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GLASS RECOVERY SERVICES PTY LTD

NOISE IMPACT ASSESSMENT
126 ANDREWS ROAD, PENRITH

REFERENCE NO. S9340

SEPTEMBER 2016

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FINAL REPORT

for

NOISE IMPACT ASSESSMENT
126 ANDREWS ROAD, PENRITH
NSW 2750

Prepared for

GLASS RECOVERY SERVICES PTY LTD

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PENRITH NSW 2750

by

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126 ANDREWS ROAD, PENRITH
NOISE IMPACT ASSESSMENT

EXECUTIVE SUMMARY

Glass Recovery Services Pty Ltd (GRS) operate a glass recycling facility at 126 Andrews Road, Penrith (Lot 1 in DP 747153). GRS proposes to modify Schedule 2, Condition 5 of the current development approval DA/SSD5267 to raise the maximum permissible quantum of glass material processed from 150,000 tonnes per year to 200,000 tonnes per year.

The NSW Department of Planning and Environment (DPE) has required, inter alia, that a Noise Impact Assessment (NIA) be conducted in order to understand and assess the potential impacts from noise associated with the increase in processing capacity and from the traffic on site.

Accordingly, Hibbs & Associates has conducted a NIA in accordance with the INP, which is supported by a noise survey and modelling to provide a thorough investigation of key aspects of the proposal.

The noise emissions from GRS are effectively controlled in a number of ways, including site design and management procedures. Truck movements for raw material delivery and finished product and waste removal only occur during the daytime between 06:00 and 18:00 hours. In this context, given the separation distances between the site and NSRs (i.e. several hundred metres), the shielding provided by the local topography (i.e. the bund around Echo Place) and the acoustic masking provided by the heavy traffic on Andrews Road, it is unsurprising that noise from the GRS site is barely audible offsite and that the site has never received any complaints about noise.

With regards to the proposal:

- the processing plant may be run at times during which it is currently shut down for maintenance in order to achieve the proposed increase capacity. However, there will be no increase in noise emission level because no additions or modifications to the plant or building are necessary,
- the increase in processing capacity will lead to an increase in the overall number of trucks visiting the site to deliver material and remove product and waste,
- the noise level from the site when the processing plant is operating will remain the same as currently during the evening and night-time because there will continue to be no truck movements during these periods,
- the maximum number of delivery trucks present in the yard at any one time will not be materially greater in the future than currently, and
- the future busiest/noisiest 15-minute period will be no busier/noisier than the current busiest/noisiest 15-minute period.

The conclusions of the NIA are that:

- the noise impacts associated with the proposed modification to increase capacity will be negligible, and
- compliance with the noise limits contained within the current conditions of consent will continue to be achieved.

A model of the south-eastern corner of the site has been produced to evaluate the effect that increasing the height of the bunker walls in this area would have on noise immissions to NSRs. The results of the noise model indicate that replacing the existing bunker walls or adding 5 m high barriers would have no influence on the noise impacts at any NSRs.

Consequently, requiring that GRS replace their existing bunker walls with higher walls is considered contrary to the principles of the INP. Replacement of the bunker walls would place a significant financial burden on GRS without yielding any positive benefit to any NSRs. As described in Section 3.2, the noise emissions from GRS are effectively and sufficiently controlled at present and by the existing bunker structures.

126 ANDREWS ROAD, PENRITH
NOISE IMPACT ASSESSMENT

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1.0 INTRODUCTION

1.1 Background Information

Glass Recovery Services Pty Ltd (GRS) is an Australian owned company with its head office based in Victoria. GRS operate a glass recycling facility at 126 Andrews Road, Penrith (Lot 1 in DP 747153). The site is currently zoned IN1 – General Industrial under the Penrith City Council Local Environmental Plan 2010. GRS proposes to modify Schedule 2, Condition 5 of the current development approval DA/SSD5267 to raise the maximum permissible quantum of glass material processed from 150,000 tonnes per year to 200,000 tonnes per year.

The Statement of Environmental Effects (SEE)[1] provides details of the proposals. The proposed maximum permissible quantum of glass material processed is within the capacity of the existing processing plant. Consequently, the processing plant will continue to operate as present and the proposal only affects the number of trucks bringing material in and taking product and waste out of the site. On this basis, the potential noise impact of the proposals relate solely to noise associated with truck movements and materials handling in the yard of the site.

In response to the SEE, the NSW Department of Planning and Environment (DPE) has required[2], inter alia, that a Noise Impact Assessment (NIA) be conducted and stated:

> Noise assessment
>
> The noise modelling that was undertaken as a part of the original Environmental Impact Statement for the consent approval was based on 150,000tpa of waste being received and processed at the site. The noise assessment in the SEE for the modification has not considered the potential impacts from noise associated with the increase in processing capacity of 50,000tpa at the site or from the traffic impacts on site.
>
> In order to understand and assess these potential impacts associated with the modification, the Department requires a Noise Impact Assessment to be undertaken by an experienced and qualified consultant in accordance with EPA's "*Industrial Noise Policy*" (2000).

This is commensurate with the response to the SEE provided by Penrith City Council (PCC)[3] that stated:

> In assessing this modification application, it is requested that the Department ensure that the additional noise that may be generated by the proposed increased capacity is thoroughly assessed to ensure that compliance with the current conditions of consent is achievable.

---

[1] Carlo Ranieri & Associates Pty Ltd. Statement of Environmental Effects, Section 96 Amendment, Glass Recovery Services, 126 Andrews Road Penrith. 150916GRS SEE. Issue: A. 18 September 2015

[2] NSW Department of Planning and Environment. Letter to Glass Recovery Services, SSD 5267 (MOD1). 28 July 2016.

[3] Penrith City Council. Letter to NSW Department of Planning and Environment. 16 June 2016.

It is noted that the letter from the NSW Environment Protection Agency (EPA)[4] to the DPE does not request a NIA.

1.2 Consultant's Brief

Accordingly, this report provides a NIA to determine the likely magnitude and significance of noise impacts generated by the proposed extension of capacity at the site, i.e. the proposed modification to Schedule 2, condition 5. The study follows the procedures and methodology outlined in our approved "*Proposal for Environmental Acoustics Assessment*", Reference SQ6189-L1. An investigation of increasing the bunker wall heights to 5 m, as required by paragraph 2.1.2 of Appendix A of the development consent is also provided.

The survey, assessment and reporting was conducted by Mr Toby Dudman, Principal Acoustics Engineer at Hibbs & Associates Pty Ltd. The study was peer reviewed by Mr Ritesh Patel, Principal Occupational Hygienist at Hibbs & Associates Pty Ltd. The assessment is based primarily on a site visit and survey on the morning of Monday 05 August 2016. Reference has also been made to the data provided by the Noise Validation Report[5], which surveyed the site in operation in February and May 2014.

1.3 Structure of the Report

This report commences with a brief overview of the relevant legislation followed by a description of the survey and assessment methodology. The results of the survey are presented followed by an interpretive discussion. The report concludes with recommendations for actions where appropriate. Explanations of the technical terminology used in the report are provided in Appendix 1.

