potentially affected receiver on Manning Street are presented in **Table 5**.

The table presents predicted noise levels for when works are undertaken at the nearest and farthest point from the receiver.

Table 5 Predicted Noise Levels at Nearby Receivers

Location	Distance of Works to Receiver	L_{A10} Noise Objective (dBA)	Predicted Typical /Worst-Case L_{A10} for each Scenario (dBA) [1]		
			Scenario 1	Scenario 2	Scenario 3
Nearest Receiver on Manning Street	20 m (closest)	53	82/93	77/79	76/81
	75 m (furthest away)		71/82	65/79	64/81

Note 1 The range of noise levels presented in each cell of the table represents the typical and worst case L_{A10}, based on the equipment described in **Table 4**. Lower levels would occur at any given receiver in between periods of intensive works.

The above predictions indicate that noise levels during many of the activities will exceed the background L_{A90} + 10 dBA objective. Exceedances of this nature are reasonably common on projects involving works in close proximity to sensitive receivers. It is worth noting that existing L_{A10} noise levels at the noise logger locations were in the order of 70 dBA, likely to be the result of industrial, rail and road traffic noise.

The noise intensive activities are unlikely to occur on a continuous basis and hence periods of lower construction noise levels are likely to occur during lower intensity works.

It is also noteworthy that the SSFL is currently being constructed immediately adjacent to the western boundary of the IPMG site. These works would be undertaken approximately 35 m from the receivers on Manning Street. The noise impacts from IPMG related construction works would be expected to be comparable to the SSFL works.

The extent of the predicted construction noise goal exceedances does not indicate that the project should not proceed, but rather highlights the need to ensure all feasible and reasonable measures are implemented to minimise the impacts. The contractor(s) should prepare and implement a site-specific Construction Noise and Vibration Management Plan including the measures listed in **Section 8** and any other initiatives identified to minimise the potential noise impacts.

The above assessment assumes that all constant sources of noise (eg generators) would be suitably positioned as far away from nearby residences as possible and, where possible, be shielded from residences by other construction related items such as site offices and sheds.

6.3.2 Noise from Construction Traffic on Local Roads

Whilst there would be a requirement for construction traffic to access the IPMG site via Manning Street, the daily numbers are expected to be low. When considering the industrial nature of the area and the fact that delivery trucks associated with the numerous industrial facilities in the area already use Manning Street on a frequent basis, the impact of construction trucks is expected to be negligible.

Notwithstanding the above, noise from idling trucks near construction sites can impact on amenity in some instances. For this reason, it is recommended that the idling of trucks is minimised where practicable particularly when in the vicinity of residences, and that engines should be shut down when possible.

6.4 Potential Noise Mitigation

In view of the predicted construction noise goal exceedances, noise mitigation is recommended to minimise the impact of construction noise at nearby residential receivers.

It will be necessary for the contractor(s) to prepare and implement a site-specific Construction Noise and Vibration Management Plan (CNVMP) including consideration of the measures listed in **Section 8** and any other initiatives identified to minimise the noise impacts.

7 CONSTRUCTION ASSESSMENT - VIBRATION

7.1 Operational Vibration Metrics

The three primary metrics used to describe construction vibration are:

PPV 'Peak Particle Velocity' evaluated at the building footings and used to assess the risk of damage to structures.

V_{rms} 'Root mean squared vibration velocity', a vibration parameter used to assess human response to continuous or intermittent vibration.

eVDV 'Estimated Vibration Dose Value', the overall vibration exposure assessed over the daytime or night-time period to assess human response to intermittent vibration.

7.2 Construction Vibration Goals

The DECC's *'Assessing Vibration: a technical guideline'* is based on the guidelines contained in British Standard BS 6472-1992. BS 6472 refers only to the human comfort criteria for vibration, hence the vibration due to construction has been assessed in accordance with the German Standard DIN 4150 Part 3-1999 and British Standard BS 7385 Part 2-1993. These are the standards normally used for assessing the risk of vibration damage to structures.

For continuous vibration or repetitive vibration with potential to cause fatigue effects, DIN 4150 provides the following PPV values as safe limits, below which even superficial cosmetic damage is not to be expected:

- 10 mm/s for commercial buildings and buildings of similar design.
- 5 mm/s for dwellings and buildings of similar design.
- 2.5 mm/s for buildings of great intrinsic value (eg heritage listed buildings).

For short term vibration events (i.e. those unlikely to cause resonance or fatigue), DIN 4150 offers the criteria shown in **Table 6**. These are maximum levels measured in any direction at the foundation <u>or</u> in the horizontal axes, in the plane of the uppermost floor.

Table 6 DIN 4150 - Structural Damage - Safe Limits for Short Term Building Vibration

Group	Type of Structure	Peak Particle Velocity (mm/s)			
		At Foundation			Plane of Floor of Uppermost Storey
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz [1]	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 at 10 Hz increasing to 40 at 50 Hz	40 at 50 Hz increasing to 50 at 100 Hz	40
2	Dwellings and buildings of similar design and/or use	5	5 at 10 Hz increasing to 15 at 50 Hz	15 at 50 Hz increasing to 20 at 100 Hz	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (eg buildings that are under a preservation order)	3	3 at 10 Hz increasing to 8 at 50 Hz	8 at 50 Hz increasing to 10 at 100 Hz	8

Note 1: For frequencies above 100 Hz the upper value in this column should be used.

These levels are 'safe limits', up to which no damage due to vibration effects has been observed for the particular class of building. 'Damage' is defined by DIN 4150 to include even minor non-structural effects such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls.

Human comfort is normally assessed with reference to the NSW Department of Environment and Conservation document '*Assessing vibration: a technical guideline*' which is based on British Standard BS 6472-1992 '*Evaluation of human exposure to vibration in buildings (1–80 Hz)*'. For daytime activities, the limiting objective for continuous vibration at residential or commercial receivers is V_{rms} 0.4 mm/s.

BS 6472-1992 also contains a formula for the Vibration Dose Value (VDV), which can be used to evaluate intermittent vibration or vibration levels that vary significantly over time. As the vibration approaches continuous, this VDV trends to the continuous vibration criterion.

