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# Environmental Noise Assessment

## Proposed Dry Boat Storage Facility, Mindarie Marina

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# 1 INTRODUCTION

It is proposed to construct a dry boat storage facility in the main carpark area at the Mindarie Marina. The facility will provide a secure location for boat owners to store their boats on trailers. The facility will not be used for maintenance of boats or powered flushing of the motor. As such, the activities will primarily be for an owner to drive their car to their boat, connect the trailer, drive to the existing boat ramp and launch the boat. Following use of the boat, it will be returned to the facility and the trailer unhitched. *Figures 1-1* to *1-3* show the proposed facility.

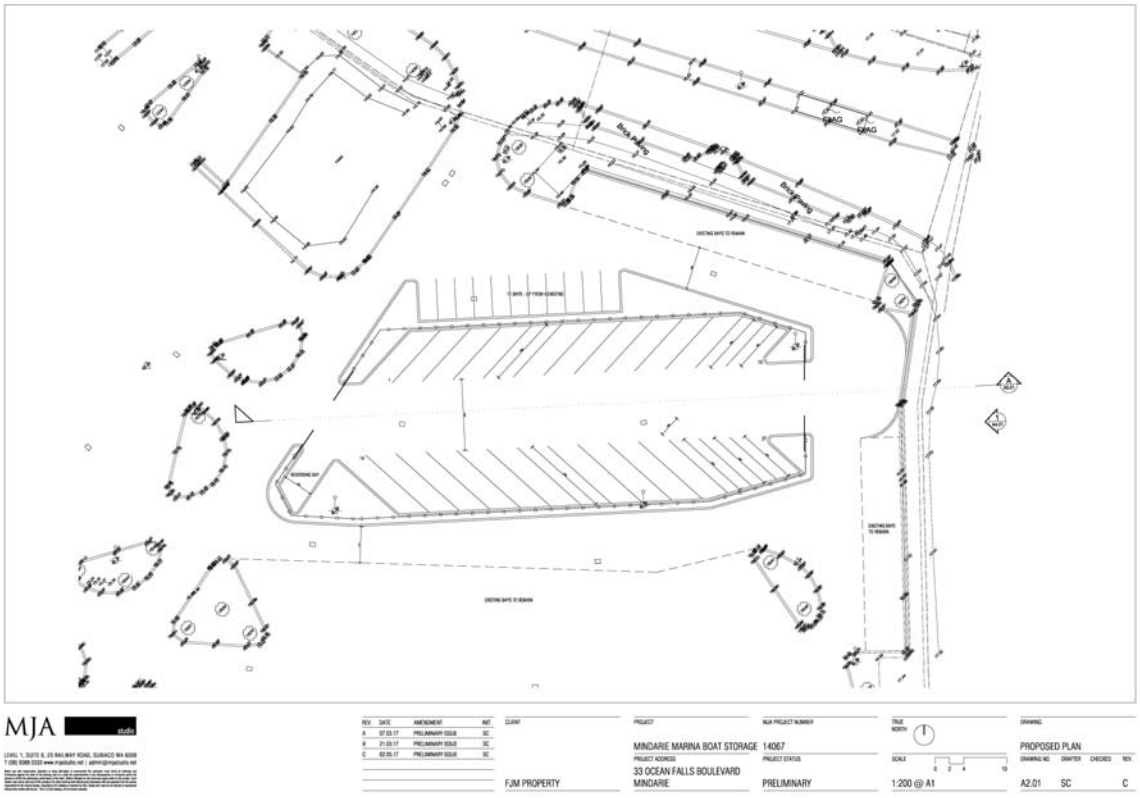



*Figure 1-1 Site Plan*

To the north and south of the facility are residences. Those to the north are not considered specifically in this report since noise from the vehicles on the public roads (Ocean Falls Boulevard and Anchorage Drive), will be noisier than vehicles using the facility. Those to the south (refer *Figure 1-3*) have however been considered in detail due to their separation from the public roads.

It should be noted however that as the carpark (excluding the facility itself) is publicly accessible, noise from the propulsion and braking systems of vehicles are exempt from the prescribed standards of the *Environmental Protection (Noise) Regulations 1997*. Once these same vehicles enter the storage facility, they are no longer exempt given this is not publicly accessible.


*Figure 1-2 Site Plan Over Aerial*


*Figure 1-3 Site Locality in Relation to Residences*

In terms of amenity and actual impacts however, the activities proposed in the storage facility are no different to those that can currently occur in the carpark. Using the *Google Earth* time history (7 February 2016), an example is shown in *Figure 1-4* where cars with trailers are parked in bays closer than the proposed storage facility to the houses in question.