---

[4] Environment Protection Authority. Letter to Chris Ritchie, NSW Department of Planning and Environment (Ref: DOC16/297032), 17 June 2016.

[5] National Integrated Creative Solutions. Glass Beneficiation Plant, 126 Andrews Road, Penrith, Noise Validation Report. May 2014 (Rev02)

2.0 REPORT LIMITATIONS AND DISCLAIMER

This report was prepared for Glass Recovery Services Pty Ltd solely for the purposes set out herein and it is not intended that any other person use or rely on the contents of the Report. The information contained in this report is based on a limited remote (online) review of the site and review of documentation provided to Hibbs & Associates Pty Ltd at the time of the review. Whilst the information contained in the Report is accurate to the best of our knowledge and belief, Hibbs & Associates Pty Ltd cannot guarantee the completeness or accuracy of any of the descriptions or conclusions based on the information supplied to it or obtained during the investigations.

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3.0 Site Description

3.1 Spatial Context

The site, surroundings and nearest Noise Sensitive Receptors (NSRs) are shown in Figure 1 below. The approximate location of the site boundary is indicated by the red line.

Figure 1: Surroundings and NSRs (© 2016 Google)

GRS site at 126 Andrews Road, Penrith is at a boundary between industrial and residential areas. The Northern Road (A9) runs north-south and junctions Andrews Road approximately 1 km to the east. Intervening land comprises residential use. Road traffic on Andrews Road is the principal environmental noise source in the local acoustic environment. There is high proportion of trucks due to the preponderance of industrial uses in the area. This observation is reinforced by the results of the surveys conducted throughout the day, evening and night-time for the Noise Validation Report.

The site is bounded by Nepean Rugby Park to the east, Andrews Road to the north and Owens Illinois (O-I) glass container factory to the west. The closest residential NSRs are in Koala Glen, which is approximately 200 m east-northeast from the site boundary and separated from the site by Andrews Road; and Echo Place, which is approximately 300 m southeast of the site boundary and separated from the site by Nepean Rugby Park. The areas to the west and south comprise industrial, manufacturing and utilities usage.

Penrith Lakes is a recent area of residential development approximately 300 m north of the site boundary and separated from the site by Andrews Road. The closest houses are no closer to the site than the closest houses in Koala Glen and are a terrace 'single façade' houses facing north. That is, the southern façade that faces the site is a plain wall and is not noise sensitive.

The land is broadly flat to the west and elevated to the east. Consequently, the ground levels at Koala Glen and Ariel Crescent are approximately 10 m higher than that at the site. Nepean Rugby Park is heavily landscaped. There is a bund on the boundary between the park and the rear of Echo Place. The top of the bund is approximately level with the eaves of the bungalows on Echo Place as can be seen in Figure 2. The photograph was taken from the location illustrated by the camera icon (📷) in Figure 1.

Figure 2: View Southeast Showing Bund around Echo Place (dotted line)

3.2 GRS Penrith Site

An aerial view of the GRS site at 126 Andrews Road, Penrith is shown in Figure 3.

The glass processing plant and equipment is within the building that provides significant noise attenuation. Roller-shutter doors on the eastern façade are closed during the evening and night-time to minimise noise emission during these more sensitive periods. Noise from the internal plant was barely audible offsite during the survey, which is commensurate with the observations made in 2014 for the Noise Validation Report.

The only significant external item of static plant is the bag filter dust collector at the north-eastern corner of the building. A fork-lift truck (FLT) is commonly present in the northeast corner of the site bringing bins of waste out of the facility from door D4 and unloading them into the container and stockpile outside the eastern façade. The north-eastern corner of the site is shown in Figure 4.

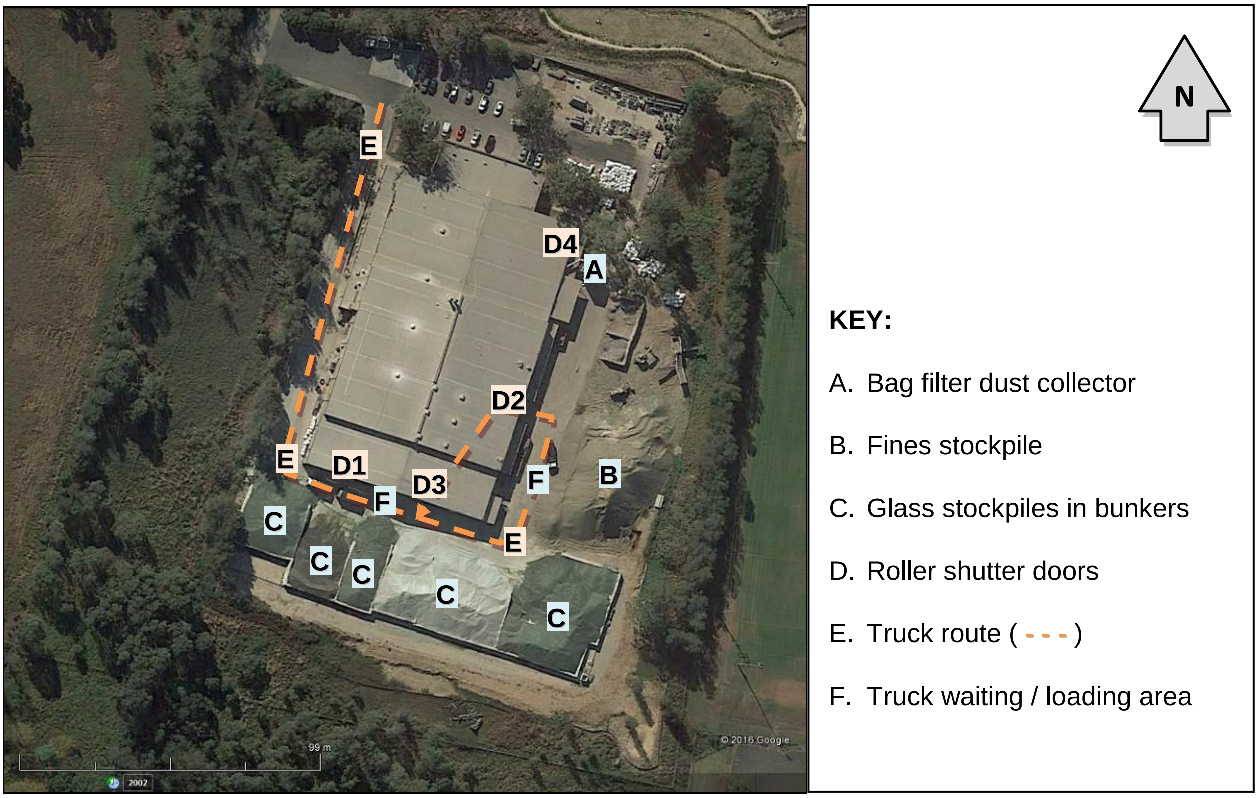

Figure 3: GRS Penrith Site (© 2016 Google)

Figure 4: North-eastern Corner of Site

There are two front-end loaders (FELs) used on site concurrently. One is mostly within the building, handling incoming glass and loading the processing lines. The other is mostly in the external loading areas to the south and east of the building, moving product from the end of the lines out of door D1 into stockpiles on the southern boundary and loading trucks.