7.3 Ground Vibration - Safe Working Distances for Intensive Activities

As a guide, safe working distances for typical items of vibration intensive plant are listed in **Table 7**. Safe working distances are quoted for both 'cosmetic' damage (refer DIN 4150) and human comfort (refer DECC Guideline).

The highest vibration impact is likely to occur during 'Scenario 1 - Excavation and Breaking Concrete' (refer **Section 6.2.3**). The nearest affected structure is the stables building to the north of the site, at an approximate worst-case distance of 10 m away from the construction works. The nearest affected residential receiver is approximately 20 m away.

Table 7 Recommended Safe Working Distances for Vibration Intensive Plant

Plant Item	Rating/Description	Safe Working Distance	
		Cosmetic Damage (DIN 4150)	**Human Response (DECC Guideline)**
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7m	23m

The safe working distances presented in **Table 7** are indicative and will vary depending on the particular item of plant and local geotechnical conditions. The safe working distances apply to typical buildings and typical geotechnical conditions.

As the nearest effected structure to the construction works is situated approximately 10 m away, **Table 7** indicates that exceedances of the structural damage criteria (DIN 4150) are unlikely to occur. Exceedance of the human response criteria may however occur.

7.4 Assessment of Construction Vibration Impact

The use of the 14 tonne excavator with hammer and/or the medium breaker has the potential to exceed the human comfort vibration criteria. It is therefore recommended that when working in proximity to the nearest receiver on Manning Street (northern end of the works), equipment is to be carefully selected to reduce the potential vibration impact (for example by using a smaller excavator) insofar as possible (without compromising the ability to complete the required task).

It will also be necessary to implement the measures listed in **Section 8** for the CNVMP and any other initiatives identified to minimise potential vibration impacts.

8 CONSTRUCTION NOISE AND VIBRATION MANAGEMENT PLAN

It will be necessary for the contractor(s) to prepare and implement a site-specific Construction Noise and Vibration Management Plan (CNVMP) including consideration of the measures listed below and any other initiatives identified to minimise the potential noise impacts.

- Noise and vibration intensive construction works would be carried out during normal construction hours wherever practicable. Where works involving the operating line need to be carried out during track possessions, noise intensive activities should be scheduled to occur during the daytime, where possible.
- Quietest available plant suitable for the relevant tasks would be used.
- The duration of noise and vibration intensive activities would be minimised insofar as possible.
- Where feasible and reasonable, site hoardings or temporary noise barriers would be used to provide acoustic shielding of noise intensive activities.
- Rock breakers (if required) would be of the 'Vibro-silenced' or 'City' type, where feasible and reasonable.
- Activities resulting in highly impulsive or tonal noise emission (eg rock breaking) would be limited to 8 am to 12 pm Monday to Saturday and 2 pm to 5 pm Monday to Friday (except where essential during track possessions) or when otherwise approved.
- Noise and vibration awareness training would be included in inductions for site staff and contractors.

- Noise generating plant would be orientated away from sensitive receivers, where possible.
- Notification would be provided to residents via newspaper advertising and letterbox drops, advising of the nature and timing of works, contact number and complaint procedures.
- Noise and vibration monitoring would be carried out to confirm that noise levels do not significantly exceed the predictions and that noise levels of individual plant items do not significantly exceed the levels shown in **Table 4**.
- Deliveries would be carried out within standard construction hours.
- Non-tonal reversing beepers or equivalent would be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
- Trucks would not be permitted to queue near residential dwellings with engines running.

9 OPERATIONAL NOISE ASSESSMENT

The primary noise metrics used to describe railway noise emissions in the modelling and assessments are:

L_{Amax} the 'Maximum Noise Level' occurring during a train passby noise event.

$L_{Aeq(24\ hour)}$ the 'Equivalent Continuous Noise Level', sometimes also described as the 'energy-averaged noise level'. The $L_{Aeq(24hour)}$ may be likened to a 'noise dose', representing the cumulative effects of all the train noise events occurring in one day.

$L_{Aeq(15\ hour)}$ the Daytime 'Equivalent Continuous Noise Level'. The $L_{Aeq(15hour)}$ represents the cumulative effects of all the train noise events occurring in the daytime period from 7.00 am to 10.00 pm.

$L_{Aeq(9\ hour)}$ the Night-time 'Equivalent Continuous Noise Level'. The $L_{Aeq(9hour)}$ represents the cumulative effects of all the train noise events occurring in the night-time period from 10.00 pm to 7.00 am.

L_{AE} the 'Sound Exposure Level', which is used to indicate the total acoustic energy of an individual noise event. This parameter is used in the calculation of L_{Aeq} values from individual noise events.

The subscript 'A' indicates that the noise levels are filtered to match normal human hearing characteristics (i.e. A-weighted).

9.1 Operational Noise Goals (IGANRIP)

The airborne noise assessment is required to be undertaken in accordance with the requirements of the DECC's *'Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects'* (IGANRIP). The noise design goals contained within this guideline are expressed as non-mandatory 'trigger levels', which if exceeded will trigger the need to consider feasible and reasonable noise mitigation measures.

For airborne noise created by the operation of surface track, trigger levels are provided for rail infrastructure projects including a 'new railway line' or 'redevelopment on an existing railway line'. The noise trigger levels for residential receiver locations are provided in **Table 8**.

Table 8 Airborne Noise Trigger Levels for Surface Track - Residential

Type of Development	Residential noise trigger levels (dBA)		
	Day (7 am to 10 pm)	**Night (10 pm to 7 am)**	**Commentary**
New rail line development	Development increases existing rail noise levels AND Resulting rail noise levels exceed:		These numbers represent levels of noise that trigger the need for a rail infrastructure project to conduct an assessment of potential noise impacts. An increase in existing rail noise levels is taken to be an increase of 2.0 dB or more in LAeq in any hour or an increase of 3.0 dB or more in LAmax.
	60 LAeq(15hour) 80 LAmax	55 LAeq(9hour) 80 LAmax	
Redevelopment of existing rail line	Development increases existing rail noise levels AND Resulting rail noise levels exceed:		
	65 LAeq(15hour) 85 LAmax	60 LAeq(9hour) 85 LAmax	

The noise trigger levels in **Table 8** refer to noise from the proposed rail operations only and do not include ambient noise from other sources such as major roads and industry. However, they refer to noise from all rail traffic at the receiver location, not only noise due to the specific rail project under consideration.