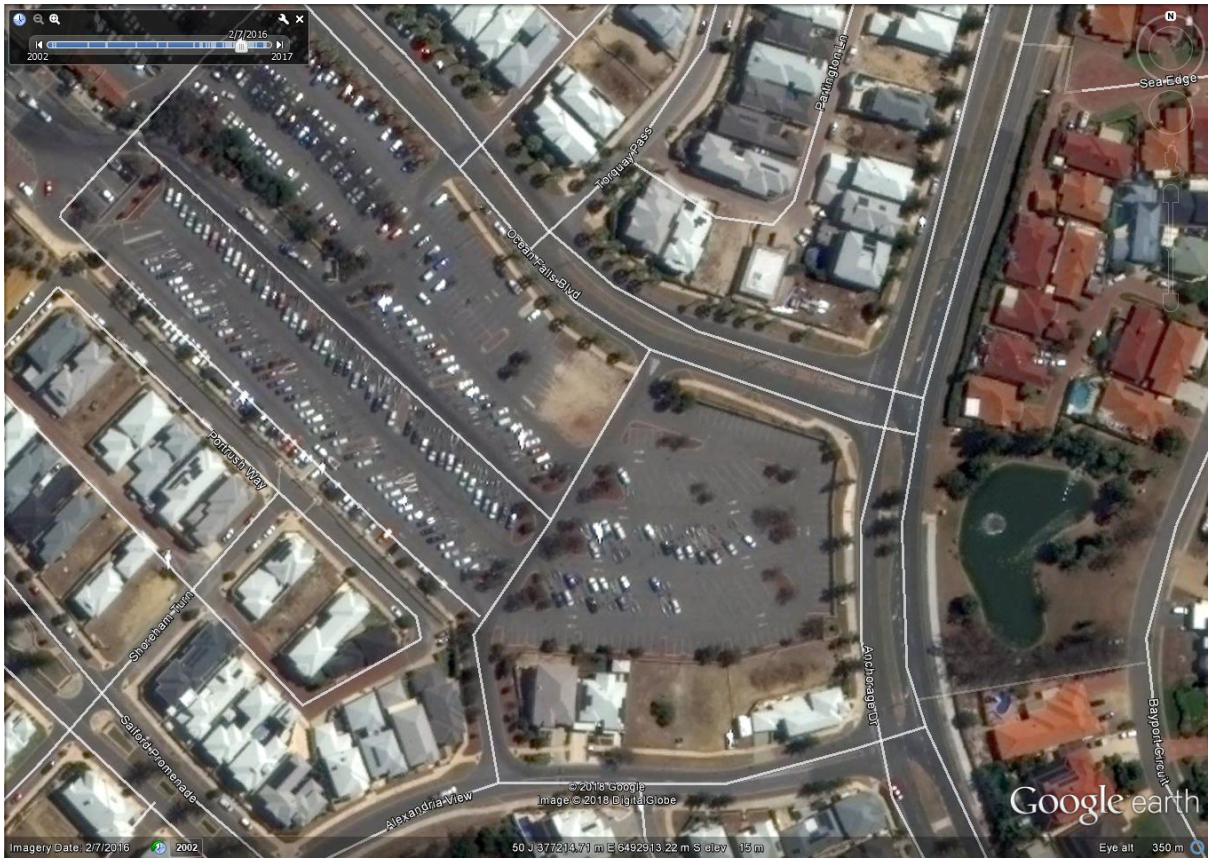



***Figure 1-4 Imagery Showing Existing Use of Carpark***

This report presents the relevant noise criteria, results of indicative noise level measurements for such a facility, calculated noise levels to the residents and assessment of noise.

*Appendix A* contains a description of some of the terminology used throughout this report.

# 2 CRITERIA

Environmental noise in Western Australia is governed by the *Environmental Protection Act 1986*, through the *Environmental Protection (Noise) Regulations 1997* (the Regulations).

Regulation 7 defines the prescribed standard for noise emissions as follows:

"7. (1) Noise emitted from any premises or public place when received at other premises –

(a) Must not cause or significantly contribute to, a level of noise which exceeds the assigned level in respect of noise received at premises of that kind; and

(b) Must be free of –

i. tonality;
ii. impulsiveness; and
iii. modulation,

when assessed under regulation 9"

A "…noise emission is taken to significantly contribute to a level of noise if the noise emission … exceeds a value which is 5 dB below the assigned level…"

Tonality, impulsiveness and modulation are defined in Regulation 9. Noise is to be taken to be free of these characteristics if:

(a) The characteristics cannot be reasonably and practicably removed by techniques other than attenuating the overall level of noise emission; and

(b) The noise emission complies with the standard prescribed under regulation 7 after the adjustments of *Table 2-1* are made to the noise emission as measured at the point of reception.