The stockpiles on the southern boundary are held within concrete block walls, as shown in Figure 5. The walls are approximately 3 m high. The stockpiles can be much higher than the bunker walls. On the day of the survey, the stockpiles in the bunkers were between 4 to 6 m high.

Figure 5: Bunkers & Stockpiles – left: looking west; right: south of bunker walls

The stockpile of 'fines' on the eastern boundary of the site (as shown in Figure 6) will not remain. Once this area is clear, it will be restored to a natural wetland reserve. On the day of the survey, this stockpile was approximately 8 m high.

Figure 6: Bunkers & Stockpiles – left: looking north; right: fines

Trucks delivering glass to the facility follow a predominantly 'forwards-motion' route through the site. After passing through the weighbridge on the western façade, they travel round the southern façade to door D2 in the eastern façade. If it is not possible to enter immediately, they wait adjacent to the eastern façade. After unloading within the building, they leave through door D3 and exit the site via the weighbridge. Reversing, and hence reversing bleepers on trucks, is avoided in normal operations.

Trucks are loaded outside the southern or eastern façade, where the bunkers and stockpiles provide noise screening to NSRs to the southeast, e.g. Echo Place. Truck speeds are very low. The site speed limit is 20 km/h. On the day of the survey, trucks manoeuvred through the site little faster than walking pace.

The GRS FELs are fitted with white-noise reversing alarms; i.e. they make a '*schh-schh-schh*' sound instead of a bleeping. The acoustic character of white-noise reversing signals is significantly less audible at a distance, significantly less annoying to nearby residents (if they hear them at all) and hence a significantly lower noise impact compared with the common bleeping alarms.

Trucks only visit the site during the daytime between 06:00 and 18:00 hours. There are more deliveries within the first three hours (i.e. between 06:00 and 09:00 hours) than in the rest of the day. Only about 10% of truck traffic occurs in the last three hours (i.e. between 15:00 and 18:00 hours). An indicative summary of current daily truck movements is provided in Table 1.

Table 1: Indicative Current Daily Truck Movements

	Truck & Dog (T&D)	8-tonne	Other
Glass In	9 to 11	3	
Glass In & Waste Out (Note 1)	2		
Glass In & Fines Out (Note 1)	3		
Glass Out to O-I	Up to 10		
Paper Out	0 or 1 (note 2)		
Waste Containers Out			0 or 5 to 6 (note 3)
Waste Bins Out		0 or 1 (note 4)	
TOTALS	**<24 to 27**	**3 to 4**	**0 to 6**
	<27 to 37		

Notes:

1. These movements describe a single truck delivering glass to the site after which it is loaded with waste or fines that is taken off the site.
2. 1 truck every 2-days
3. 5 to 6 containers out on one day once a week
4. 2 trucks per week

In summary, the noise emissions from GRS are controlled at source by:

- Site design:
  - plant is within a building,
  - unloading is conducted within the building,

- bunkers have been built where they acoustically screen noise during loading,
- truck route only conducive to very slow movement of trucks and is designed to eliminate reversing / reversing bleepers;

- Selection of appropriate equipment:
  - GRS FELs have white-noise reversing alarms;
- Management controls:
  - Trucks only attend site during the daytime.

In this context, given the separation distances between the site and NSRs (i.e. several hundred metres), the shielding provided by the local topography (i.e. the bund around Echo Place) and the acoustic masking provided by the heavy traffic on Andrews Road, it is unsurprising that noise from the GRS site is barely audible offsite and that the site has never received any complaints about noise since they started operations in 2014.

4.0 REGULATORY FRAMEWORK

A brief description of the main technical acoustics concepts and terminology used in this report is provided in Appendix 1.

4.1 Regulations, Standards and Guidance

The following regulations, standards and guidelines are apposite to this assessment:

- Protection of the Environment Operations Act 1997 (POEO Act);
- Protection of the Environment Operations (Noise Control) Regulation 2008 (Noise Control Regulation);
- NSW Industrial Noise Policy (INP), 2000;
- Australian Standard (AS) 1055 Acoustics - Description and measurement of environmental noise,
    - Part 1: General procedures, 1997;
    - Part 2: Application to specific situations, 1997; and
    - Part 3: Acquisition of data pertinent to land use, 1997.

Human responses to noise are not straight-forward and cannot be represented robustly by simple numerical methods. NSW noise policy takes a pragmatic approach to balance the needs of development and the community. For example, the INP states:

> *The noise criteria have been based around identifying the upper (rather than the average) level of impact. They seek to restrict the risk of people being highly annoyed to less than 10 per cent, and to meet this for at least 90 per cent of the time.*

On the basis of the above, NSW noise policy does not aim to remove all impact to all people for all of the time. It accepts that some noise impact to some people for some of the time is an inevitable and tolerable consequence of a technologically developed society. Nevertheless, as described at the end of Section 3.2, noise emissions from GRS Penrith has been successfully controlled such that there are no noise impacts on NSRs and no complaints have been received about noise.

4.2 Industrial Noise Policy

The INP is freely available from the EPA website[6]. The discussion below provides only a brief overview as is appropriate for this assessment. The aim of INP is:

> *To allow the need for industrial activity to be balanced with the desire for quiet in the community.*

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[6] http://www.epa.nsw.gov.au/noise/industrial.htm

The quantitative assessment methodology contained within the INP is based on two criteria:

- **Intrusiveness** – the noise level from the industrial site, evaluated as a $L_{Aeq,,15min}$, should not exceed the background noise level, evaluated as an $L_{A90,15min}$, by more than 5 dB. A penalty of up to 10 dB is added to the noise level from the industrial site if the noise contains annoying and distinctive acoustic characteristics such as whines, hums, bangs and crashes.

- **Amenity** – the noise level from the industrial site, evaluated as and $L_{Aeq,T}$, should not exceed criteria that are determined on the basis of the land use, associated activities and the time of day.

The assessment location for the INP criteria is at most affected point on or within the residential property boundary or, if the boundary is more than 30 m from the residence, at the most-affected point within 30 m of the residence. In assessing noise levels at passive and active recreational areas, the noise level is to be assessed at the most-affected point within 50 m of the area boundary. For the Nepean Rugby Park, this location is approximately at in the middle of the rugby pitch that abuts the eastern boundary of GRS.

4.3 Noise Limits

Schedule 3 Condition 8 of development approval DA/SSD5267 contains the noise limits that apply to the operation of the site. These are defined in terms of the Project Specific Noise Level (PSNL) determined in accordance with the INP and are reproduced in Table 2 below for residential NSRs. For recreational NSRs, the noise limit is 55 dB $L_{Aeq,T}$ *"when in use*".