The noise levels are evaluated externally at a distance of 1 m from the most affected building facade. 'Residential' typically means any residential premises located in a zone as defined in a planning instrument that permits new residential land use as a primary use.

The LAmax noise level refers to the 95th percentile train passby event (ie, 5% of train passbys are permitted to exceed the noise trigger levels). The absolute maximum event is not used for design, as it cannot be precisely defined and would be a highly infrequent event.

For redeveloped rail projects, the noise trigger levels apply immediately after operations commence and for projected traffic volumes to a period over an indicative period into the future that represents the expected typical level of rail traffic usage (eg 10 years or a similar period into the future). For this project, the 'redevelopment of an existing rail line' trigger levels are appropriate.

9.1.1 Daytime/Night-time Periods

It is anticipated that freight trains would arrive at the IPMG site at around 7.00 am. As the night-time IGANRIP period ends at 7.00 am there is the possibility that trains could arrive before 7.00 am and hence be in the more sensitive night-time period.

It is however noteworthy that, as described in **Section 5.1**, the residences to the north of the IPMG site are associated with the Warwick Farm Racecourse. The daily routine for these residences includes the early morning training of horses which typically begins at about 3.30 am.

The application of the night-time criteria to trains arriving in the shoulder period slightly before 7.00 am may be considered to be unduly stringent as the majority of residents would have already been awake for several hours.

9.1.2 Operational Noise Modelling

A detailed spreadsheet based noise model has been constructed to assess the operational phase of the IPMG rail siding, using the Nordic algorithm. The IGANRIP operational assessment has been used to assess the potential noise impacts from the operation of IPMG freight trains operating on the proposed IPMG rail line up to the site boundary. Once the train is within the site boundary, the Industrial Noise Policy is relevant. This assessment has is presented in **Section 9.2**.

9.1.3 Passenger and Freight Rail Services

Noise emissions from suburban electric passenger trains are predominantly caused by the rolling contact of steel wheels on steel rails. Even under ideal conditions, noise would occur as a result of the rolling contact and the finite roughness of typical wheel and rail running surfaces. Other noise sources on electric passenger trains, (such as air-conditioning plant and air compressors) are generally insignificant when compared with the wheel-rail interaction, unless the train is travelling at a very low speed or is stationary.

In addition to general rolling noise, freight movements can also generate high levels of engine and exhaust noise. This noise is dependant on a number of factors including the track gradient, number of locomotives, train length, train load, momentum and speed. At low speeds, the noise from the locomotive engine and exhaust is usually dominant, and at high speeds, the general rolling noise is usually dominant.

The input data used in the modelling for this project has been adapted to ensure that the calculated noise levels accurately reflect local conditions (ie CityRail trains, etc). The reference noise levels used for the noise modelling were based on attended noise measurements undertaken adjacent to the railway corridor on other projects.

Table 9 Reference Noise Levels used for Modelling

Train Types	Reference Conditions	LAmax (dBA)	LAE (dBA)
Millennium/Tangara	15 m, 80 km/h	85	88
Double Deck Suburban	15 m, 80 km/h	87	91
Freight Locomotive Engine Noise (per loco)	15 m, 50 km/h low notch setting	78	76
	15 m, 50 km/h medium notch setting	85	82
Freight Wagons (per 1000 m)	15 m, 80 km/h	93	100

9.1.4 Noise Modelling Inputs

Rail Traffic Data

The train numbers for the existing RailCorp line, the new Southern Sydney Freight Line and for the IPMG rail line are presented in **Table 10**. Both the existing and future scenarios are presented, as required by IGANRIP.

Table 10 Train Numbers

Line	Train Movements (Day/Night)			
	Existing (2008)		Future (project opening plus 10 years)	
	Up	Down	Up	Down
RailCorp Line	110/30	113/30	110/30	113/30
SSFL	-	-	11/5	9/8
IPMG Rail Line	-	-	1/0	1/0

Note 1 The daytime period is 7 am - 10 pm and the night-time period is 10 pm – 7 am.

Existing rail traffic data for the year 2008 noise model was based on the current City Rail timetable (dated May 2006, updated February 2007). Train speeds for the RailCorp line were derived from site observations and aerial photography. Heggies has been informed that the SSFL in this locality will have a maximum speed of 80 km/h, with freight trains assumed to be operating on a medium notch setting.

As shown in the table, it is anticipated that a maximum of one train would access the IPMG facilities per day at the opening year. This train would access the site at approximately 7 am and depart at around 3 pm. The number of IPMG related freight trains is not expected to increase for the future assessment year (10 years after opening).

The existing 2008 rail traffic data for the RailCorp Line and the opening year data for the SSFL has been replicated for the assessment year in order to demonstrate the increase in rail noise levels as a result of the IPMG rail line upgrade project.

Buildings and Receiver Locations

A visual inspection of existing buildings adjacent to the project area was undertaken in order to determine the occupancy type, number of levels, number of receivers per level, address and receiver height above ground.

9.1.5 Validation of the Computer Model

To validate the noise model the noise taken at the unattended measurement location that was closest to the railway corridor have been made use of.

A summary of the measured noise levels, together with the modelling results for the same location is provided in **Table 11.** The noise model validation for the L_{Aeq} assessment parameter has been compared with the $L_{Aeq(24hour)}$, representing the equivalent continuous noise level of all trains during a typical 24 hour period.

Table 11 Measured vs Modelled Noise Levels - Electric Passenger Trains

Measurement Location	Number of Train Events	Measured Noise Level $L_{Aeq\ (24hour)}$ (dBA)	Modelled Noise Levels $L_{Aeq(24hour)}$ (dBA)	Difference - Modelled minus Measured (dBA)
1	283	62	61	-1

Note 1 Modelled noise levels based on reference levels presented in **Table 9**.

On the basis of the above results, it is concluded that the noise model is providing satisfactory noise levels.