***Table 2-1 Adjustments Where Characteristics Cannot Be Removed***

| Where Noise Emission is Not Music | | | Where Noise Emission is Music | |
|---|---|---|---|---|
| **Tonality** | **Modulation** | **Impulsiveness** | **No Impulsiveness** | **Impulsiveness** |
| + 5 dB | + 5 dB | + 10 dB | + 10 dB | + 15 dB |

Note: The above are cumulative to a maximum of 15dB.

The baseline assigned levels (prescribed standards) are specified in Regulation 8 and are shown in *Table 2-2*.

***Table 2-2 Baseline Assigned Noise Levels***

| Premises Receiving Noise | Time Of Day | Assigned Level (dB) | | |
|---|---|---|---|---|
| | | $L_{A10}$ | $L_{A1}$ | $L_{Amax}$ |
| Noise sensitive premises: highly sensitive area[1] | 0700 to 1900 hours Monday to Saturday (Day) | 45 + influencing factor | 55 + influencing factor | 65 + influencing factor |
| | 0900 to 1900 hours Sunday and public holidays (Sunday) | 40 + influencing factor | 50 + influencing factor | 65 + influencing factor |
| | 1900 to 2200 hours all days (Evening) | 40 + influencing factor | 50 + influencing factor | 55 + influencing factor |
| | 2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night) | 35 + influencing factor | 45 + influencing factor | 55 + influencing factor |

1. ***highly sensitive area*** means that area (if any) of noise sensitive premises comprising —
   (a) a building, or a part of a building, on the premises that is used for a noise sensitive purpose; and
   (b) any other part of the premises within 15 metres of that building or that part of the building.

The influencing factor, applicable at the noise sensitive premises has been calculated as 0 dB, as such the baseline assigned noise levels are applicable.

It must be noted the assigned noise levels above apply outside the receiving premises and at a point at least 3 metres away from any substantial reflecting surfaces. Given the close proximity of existing buildings and fences, the noise emissions were assessed at a point 1 metre away from building facades and a -2 dB adjustment was made to the predicted noise levels to account for reflected noise.

Under regulation 3, nothing in the Regulations applies to the following noise emissions –

(a) *noise emissions from the propulsion and braking systems of motor vehicles operating on a road;*

As described in *Section 1*, the above means that whilst any vehicle is outside of the storage area, the assigned noise levels are not applicable to the propulsion and braking system.

# 3 METHODOLOGY

## 3.1 Site Measurements

Under the Regulations, there are certain requirements that must be satisfied when undertaking measurements and are defined in Regulations 19, 20, 22 and 23 and Schedule 4. In undertaking the measurements, these have been satisfied, specifically noting the following:

- The sound level meter used was:
    - Bruel & Kjaer Type 2260 Investigator (S/N: 2311736);
- All equipment holds current laboratory certificates of calibration that are available upon request. The equipment was also field calibrated before and after the Event and found to be within +/- 0.5 dB.
- The microphone was fitted with a standard wind screen.
- The microphone was at least 1.2 metres above ground level and at least 3.0 metres from reflecting facades (other than the ground plane).

Measurements were recorded on 23 August 2018 between 10.00am and 10.30am. Meteorological conditions at the time, recorded at the Bureau of Meteorology's Mt Lawley site, were:

- Temperature 13°C
- Humidity 64%
- Wind Speed 3m/s
- Wind Direction Southerly

Background noise was influenced by road traffic and nearby construction activities. Measurements were stopped where either of these were influencing the measurement.

Measurements undertaken at the proposed facility consisted of the following:

- Car, boat and trailer being reversed into a parking bay;
- Trailer was unhitched, which included the car boot being opened and closed and the jockey wheel fitted;
- The trim/tilt of the motor was adjusted;
- The trailer was connected back to the car, which included the jockey wheel being removed and placed back into the boot.

## 3.2 Noise Modelling

The measurements described above were undertaken in close proximity to the noise source. It was not possible to measure the noise directly at the houses due to the low noise levels relative to background noise levels. As such, computer modelling was used to predict the noise emissions to the residences.

The software used was *SoundPLAN 7.4* with the CONCAWE algorithms selected. These algorithms have been selected as they include the influence of wind and atmospheric stability. Input data required in the model are:

- Meteorological Information;
- Topographical data;
- Ground Absorption; and
- Source sound power levels.

### 3.2.1 Meteorological Information

Meteorological information utilised is provided in *Table 3-1* and is considered to represent worst-case conditions for noise propagation. At wind speeds greater than those shown, sound propagation may be further enhanced, however background noise from the wind itself and from local vegetation is likely to be elevated and dominate the ambient noise levels.