Table 2: Noise Limits for Residential NSRs

Day 06:00 to 18:00	Shoulder 05:00 to 06:00	Evening 18:00 to 22:00	Night 22:00 to 05:00	
$L_{Aeq,15-min}$ (dB)	$L_{Aeq,15-min}$ (dB)	$L_{Aeq,15-min}$ (dB)	$L_{Aeq,15-min}$ (dB)	$L_{Amax,F}$ (dB)
46	46	42	35	45

The assessment conducted for the Noise Validation Report predicted that the noise immissions at NSRs would be below the PSNL limits. It is noted that the measurements for this assessment were conducted with the acoustic enclosure around the bag filter installed but not fully sealed. This would have led to an over-estimate of the sound power level of the bag filter. The model included 5 m high bunker walls, which are approximately 2 m high than the existing bunker walls. The difference that this makes on the overall noise immissions at NSRs is negligible and is explained in Section 5.3.

5.0 NOISE IMPACT ASSESSMENT

5.1 Increase in Capacity

5.1.1 Processing Plant

An indication of the order of magnitude of the increase in noise emission from the site may be calculated from the increase in the volume of material handled by the site[7]. On the basis of an increase from 150,000 to 200,000 tonnes per year (tpa), the annual average noise emission may be expected to increase by around 1.2 dB. This is a negligible increase. Furthermore, such a change is unlikely to be noticeable.

However, noise impacts in NSW are not considered in terms of annual average immissions. With reference to Section 4.2, the INP intrusiveness criteria considers site noise in terms of 15-minute periods. Consequently, the noise impact is related to changes that are likely to occur within individual 15-minute periods and not to the overall annual change.

As stated in Section 1.1, the processing plant will continue to operate as present and no additions or modifications are necessary. Consequently, there will be no increase in the 15-minute noise emissions ($L_{Aeq,15\text{-}min}$) from the building.

It is understood that the additional processing throughput will be accommodated mostly within the current working hours because the plant is currently operating under capacity. It is possible that some weekend shifts, during which the plant is currently shut down for maintenance, may be used for production. However, the 15-minute noise emissions ($L_{Aeq,15\text{-}min}$) from the building at these times will be no different from the 15-minute noise emissions ($L_{Aeq,15\text{-}min}$) from the building currently occurring during the day, evening and night-time because no changes to the process plant are proposed.

The Noise Validation Report demonstrated that the noise levels from this facility complied with the PSNL ($L_{Aeq,15\text{-}min}$) . The report also noted that the noise from the facility was inaudible at the NSRs. There are no reasons to expect that these conclusions will change during the evening and night-time because the proposals will not affect the 15-minute noise emissions ($L_{Aeq,15\text{-}min}$) from the site during these periods for the reasons set out above.

[7] The calculation follows the standard approach for scaling noise emissions proportional to quantities; i.e. $\Delta L = 10 \log (Q_2 / Q_1)$, where the change in noise level is ΔL in dB and Q_1 and Q_2 are the quantities related to the noise generation before and after the change, respectively.

5.1.2 Trucks and Service Yard

The increase in processing capacity will lead to an increase in the overall number of trucks visiting the site to deliver material and transport product and waste. Trucks will continue to be constrained to the daytime between 06:00 and 18:00 hours. Consequently, the increase in capacity will not affect the 15-minute noise emissions ($L_{\text{Aeq,15-min}}$) from the site during the evening and night-time.

The breakdown of types of vehicle is expected to remain principally as described in Table 1. Similarly, the temporal distribution of truck movements within the day, i.e. more at the beginning of the day and very few at the end, is expected to remain the same. The average number of trucks per day will increase in proportion to the increase in capacity, i.e. there is expected to be 133% of the current truck movements.

As can be seen in Figure 5 and Figure 6, there is limited space on site for more than a few trucks at a time. During the survey, we witnessed two trucks waiting at the eastern façade outside the entrance to the raw product reception hall whilst a third was being unloaded within. Had many more trucks arrived then maybe two more could be held at the south-eastern corner of site but any others would probably need to be held on at the western façade of the building to avoid blocking the exit route of trucks already on the site[8]. Consequently, the site layout naturally constrains the maximum number of trucks that may be on the site at any single time.

GRS management expect that the busiest hour may accommodate one extra truck movement. An increase from 6 to 7 in one hour was suggested. On this basis, the majority of additional trucks associated with the increase in capacity will be accommodated within less busy hours. If more trucks arrive within a single 15-minute period then, as described above, they will have to be held at the western façade and their unloading noise will be spread into subsequent 15-minute periods rather than increasing the noise of the busiest 15-minute period.

In summary due to the proposed increase in processing capacity from 150,000 tpa to 200,000 tpa:

- the maximum number of delivery trucks present in the yard at any one time will not be materially greater in the future than currently, and
- the future busiest/noisiest 15-minute period will be no busier/noisier than the current busiest/noisiest 15-minute period.

The Noise Validation Report demonstrated that the PSNL limits would be achieved by at least 5 dB during the daytime. If the busiest/noisiest 15-minute period currently has 6 truck movements and this increases to 7 then an increase in noise emissions from trucks of around 0.7 dB would be expected. On this basis, the increase in noise due to increased truck movements is unlikely to be noticeable at NSRs and will not affect compliance with the conditions of the consent.

[8] It must be appreciated that the author is an acoustician and not a haulage traffic specialist.

5.1.3 Summary of NIA

With reference to the specific questions asked by the DPE and PCC, which are reproduced in Section 1.1, the NIA that is provided above and is in accordance with the INP:

- quantifies the potential impacts associated with the modification and demonstrate that they will be negligible, and
- quantifies the additional noise that may be generated by the proposed increased capacity and demonstrate that compliance with the current conditions of consent is achievable.

Nevertheless, a noise survey and modelling were conducted to provide a thorough investigation of key aspects of the proposal.

5.2 Noise Survey

An attended noise survey was conducted to obtain detailed acoustic signatures of the key noise sources on the site. Measurements were made in the morning of 05 August 2016 between 07:00 and 09:30 hours (nominally). The yard is busiest at the beginning of the day. On this basis, the measurements are representative of the noisiest period. The weather conditions were dry, clear (0 okta), mild (6 ºC at the start rising slowly to 12 ºC at the end), and calm (0 m/s average wind speed).

Measurements were conducted with a Svantek SV 979 Class 1 sound level meter (SLM) serial no. 34014. Calibration was checked before and after the survey with a Svantek SV30A acoustical calibrator, serial no. 31827; no significant deviation was found. Raw data, including concurrent audio recordings, are available and may be provided with review software to regulators upon request (approximately 1 GB of data).

Measurement locations are shown in Figure 7. In the broadest terms, the measurements comprised:

- delivery trucks during L1 (location shown in Figure 6 ‘left’),
- the bag filter and FLT that operates in that area during L2 (location shown in Figure 4 ‘right’), and
- a truck being loaded by a FEL to the south of the building during L3 (location shown in Figure 7 ‘right’).