9.1.6 Noise Modelling Scenarios

In order to assess the operational noise emissions for the IPMG rail sidings, three noise modelling scenarios have been considered:

- **Scenario 1** - Existing Situation (2008), inclusive of:
  - RailCorp Passenger Trains
- **Scenario 2** – Future Situation A (Project Opening Year & 10) , inclusive of:
  - RailCorp Passenger Trains and SSFL Freight Trains
- **Scenario 3** - Future Situation B (Project Opening Year & 10) , inclusive of:
  - RailCorp Passenger Trains, SSFL Freight Trains and IPMG Freight Trains

9.1.7 Prediction of Operational Noise Emissions

Using the above scenarios, noise levels have been predicted at the nearest potentially affected sensitive receiver to the IPMG rail sidings. The results are presented in **Table 12.**

Table 12 Operational Noise Emissions (IGANRIP)

Location	Scenario 1 – Existing (dBA)			Scenario 2 – Future A (dBA)			Scenario 3 – Future B (dBA)		
	LAeq(15hr)	LAeq(9hr)	LAmax	LAeq(15hr)	LAeq(9hr)	LAmax	LAeq(15hr)	LAeq(9hr)	LAmax
Manning Road	56	53	78	60	59	86	60	59	86

The above results indicate that the combined operations of the IPMG rail siding together with RailCorp's passenger line and the SSFL (Scenario 3) would not increase the future $L_{Aeq(15hour)}$, $L_{Aeq(9hour)}$ or the L_{Amax} noise levels compared to the operation of RailCorp's passenger line and the SSFL (Scenario 2).

It is noted that the above predictions assume a direct line of sight from the receiver to the various rail lines. The noise levels **do not** include the potential noise attenuation that the stables building may offer. This methodology has been utilised as the stables building was in an incomplete state at the time of writing and accurate dimensions are not known.

Notwithstanding the above, a building of this type would be expected to provide a further attenuation of around 15 dBA to the noise levels presented in **Table 12**.

When taking the above statement into consideration, the results presented in **Table 12** are predicted to comply with the residential IGANRIP trigger levels presented in **Table 8**. Furthermore, there is no increase in future $L_{Aeq(15hour)}$, $L_{Aeq(9hour)}$ or L_{Amax} noise levels as a result of the project, and as such, no need for further assessment of mitigation.

The above assessment also shows that the project related noise increase is less than the +0.5 dBA stipulated in the DGR's (refer **Section 4**) and as such, a detailed assessment of the impact of rail noise is not required.

9.2 On-Site Operational Noise Sources (INP)

The operation of freight trains whilst within the IPMG site boundary has been assessed in accordance with the DECC's *'Industrial Noise Policy'* (INP). The operational activities expected to be performed on-site include idling locomotives and shunting operations.

9.2.1 Intrusiveness and Amenity Assessment

To assess noise of an industrial nature, the INP procedures make use of the Rating Background Level (RBL) and ambient L_{Aeq} noise levels during daytime, evening and night-time periods.

The RBL is the background noise level used for assessment purposes and represents the median of the daily background (L_{A90}) noise levels during each assessment period. The L_{Aeq} noise level represents the energy-averaged noise level during each assessment period.

The INP assessment procedure for industrial noise sources has two components:

- Controlling the intrusive noise impacts in the short-term for residents
- Maintaining noise level amenity for particular land uses for residences and other land uses

The **intrusive** $L_{Aeq(15minute)}$ noise goal for residential receivers limits noise emission levels to the RBL plus 5 dBA.

The **amenity** noise goal depends upon existing ambient LAeq noise levels within a locality and their relation to the acceptable noise levels specified in **Table 13**. For example, where existing LAeq noise levels exceed the acceptable noise levels given in **Table 13** by 2 dBA or more, the LAeq amenity noise goal would be set at 10 dBA below the existing LAeq levels in order to limit any further increase in ambient noise levels.

Both noise goals (intrusive and amenity) are applicable at residential receiver locations.

Table 13 NSW Industrial Noise Policy Amenity Goals

Type of Receiver	Indicative Noise Amenity Area	Time of Day[1]	Recommended LAeq Noise Level (dBA)	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
	Urban	Day	60	65
		Evening	50	55
		Night	45	50

Note 1: DECC Governing Periods - Day: 7.00 am to 6.00 pm, Evening: 6.00 pm to 10.00 pm, Night: 10.00pm to 7.00 am.

The INP stipulates that where unusual or one-off events occur, modifying corrections are required to be applied to account for their infrequent occurrence. These are detailed below in **Figure 5**.

Figure 5 INP Modifying Corrections

Table 4.2. Adjustments for duration

Duration of noise (one event in any 24 hour period)	Increase in acceptable noise level at receptor, dB(A)	
	Daytime and evening (0700–2200 h)	Night-time (2200–0700 h)
1.0 to 2.5 hours	2	Nil
15 minutes to 1 hour	5	Nil
6 minutes to 15 minutes	7	2
1.5 minutes to 6 minutes	15	5
less than 1.5 minutes	20	10

As only one train services the IPMG site per day it is considered necessary to apply the adjustment detailed above. The total duration of rail siding associated activities that have the potential to generate noise at the nearest sensitive receiver is assumed to be in the region of 3 to 5 minutes. The 15 dBA increase in the acceptable daytime receiver noise level is therefore applicable.

Reference to the noise monitoring data contained in **Table 2** concludes that for the closest receivers on Manning Road the **intrusive** noise goal is the more stringent. With the inclusion of the adjustment factor, as detailed in **Figure 5**, the noise goal for the receiver is therefore 63 dBA (calculated as 48 dBA $L_{Aeq(15minute)}$ PLUS 15 dBA).

9.2.2 Operational Noise Modelling Inputs

Noise Source Data

Noise level data for Class 81 locomotives was measured by Heggies at the Pacific National Clyde Yard, this included both passby and idling measurements.

Modelling Assumptions

The calculations undertaken in order to assess the potential impact of the on-site activities associated with the operation of the rail siding incorporate the following assumptions:

- Class 81 locomotives are to be used at the IPMG site
- The operational procedures of the rail sidings are as described in **Section 3**
- The locomotive would idle for a duration of 30 seconds whilst being re-coupled to the wagons, prior to propelling them into the IPMG building
- Whilst idling before departure, the locomotive would be located approximately 75 m from the nearest residence. Locomotive engines would be turned off at all other times (when parked).
- The maximum locomotive speed whilst on-site would be 5 kph, at notch 1 or 2
- Locomotive horns would not be required to be used
- Train brakes would be used at all times
- Engine brakes would not be used
- Unloading of wagons would be entirely performed with the envelope of the building and are therefore not expected to result in an appreciable contribution to noise levels at the nearest sensitive receivers

9.2.3 Prediction of Operational On-Site Noise Emissions

Using the above scenarios, noise levels have been predicted at the nearest potentially affected sensitive receiver to the IPMG rail sidings. The results are presented in **Table 14.**

Table 14 Operational Noise Emissions (INP)

Location	INP Corrected Noise Goal $L_{Aeq(15min)}$ (dBA)	Predicted Noise Level $L_{Aeq(15min)}$ (dBA)
Manning Road	63	63

It should be noted that the above calculations include the cumulative noise from all operational activities expected to be performed at the IPMG site. The source noise levels for these activities have been referenced from Heggies Report 10-6970-R1 *'Proposed Printing Facility 23 Scrivener Street, Warwick Farm, Acoustical Assessment'*, 10 July 2008.

Reference to **Table 12** and **Table 14** shows that whilst operation of the rail siding would be audible at the closest sensitive receiver, the noise levels resulting from on-site operations are predicted to comply with the appropriate INP noise goal.

9.3 Sleep Disturbance

Although the application of the 10.00 pm to 7.00 am night-time period is considered to be stringent for the reasons discussed in **Section 9.1.1**, an assessment of the potential for sleep disturbance during on-site freight train movements has been undertaken in the even that a train does enter the site before 7.00 am.

9.3.1 Sleep Disturbance Criterion

Guidance for assessing potential sleep disturbance is provided in Chapter 19 of the DECC's (previously EPA's) '*Environmental Noise Control Manual'* (ENCM). The guideline recommends a sleep disturbance noise goal based on the $L_{A1(60second)}$ noise parameter, representative of the maximum noise level. According to this guideline, $L_{A1(60second)}$ noise level measured outside a bedroom window during the night-time period should not exceed the background L_{A90} noise level by more than 15 dBA.

DECC's current approach is to apply this background plus 15 dBA criterion as an initial screening procedure and to undertake further analysis using ECRTN and/or other criteria where the screening criterion is exceeded.

Based on the measured background noise levels, the sleep disturbance criterion for the nearest potentially affected residential receiver is presented in **Table 15**.

Table 15 Night-time Sleep Disturbance Criterion

Location	Sleep Disturbance Criteria	
	Measured RBL	**Criterion $L_{A1(60second)}$**
Residential Premises on Manning Street	37 dBA	52 dBA

A review of research on sleep disturbance in the DECC's '*Environmental Criteria for Road Traffic Noise'* (ECRTN) indicates that in some circumstances, higher noise levels may occur without significant sleep disturbance. Based on studies into sleep disturbance, ECRTN concludes that:

- "Maximum internal noise levels below 50-55 dBA are unlikely to cause awakening reactions."
- "One or two noise events per night, with maximum internal noise levels of 65-70 dBA, are not likely to affect health and wellbeing significantly."

It is generally accepted that internal noise levels in a dwelling, with the windows open, are 10 dBA lower than external noise levels. Based on a worst case minimum attenuation, with windows open, of 10 dBA, the first conclusion above suggests that short term external noises of 60-65 dBA are unlikely to cause awakening reactions.

9.3.2 Sleep Disturbance Assessment

A maximum noise level of 81 dBA is predicted at the Manning Street receiver for operation of the IPMG rail sidings (attributable to locomotive engine/exhaust noise). This can be seen to exceed the sleep disturbance screening criterion in **Table 15**.

It is noteworthy that the predicted IPMG noise emission levels are in the same order of the noise levels predicted for the passing of existing rail traffic and the proposed SSFL operations

The operation of the IPMG rail line does not result in an increase to the maximum noise levels as the on-site freight trains would operate at a very low speed and throttle notch settings. It should be noted that $L_{A1(15minute)}$ noise levels in the order of 80 dBA were measured at Location 2 as part of the ambient noise investigations during the 6.00 am to7.00 am period.

On the basis of the measured existing maximum noise levels, the predicted maximum noise levels and the proposed operating protocols it is recommended that all train on-site train movements are restricted to the daytime and evening periods.

10 OPERATIONAL VIBRATION

10.1 Introduction

Railway vibration is generated by dynamic forces at the wheel-rail interface and will occur to some degree, even with continuously welded rail and smooth wheel and rail surfaces (due to the moving loads, finite roughness of the surfaces and elastic deformation). Significantly higher vibration levels can occur due to rail and wheel surface irregularities, including some irregularities that do not cause significant levels of airborne noise.

This vibration propagates via the sleepers or rail mounts into the ground or track support structure. It then propagates through the ground or structure, and may sometimes be felt as tactile vibration by the occupants of buildings.

The effects of vibration in buildings can be divided into three main categories; those in which the occupants or users of the building are inconvenienced or possibly disturbed, those where the building contents may be affected and those in which the integrity of the building or the structure itself may be prejudiced.

10.2 Vibration Trigger Levels

The human comfort design goals for vibration tend to be more stringent than other possible design goals relating to the disturbance of building contents or building damage.

For new or upgraded railway lines, the IGANRIP specifies that a separate guideline, *'Assessing Vibration: a technical guideline'* (DEC 2006) is to be applied. The DEC guideline is based on British Standard BS 6472-1992 and provides vibration trigger levels to minimise the disturbance to building occupants from continuous, impulsive and transient vibration. For train passbys, the DEC guideline classifies vibration levels as being intermittent.

For **intermittent** vibration at residential receiver locations, vibration trigger levels are expressed in terms of the Vibration Dose Value (VDV) during the daytime (7.00 am to 10.00 pm) and night-time (10.00 pm to 7.00 am) periods. The VDV is a measure that takes into account the overall magnitude of the vibration levels during a train passby, as well as the total number of train passbys during the daytime and night-time periods.

For residential receiver locations, the guideline nominates 'preferred' vibration dose values of 0.2 $m/s^{1.75}$ (daytime) and 0.13 $m/s^{1.75}$ (night-time) and 'maximum' vibration dose values of 0.4 $m/s^{1.75}$ (daytime) and 0.26 $m/s^{1.75}$ (night-time). For this proposal, the more stringent 'preferred' vibration dose values have been applied.