Figure 7: (left) Measurement Locations (© 2016 Google) and (right) Location L3

A summary of the measurements is provided in Table 3. It should be noted that bird calls were prevalent throughout the survey and will have influenced the measurements. Figure 8 and Table 4 provide an annotated spectrogram of the 1-hour measurement at L1. The bird calls can be seen in the upper frequency ranges in-between truck movements (vertical green lines, e.g. between annotations 10 and 11 during which there was no significant activity in the yard). The audio record illustrates that there is a bird response to trucks such that the elevated noise levels when a truck arrives/leaves is further elevated by a chorus of bird calls.

Table 3: Summary of Measured Survey Levels

Location	Start Time	$L_{Aeq,15\text{-}min}$ (dB)	$L_{A10,15\text{-}min}$ (dB)	$L_{A90,15\text{-}min}$ (dB)
L1	07:10 AM	55	58	49
L1	07:25 AM	57	60	50
L1	07:40 AM	56	59	49
L1	07:55 AM	57	60	50
L2	08:47 AM	60	61	57
L3	09:10 AM	62	65	52

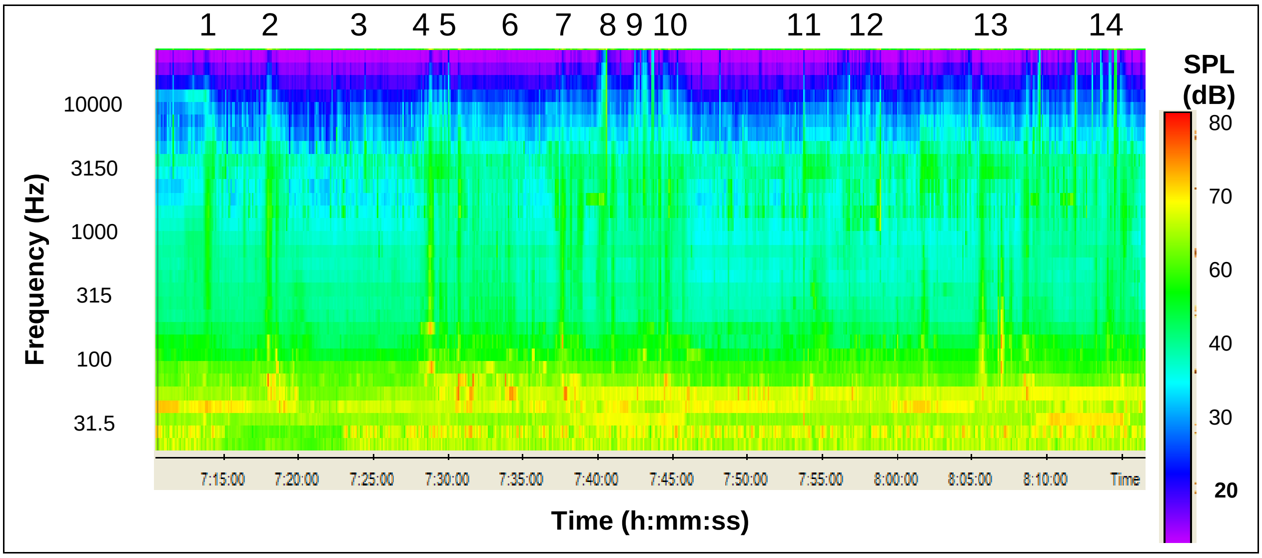

Figure 8: Spectrogram of Measurement L1

Table 4: Key to Spectrogram Annotations

1. Truck depart	2. Truck enter	3. Unloading within building
4. Truck enter	5. Truck depart	6. Unloading within building
7. Truck enter	8. Truck enter & unhitch dog trailer in bunker at L1	9. Unloading within building
10. Truck depart, other Truck enters building	11. Unloading within building	12. Truck depart
13. Truck exit building, collect dog trailer from bunker at L1	14. Truck depart	

The noise from the building is continuous, spectrally and temporally invariant. It is low-frequency and can be seen as the horizontal green and yellow bands at the bottom of the spectrogram. However, the perception of the surveyor at position L1 was that there was a contribution of acoustically similar noise from the adjacent Owens-Illinois (O-I) facility. Such a contribution cannot be separated from the GRS building noise and, if present, will result in an over-estimate of the site noise at this location.

The trucks move slowly within the site. Therefore, truck noise is typically a sustained short-term event and this can be used to separate it from bird calls, which are staccato short-term events. A 1-minute running 10^{th} percentile analysis in ⅓-octave frequency bands of the 1-hour data obtained at L1 provides an estimate of the environmental noise emission from GRS (building + trucks) at the south-eastern boundary. The $L_{\mathrm{min},f,\text{1-hour}}$ spectrum provides an estimate of the spectral signature of the building emission noise. These results are illustrated in Figure 9. The overall average site noise level at L1 thus derived is 53 dB $L_{\mathrm{Aeq},\text{15-min}}$.

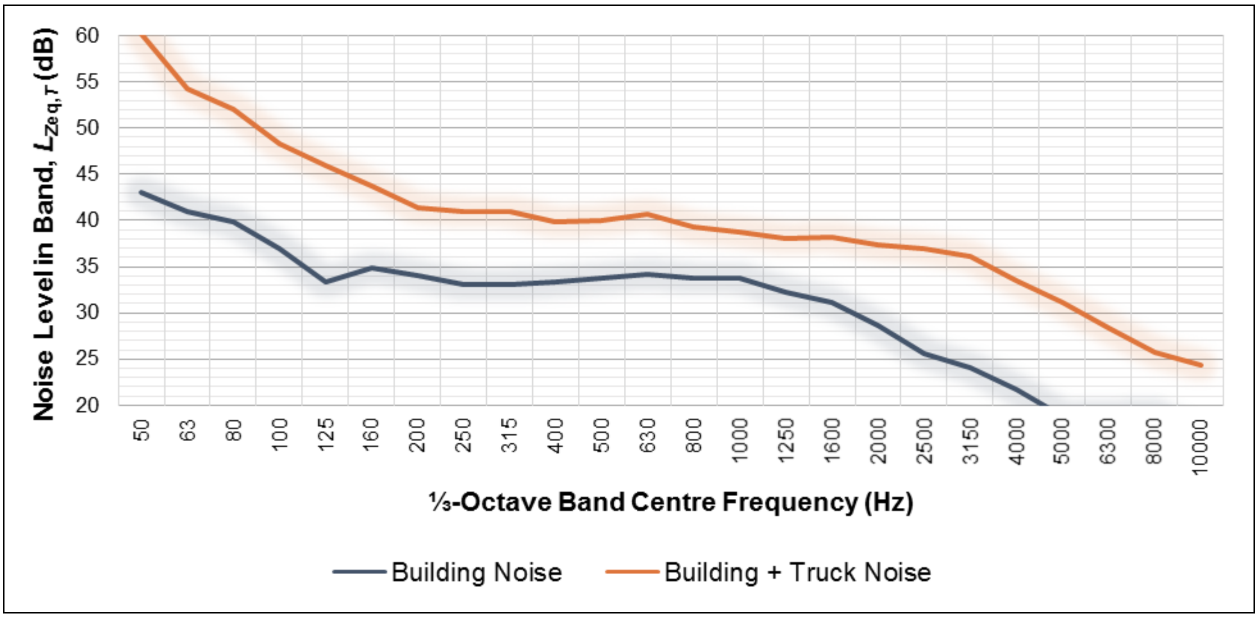

Figure 9: Environmental Noise Emissions at L1

The analysed data, as presented above, compare favourably with the on-site sample measurements made during the Noise Validation Report.