The proposed vibration trigger levels are summarised in **Table 16**.

Table 16 Trigger Levels for Intermittent Vibration

Location	VDV ($m/s^{1.75}$)[1]	
	Day[2]	Night[2]
Residential Properties	0.2	0.13

Note 1 Vibration Dose Values (VDVs) are based on the 'preferred' values in the DEC guideline '*Assessing vibration: a technical guideline'* (2006)

Note 2 Daytime is 7.00 am to 10.00 pm and Night-time is 10.00 pm to 7.00 am

10.3 Operational Vibration Assessment

Section B2.3 of the DECC vibration guideline provides a calculation procedure for determining the Vibration Dose Values (VDV) on the basis of the measured (or predicted) rms vibration velocity levels.

For a number of individual train passbys, the estimated Vibration Dose Value (eVDV) is based on the following formula:

> *eVDV (overall) = 0.07 x* V_{rms} *x (t x N)*$^{0.25}$ *(m/s*$^{1.75}$*)*, where t represents the time period for a representative train passby, V_{rms} is the vibration level for a representative train passby and N represents the number of trains within the assessment period (daytime or night-time).

On the basis of the proposed track alignments, the number of passbys and the maximum train speeds on each line, Table 17 presents the predicted Vibration Dose Value for the nearest receiver located on Manning Street.

Table 17 Vibration Dose Value Calculation

Location	Track	Distance (m)	Vibration Level		Number of Trains		Passby Time (s)	Partial Vibration Dose Value (m/s$^{1.75}$)	
			dB re 10^{-9} mm/s	mm/s	Day	Night		Day	Night
Manning Street	1	15	108	0.25	1	1	90	0.05	0.05
	2	22	108	0.25	20	13	90	0.11	0.10
	3	44	100	0.1	57	15	10	0.03	0.02
	4	48	100	0.1	55	15	10	0.03	0.02
	Overall Vibration Dose Value (m/s$^{1.75}$)							**0.12**	**0.10**

Note: The source vibration levels indicated the table were referenced from previous studies undertaken by Heggies.

The VDVs are predicted to comply with 'preferred' daytime and night-time criteria.

11 CONCLUSIONS

An assessment of the potential noise and vibration impacts resulting from the construction and operation of the IPMG rail siding has been undertaken.

Construction Noise and Vibration

Whilst construction noise noise levels are predicted to exceed the relevant noise goals, it should be noted that exceedances of this nature are reasonably common on projects involving works in close proximity to sensitive receivers.

It is also noteworthy that the SSFL is currently being constructed immediately adjacent to the western boundary of the IPMG site. The works are in the region of 35 m from the receivers on Manning Street. The noise impacts from IPMG related construction works would be expected to be comparable to the SSFL works.

Construction related vibration levels are predicted to comply with the structural damage criteria, however a potential exceedance of the human comfort criteria is predicted at the nearest sensitive receiver location.

The extent of predicted exceedances does not indicate that the project should not proceed, but rather highlights the need to ensure all feasible and reasonable measures are implemented to minimise the impacts. The contractor(s) should prepare and implement a site-specific Construction Noise and Vibration Management Plan including the measures listed in **Section 8** and any other initiatives identified to minimise the noise and vibration impact from construction activities.

Operational Noise and Vibration

An assessment of operational noise has been undertaken inline with the IGANRIP. This assessment indicates that the future noise levels are predicted to comply with the residential IGANRIP trigger levels. The assessment also indicates that the operation of the IPMG rail siding would not result in an increase to the $L_{Aeq(15hour)}$, $L_{Aeq(9hour)}$ or the L_{Amax} noise levels at the nearest noise sensitive receivers.

The operation of freight trains within the IPMG site boundary has been assessed in accordance with the INP. This assessment indicates that whilst operation of the rail siding would be audible at the closest sensitive receiver, the noise levels resulting from on-site operations are predicted to comply with the appropriate INP noise criteria.

Operation vibration has been assessed in accordance with DECC's '*Assessing Vibration: A technical guideline*'. The vibration levels are predicted to comply with the 'preferred' vibration trigger levels at the nearest sensitive receiver location.

Acoustic Terminology

1 Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that in common usage 'noise' is often used to refer to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or L_P are commonly used to represent Sound Pressure Level. The symbol L_A represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2 x 10^{-5} Pa.

2 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dBA or 2 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear', and the units are expressed as dB(lin) or dB.

3 Sound Power Level

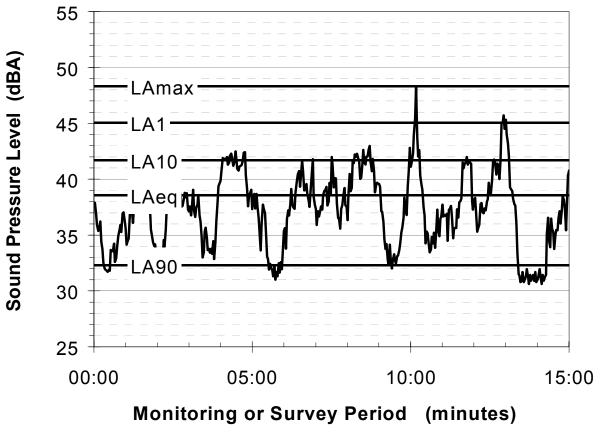
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or L_W, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure may be likened to an electric radiator, which is characterised by a power rating, but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4 Statistical Noise Levels

Sounds that vary in level over time, such as transportation noise and most community noise, are commonly described in terms of the statistical exceedance levels L_{AN}, where L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the L_{A1} is the noise level exceeded for 1% of the time, L_{A10} the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

L_{A1} The noise level exceeded for 1% of the 15 minute interval.

L_{A10} The noise level exceed for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

L_{A90} The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

L_{Aeq} The A-weighted equivalent noise level (basically the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

When dealing with numerous days of statistical noise data, it is sometimes necessary to define the typical noise levels at a given monitoring location for a particular time of day. A standardised method is available for determining these representative levels.

This method produces a level representing the 'repeatable minimum' L_{A90} noise level over the daytime and night-time measurement periods, as required by the EPA. In addition the method produces mean or 'average' levels representative of the other descriptors (L_{Aeq}, L_{A10}, etc).