It is noted that the Noise Validation Report daytime survey was conducted at the very end of the daytime period, nominally between 17:00 and 18:00 hours. As stated above, only 10% of the truck movements occur within the last 3-hours of the daytime. Although the number of truck movements is not recorded in the Noise Validation Report, it is expected that the yard was significantly less busy than when it was measured for this assessment between 07:00 and 09:30 hours (nominally).

On this basis, there is no evidence that the site has become materially noisier during the 2-years since the Noise Validation Report assessment was conducted.

The Noise Validation Report provides a measurement of the bag filter dust collector in advance of its acoustic enclosure being sealed. However, the measurement distance is not commensurate with the recommendations of ISO 3744:2010[9] such that it is too close to be in the far-field and not close enough to be in the near field so that neither hemispherical nor parallelepiped emission surface may be assumed. Therefore, the data in the Noise Validation Report cannot be used to determine a baseline sound power level for the unit to compare with current measurements. However, the absence of complaints may be taken as an indicator of satisfactory performance.

[9] International Standard ISO 3744:2010. *Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for an essentially free field over a reflecting plane*

5.3 Bunker Wall Height

The acoustic attenuation provided by a barrier is influenced by:

- The height of the barrier relative to the height of the source.

  To be effective, the barrier needs to interrupt the path of the sound ray between the source and the NSR. The greater the increase in path length over the barrier compared with the direct path without the barrier the greater the attenuation provided by the barrier is. However, this is law of diminishing returns. The additional attenuation achieved by increasing height reduces the higher the barrier is.

- The spectral content of the noise source.

  Low-frequencies (bass tones) are attenuated less than high-frequencies (treble tones).

- The distance between the source and a barrier.

  The attenuation decreases the further the barrier is from a source.

- Weather conditions.

  In acoustically adverse weather conditions such as temperature inversions and/or low-level jets, sound rays that would otherwise point upwards and away from a ground-based NSR are bent horizontal over the top of a barrier towards the ground and NSRs.

With reference to Figure 1 and Figure 3, only NSRs at Echo Place and the southern pitch of Nepean Rugby Park (adjacent to the club house) would benefit by any attenuation provided by the bunker walls. The bunker walls are likely to attenuate primarily relatively low sources, such as trucks and the lower half of the building and roller doors.

The increased attenuation for NSRs at 5 Echo Place and Nepean Rugby Park club house by raising the bunker walls from 3 m to 5 m has been predicted using a model that implements International Standard ISO 9613-2:1996[10] with the meteorological correction (C_{met}) from CONCAWE Report 4/81[11]. The model contains:

- three sources at different heights to represent the south-eastern corner of the building and roller doors, and

[10] International Standard ISO 9613-2:1996. *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation*

[11] Manning, C.J. Acoustic Technology Limited for CONCAWE's Special Task Force on Noise Propagation. (1981) *The Propagation of Noise from Petroleum and Petrochemical Complexes to Neighbouring Communities*. Report 4/81.

- two sources at different heights to represent the engine and exhaust of trucks in the south-eastern area of the site separately.

The source term for the building was derived from the building spectrum shown in Figure 9. The source term for the trucks has been derived from a section of the measurement at L3 whilst a Truck & Dog pulled around the south-eastern corner of the site, which is shown in Figure 10. The engine and exhaust sources were separated by height and frequency according to the method described by Jonasson[12], which is based on Nord2000 and Harmonoise.

Figure 10: Truck Source Term

The truck sources were factored by 5 to represent the total number of movements within the 1-hour measurement at L1. The model was then calibrated against the 'Building + Truck' noise level shown in Figure 9.

The model represents the building and truck noise emissions from the southeast corner of the site over the bunkers on the south-eastern boundary of the site during a busy hour. In this way, it is designed to capture the maximum influence that raising the bunker wall might have. The model also provides an evaluation of increasing the number of truck movements from 6 to 7 for evaluation with the assessment of such provided above.

The model does not include contributions from the rest of the building and bag filter duct collector. Whilst this leads to an under-estimate of overall site noise immission at NSRs, these contributions would dilute the predicted effect of raising the bunker wall because these sources are not influenced by the presence of the bunkers at all. The model is appropriate for the purposes of this NIA. The overall immissions at NSRs and demonstration of compliance with the PSNL limits was provided by the Noise Validation Report. This NIA has demonstrated above that these conclusions remain valid. This model is required to evaluate the differences due to changes in bunker wall height; which it does robustly.

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[12] Jonasson, H. G. (2006) *Acoustic Source Modelling of Nordic Road Vehicles*. SP Rapport 2006:12.

The results of the model are provided in Table 5.

Table 5: Model Results				
NSR	**5 Echo Place**		**Nepean Rugby Park Clubhouse**	
	Immission, $L_{Aeq,15\text{-}min}$ (dB)	**Difference $L_{Aeq,15\text{-}min}$ (dB)**	**Immission, $L_{Aeq,15\text{-}min}$ (dB)**	**Difference $L_{Aeq,15\text{-}min}$ (dB)**
Baseline	30		34	
Increased Bunker Wall	27	-3	31	-3
Increased Capacity	30	0	35	1

With reference to Table 5, the predicted increase in the contribution to site noise immission from trucks would be around 1 dB at NSRs to the southeast of the site at Nepean Rugby Club and Echo Place. This is commensurate with the assessment provided in Section 5.1.2 and concluded that the increase in noise due to increased truck movements is unlikely to be noticeable at NSRs and will not affect compliance with the conditions of the consent.

With reference to Table 5, the results of the model indicate that raising the bunker wall to 5 m would be expected to reduce the contribution of site noise from the south-eastern corner of the building and truck movements by approximately 3 dB at NSRs to the southeast of the site at Nepean Rugby Club and Echo Place. The overall reduction in site noise immission at these NSRs would be less because of the contributions from the rest of the building and from the bag filter dust collector, which are not affected by the bunker walls at all.

It is commonly stated that '*a difference of 3 dB is just perceptible*'. However, the provenance of this statement is rarely provided, which would also provide the qualifiers for the situations in which it applies. It is most commonly applied to assess road traffic noise at moderate levels, e.g. around 60 – 70 dB. As described in Appendix 1, the ear is differently responsive to different frequencies and at different levels. It is considered unlikely that a decrease of less than 3 dB in a noise immission around 30 - 40 dB $L_{Aeq,T}$ would be perceptible.