5 Tonality

Tonal noise contains one or more prominent tones (ie distinct frequency components), and is normally regarded as more offensive than 'broad band' noise.

6 Impulsiveness

An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.

7 Frequency Analysis

Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (3 bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

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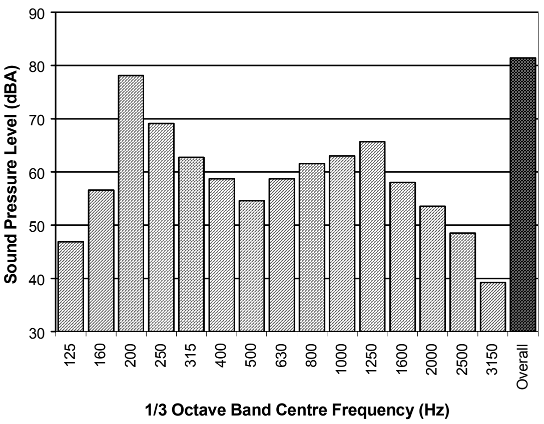

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10 Over-Pressure

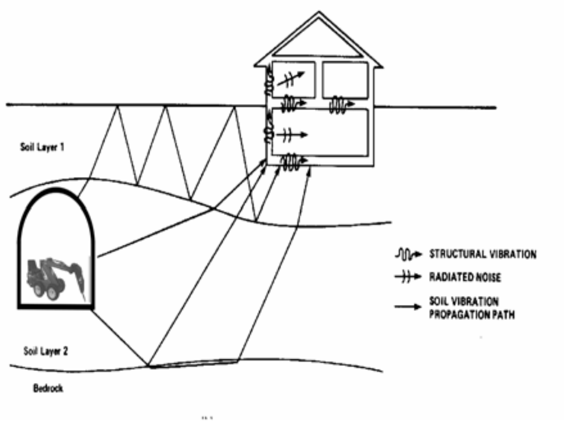
The term 'over-pressure' is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

11 Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

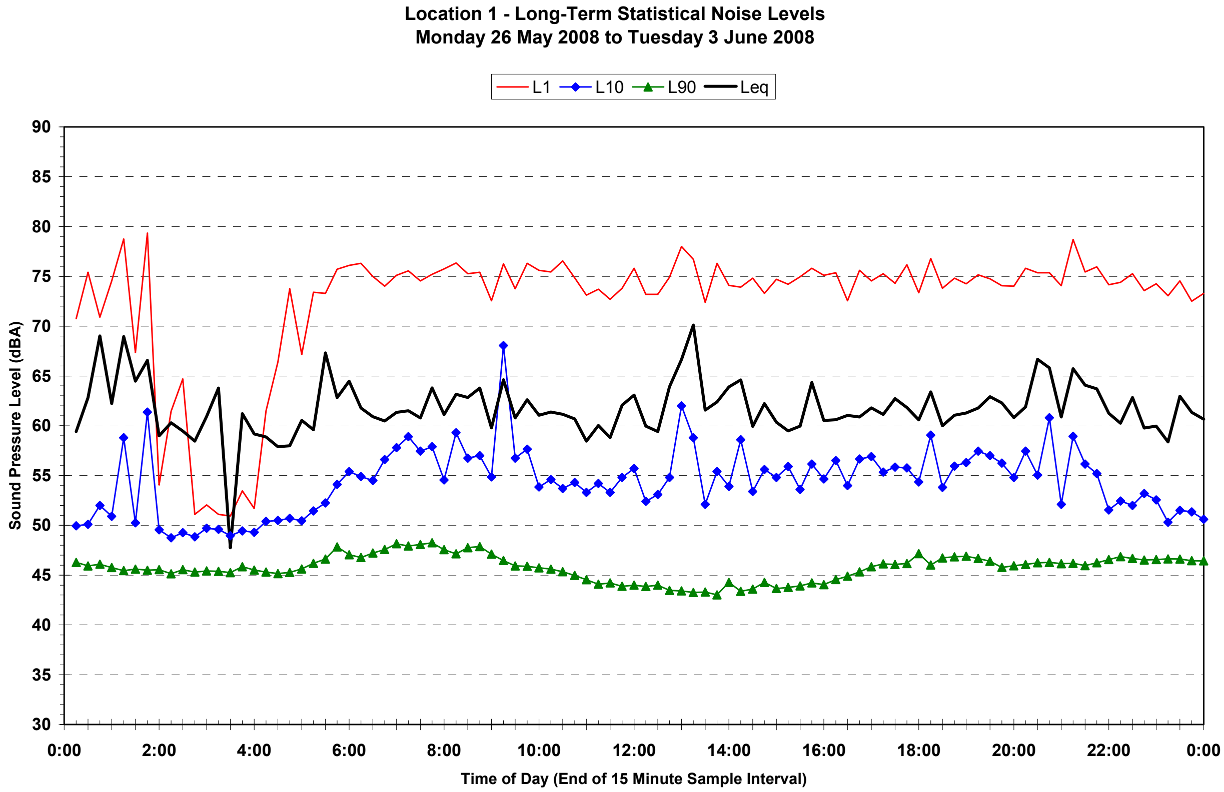
Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