Furthermore, the site noise immission is significantly masked by other environmental and natural noise sources in the area. The daytime background noise levels at Echo Place and Nepean Rugby Park are around 55 – 60 dB $L_{Aeq,T}$. It is implausible that a decrease of a few dB in the site noise level that is around 20 dB less than the background noise level at NSRs would be perceptible.

Note also that the predicted immission level at 5 Echo Place determined in accordance with the INP is at the boundary of the property, which is the top of a bund at eaves level of the house. Consequently, in this situation the level is the immission to the roof and not to a window or in a garden.

On this basis of the above, an increase in bunker wall height to 5 m or installation of additional walls or barriers would have no influence on the noise impacts at any NSRs. Consequently, requiring that GRS modify their existing bunker walls is considered contrary to the principles of the INP. Replacement or modification of the existing bunker structures would place a significant financial burden on GRS, understood to be around $1,000,000; and disrupt the operation of the site without yielding any positive benefit to any NSRs. As described in Section 3.2, the noise emissions from GRS are effectively controlled in a number of ways and the existing bunker structures provide sufficient attenuation in this regard.

6.0 SUMMARY AND CONCLUSIONS

The noise emissions from GRS are effectively controlled in a number of ways, including site design and management procedures. Truck movements for raw material delivery and finished product and waste removal only occur during the daytime between 06:00 and 18:00 hours. In this context, given the separation distances between the site and NSRs (i.e. several hundred metres), the shielding provided by the local topography (i.e. the bund around Echo Place) and the acoustic masking provided by the heavy traffic on Andrews Road, it is unsurprising that noise from the GRS site is barely audible offsite and that the site has never received any complaints about noise since the operations started in 2014.

A NIA has been conducted in accordance with the INP, which is supported by a noise survey and modelling to provide a thorough investigation of key aspects of the proposal. With regards to the proposal:

- the processing plant may be run at times during which it is currently shut down for maintenance in order to achieve the proposed increase capacity but there will be no increase in noise emission level because no additions or modifications to the plant or building are necessary,
- the increase in processing capacity will lead to an increase in the overall number of trucks visiting the site to deliver material and remove product and waste,
- the noise level from the site when the processing plant is operating will remain the same as currently during the evening and night-time because there will continue to be no truck movements during these periods,
- the maximum number of delivery trucks present in the yard at any one time will not be materially greater in the future than currently, and
- the future busiest/noisiest 15-minute period will be no busier/noisier than the current busiest/noisiest 15-minute period.

The conclusions of the NIA are that:

- the noise impacts associated with the proposed modification to increase capacity will be negligible, and
- compliance with the noise limits contained within the current conditions of consent will continue to be achieved.

A model of the south-eastern corner of the site has been produced to evaluate the effect that increasing the height of the bunker walls in this area would have on noise immissions to NSRs. The results of the noise model indicate that an increase in bunker wall height to 5 m or installation of additional walls or barriers would have no influence on the noise impacts at any NSRs.

Consequently, requiring that GRS modify or replace their existing bunker structures or install additional walls or barriers is considered contrary to the principles of the INP. Replacement or modification of the existing bunker structures would place a significant financial burden on GRS without yielding any positive benefit to any NSRs. As described in Section 3.2, the noise emissions from GRS are effectively and sufficiently controlled at present and by the existing bunker structures.

APPENDIX 1: TERMINOLOGY

Environmental Noise

Noise is commonly described as 'unwanted sound'; a definition similar to that adopted by the seminal Wilson Report[13], which stated:

> *For the purposes of this Report we accept the definition of noise as "sound which is undesired by the recipient"*.

In *Guidelines for Community Noise*[14], the WHO defined environmental (or community) noise as follows:

> *Community noise includes the primary sources of road, rail and air traffic, industries, construction and public works and the neighbourhood.*

Unlike many other pollutants, noise pollution depends not just on the physical aspects of the sound itself, but also the human reaction to it. An environmental noise assessment is required to consider not only the level of noise but also its temporal and acoustic characteristics in the context of those of the background acoustic environment, as experienced by people, and what that means to them. This approach is the consideration of soundscape as defined in ISO 12913-1:2014[15].

In NSW, the EPA state that the overall aim of the Industrial Noise Policy (INP) is to allow the need for industrial activity to be balanced with the desire for quiet in the community. Noise may audible at a level significantly lower than that likely to cause measurable health effects, such as sleep disturbance. Some outcomes of noise intrusion, such as annoyance, can be affected by the attitude of the receptor to the source. In some circumstances, effects may be moderated by adopting realistic expectations of the acoustic environment. That is, by accepting that some noise impact to some people for some of the time is an inevitable and tolerable consequence of a technologically developed society.

Notwithstanding the above, the most effective method of impact reduction is to reduce the source. Responsible operators of noise-generating sites should minimise their noise impacts by the appropriate combination of noise management tools and engineering design of the source. The Polluter Pays Principle (PPP) is the commonly accepted practice that the costs of pollution should be borne by those who cause it. It is recognised as a principle of international environmental law and is a fundamental policy of the Organisation for Economic Co-operation and Development. Quiet is vital resource that is necessary for a healthy society. In some circumstances, operators may need to accept that there are places and/or times into which noise should not be permitted to intrude.

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[13] Committee on the Problem of Noise. *Noise – Final Report*. HMSO 1963.

[14] Berglund B. *et al*. (eds.) *Guidelines for Community Noise*. WHO 1999.

[15] International Standard. ISO 12913-1:2014. *Acoustics — Soundscape — Part 1: Definition and conceptual framework*.

Emission, Propagation and Immission

Emission is the noise that ‘leaves’ (emits from) a source. The noise propagates (‘travels’) through one medium or several media (e.g. through air, ground, walls etc.) before being received at a noise sensitive receptor. ‘Immission’ is the correlative of ‘emission’ and describes the noise being received at the receptor.

An example of noise propagation through several media is trains in tunnels whereby:

- noise is emitted from the train into the air;
- propagates through the air to the tunnel wall;
- propagates through the tunnel wall and ground into the foundations of houses;
- is transmitted from the foundations to the floors and walls of the house;
- is radiated by the walls, floor and ceiling into the air within a room;
- reflects off the walls, floor and ceiling; before finally,
- being received at a person’s ears.

The propagation through a solid medium is commonly referred to as vibration. Another example of noise propagation through several media is airborne noise in a swimming pool that propagates into the water, is reflected within the pool before being received at the ears of a person swimming underwater.

The second example illustrates two acoustic phenomena:

- Some of the acoustic signal is reflected at a change in media so that the transmitted signal can be significantly weaker that the source signal.

- The received acoustic signal is influenced by the acoustic characteristics of the receiving environment.

The amount of reduction depends of differences in the acoustically relevant physical properties between the two media and can be complex and frequency dependent. Air and water are quite different acoustically, which is why it can be a lot quieter underwater in a pool than above the water. The pool is a very ‘echoey’ environment underwater and this can be heard by underwater swimmers.

'A' and 'C' frequency-weighting filters

The human ear is not equally sensitive to sound at all frequencies. In general, it is less sensitive to sound at low frequencies (i.e. 'bass' tones) than it is to mid and high frequencies (i.e. 'treble' tones). Furthermore, the extent of this relative sensitivity to sound at different frequencies is different for sounds of different volumes. The ear is less insensitive to low frequencies for sound at high volumes than it is for sound at low volumes. International Standard ISO 226:2003[16] specifies combinations of sound pressure levels and frequencies of pure continuous tones which are perceived as equally loud by human listeners and are called 'equal loudness contours'.

Sound is commonly measured with a frequency-weighting filter applied. 'A-weighting' and 'C-weighting' are the most commonly used and are illustrated in Figure 11 below. The A and C weightings are based on a tentative American standard published in 1936[17] but remain in current use and are defined in Australian Standard (AS) IEC 61672.1:2004[18]. Whilst later research provides better correlation with how loudness is perceived, the standard approaches for the measurement and assessment of occupational and environmental noise and the criteria for the control of their adverse effects are on the basis of these weightings.

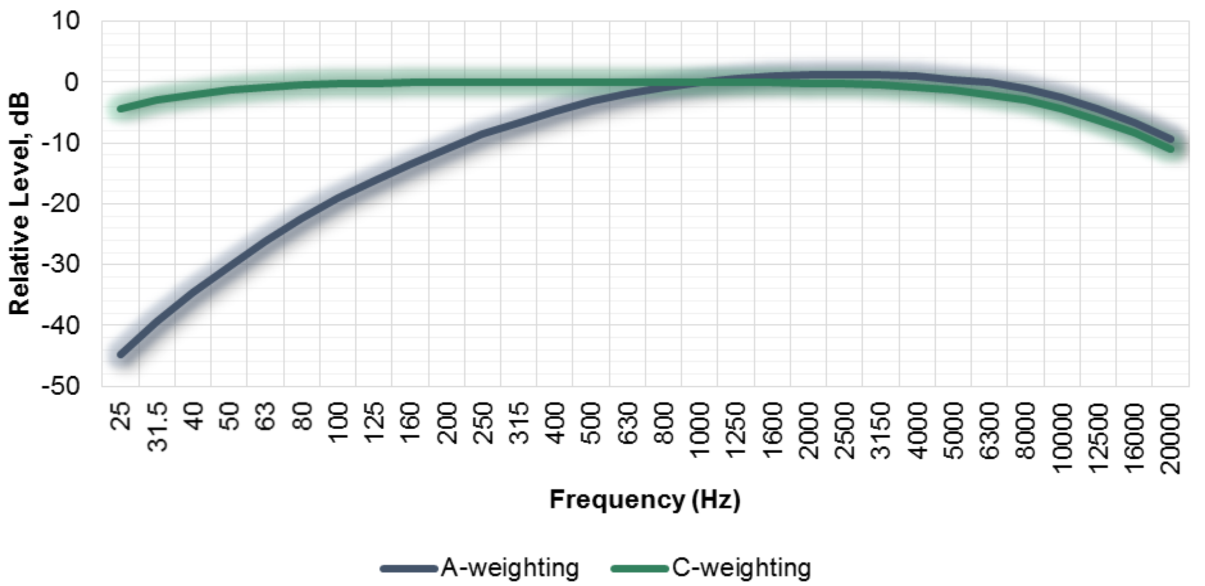

Figure 11: 'A' and 'C' Frequency Weightings

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[16] *International Standard ISO 226:2003 Acoustics - Normal equal-loudness-level contours*. ISO, 2003.

[17] *American Tentative Standards for Sound Level Meters Z24.3-1936.* Journal of the Acoustical Society of America, 1936.

[18] *Australian Standard AS IEC 61672.1-2004. Electroacoustics - Sound level meters. Part 1: Specifications*. Standards Australia, 2004.

Equivalent Sound Pressure Level, $L_{Aeq,T}$

The equivalent continuous A-weighted sound pressure level (integrated level) that has the same mean square sound pressure (referenced to 20 μPa) over the measurement period, T, as the fluctuating sound(s) under consideration. It represents the energy average noise level for the period of interest. The duration 'T' must be stated in the index for the value of the $L_{Aeq,T}$ to be meaningful.

Sound Exposure Level, L_{AE}

The Sound Exposure Level (SEL) is the level that has the same amount of energy in 1-second (i.e. T = 1-second) as the original noise event. It is commonly adopted to describe the noise from an intermittent event, such as road, rail and air vehicle pass-bys. Normalisation of the noise emission level means that overall equivalent noise level during a period, $L_{Aeq,T}$, can be calculated from the SELs of the individual events and the quantum of events.

Statistical Indices, $L_{AN,T}$

These are the A-weighted sound pressure level that is exceeded for *N*% of measurement duration, T. Commonly used percentiles are *N* = 10, 50 and 90%. The $L_{A50,T}$ is the arithmetic average sound pressure level in the time period T.

The $L_{A90,T}$ is the A-weighted sound pressure level that is exceeded for 90% of measurement duration, T. This is commonly termed the 'background noise level' and represents the level of noise that is almost always present in-between louder intermittent events. It is mostly unaffected by the noise from intermittent events; for example, from individual car pass-bys on a local road or from occasional bird calls.

Octave and 1/3rd-octave bands

With reference to the explanation of the frequency-weighting filters above, the frequency content of a noise signal affects how it is perceived and, consequently, how loud it is heard to be. In addition to this, a noise signal that has energy concentrated at a single or over a small range of frequencies, i.e. a tone, whine, hum, screech etc.; is more distinctive (and likely to be more annoying) than a noise signal that has energy spread over a wide range of frequencies (which is called 'broadband' noise) like wind, waterfalls and distant road traffic.

Furthermore, the propagation characteristics of noise outdoors can be very frequency-dependent. For example, high-frequencies attenuate far more rapidly than low-frequencies do with increasing distance from a source. The noise insulation provided by building elements (windows, louvres, walls and floors) is, in general, less to low-frequency noise than it is to high-frequency noise.

Consequently, knowledge of the acoustic frequency content of a noise signal is commonly necessary to a carry out a complete and robust assessment of environmental noise. The frequency content of an environmental noise signal is commonly determined in terms of the noise level within each of a set of time-domain bandpass filters, i.e. a set of band levels.

Octave bands are bandpass filters where the upper frequency limit of each band is twice the lower frequency limit. As would be expected, there are three 1/3-octave bands within each octave band. The upper frequency limit of a 1/3rd-octave band is 1.26 times the lower frequency limit. An octave or 1/3rd-octave band is identified by the geometric mean frequency of each band in Hertz (Hz), which is also called its' centre frequency. The frequency axis of Figure 11 lists the centre frequencies of the 1/3rd-octave bands between 25 and 20,000 Hz.