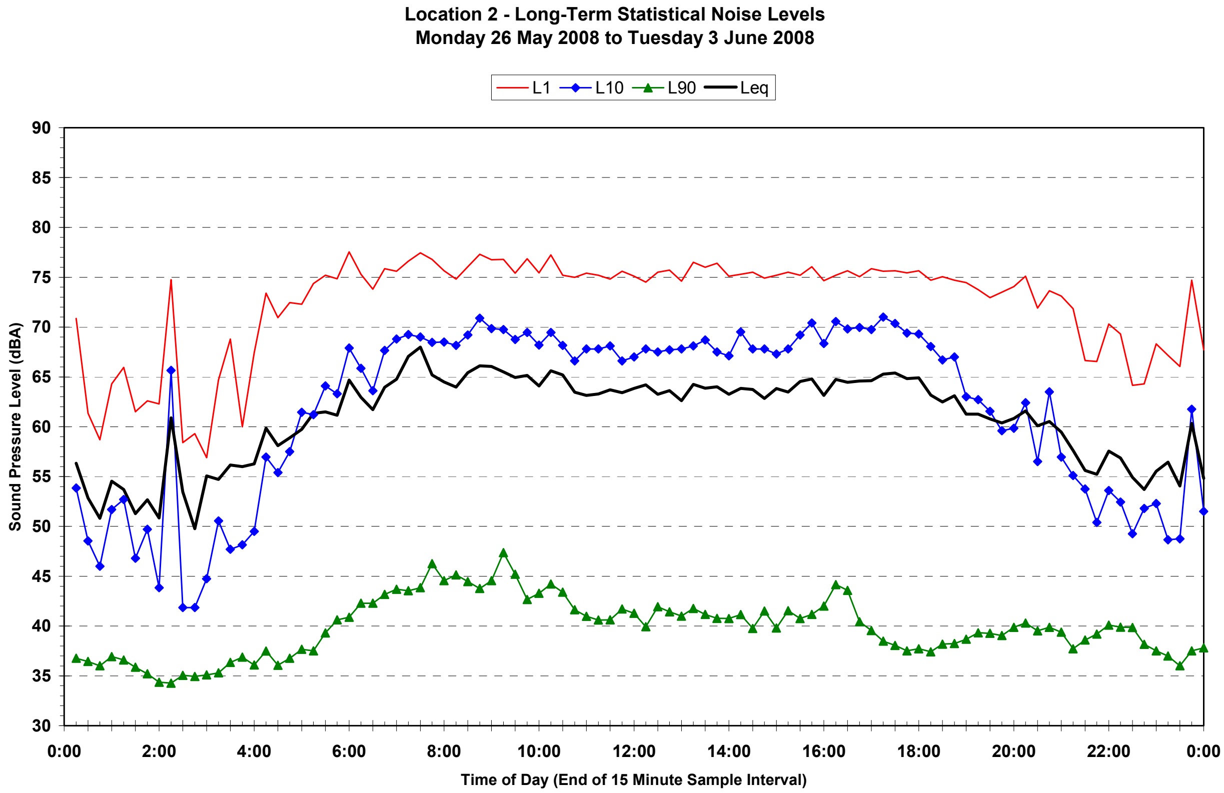
The following figure presents the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise

Ambient Noise Graphs (24 Hour Average)





Acoustic Terminology

1 Sound Level or Noise Level

The terms ‘sound’ and ‘noise’ are almost interchangeable, except that in common usage ‘noise’ is often used to refer to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or L_P are commonly used to represent Sound Pressure Level. The symbol L_A represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2×10^{-5} Pa.

2 ‘A’ Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an ‘A-weighting’ filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People’s hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dBA or 2 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as ‘linear’, and the units are expressed as dB(lin) or dB.

3 Sound Power Level

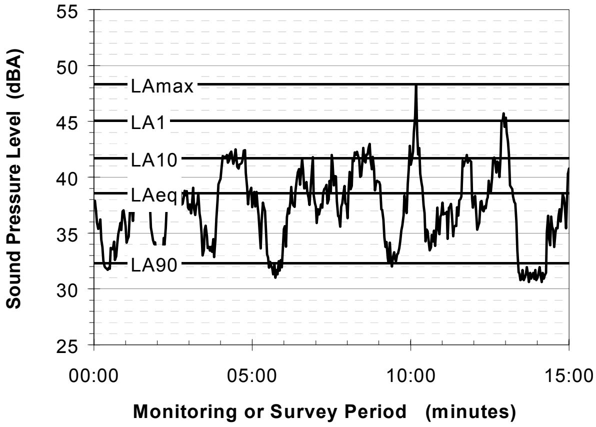
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or L_W, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure may be likened to an electric radiator, which is characterised by a power rating, but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4 Statistical Noise Levels

Sounds that vary in level over time, such as transportation noise and most community noise, are commonly described in terms of the statistical exceedance levels L_{AN}, where L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the L_{A1} is the noise level exceeded for 1% of the time, L_{A10} the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

L_{A1} The noise level exceeded for 1% of the 15 minute interval.

L_{A10} The noise level exceed for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

L_{A90} The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

L_{Aeq} The A-weighted equivalent noise level (basically the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

When dealing with numerous days of statistical noise data, it is sometimes necessary to define the typical noise levels at a given monitoring location for a particular time of day. A standardised method is available for determining these representative levels.

This method produces a level representing the ‘repeatable minimum’ L_{A90} noise level over the daytime and night-time measurement periods, as required by the EPA. In addition the method produces mean or ‘average’ levels representative of the other descriptors (L_{Aeq}, L_{A10}, etc).

5 Tonality

Tonal noise contains one or more prominent tones (ie distinct frequency components), and is normally regarded as more offensive than ‘broad band’ noise.

6 Impulsiveness

An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.

7 Frequency Analysis

Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (3 bands in each octave band)
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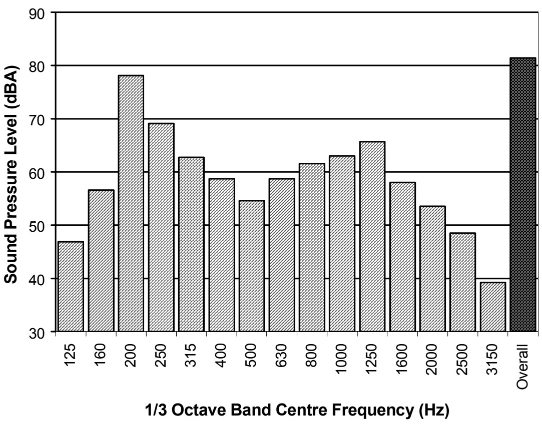

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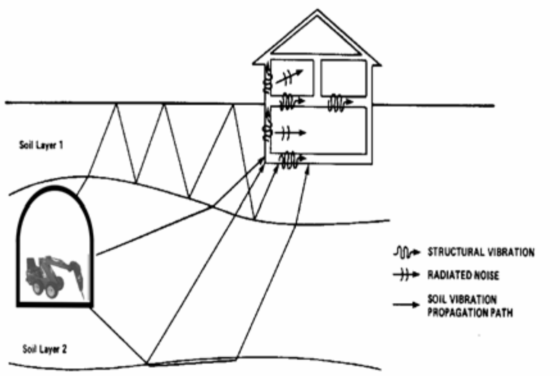

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