*Table 3-1 Modelling Meteorological Conditions*

| Parameter | Night (1900-0700) | Day (0700-1900) |
|---|---|---|
| Temperature ($^{o}$C) | 15 | 20 |
| Humidity (%) | 50 | 50 |
| Wind Speed (m/s) | 3 | 4 |
| Wind Direction* | All | All |
| Pasquil Stability Factor | F | E |

* Note that the modelling package used allows for all wind directions to be modelled simultaneously.

It is generally considered that compliance with the assigned noise levels needs to be demonstrated for 98% of the time, during the day and night periods, for the month of the year in which the worst-case weather conditions prevail. In most cases, the above conditions occur for more than 2% of the time and therefore must be satisfied.

### 3.2.2 Topographical Data

Topographical data was based on that publicly available from *Google Earth* in the form of spot heights. Where residential lots are currently vacant, an assumed dwelling was positioned on the lot, with all assumed to be of two storey construction.

### 3.2.3 Ground Absorption

Ground absorption varies from a value of 0 to 1, with 0 being for an acoustically reflective ground (e.g. water or bitumen) and 1 for acoustically absorbent ground (e.g. grass). In this instance, a value of 0.0 has been used given the area is a carpark.

### 3.2.4 Source Sound Levels

The sound power levels used in the modelling were derived from the measurements. *Figures 3-1* to *3-3* show the noise levels over time of each activity, measured at a distance of approximately 1.5 metres.

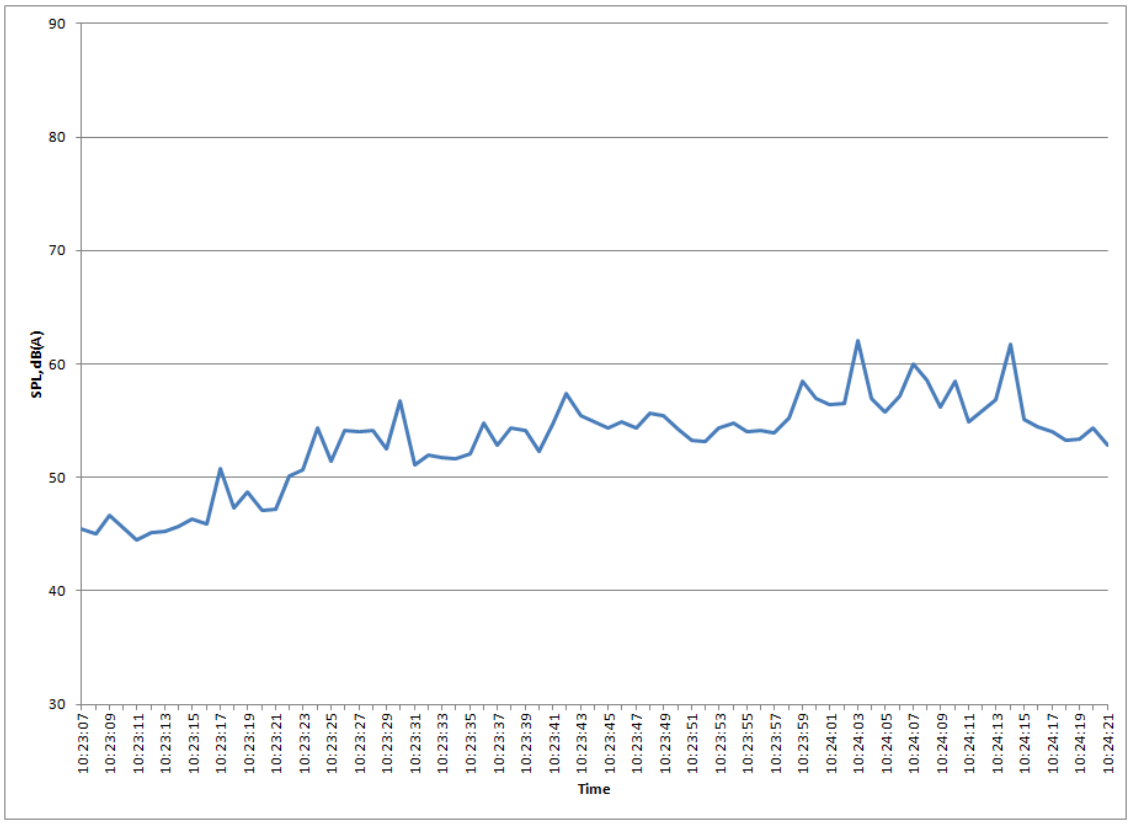



*Figure 3-1 Time History of Car Reversing*

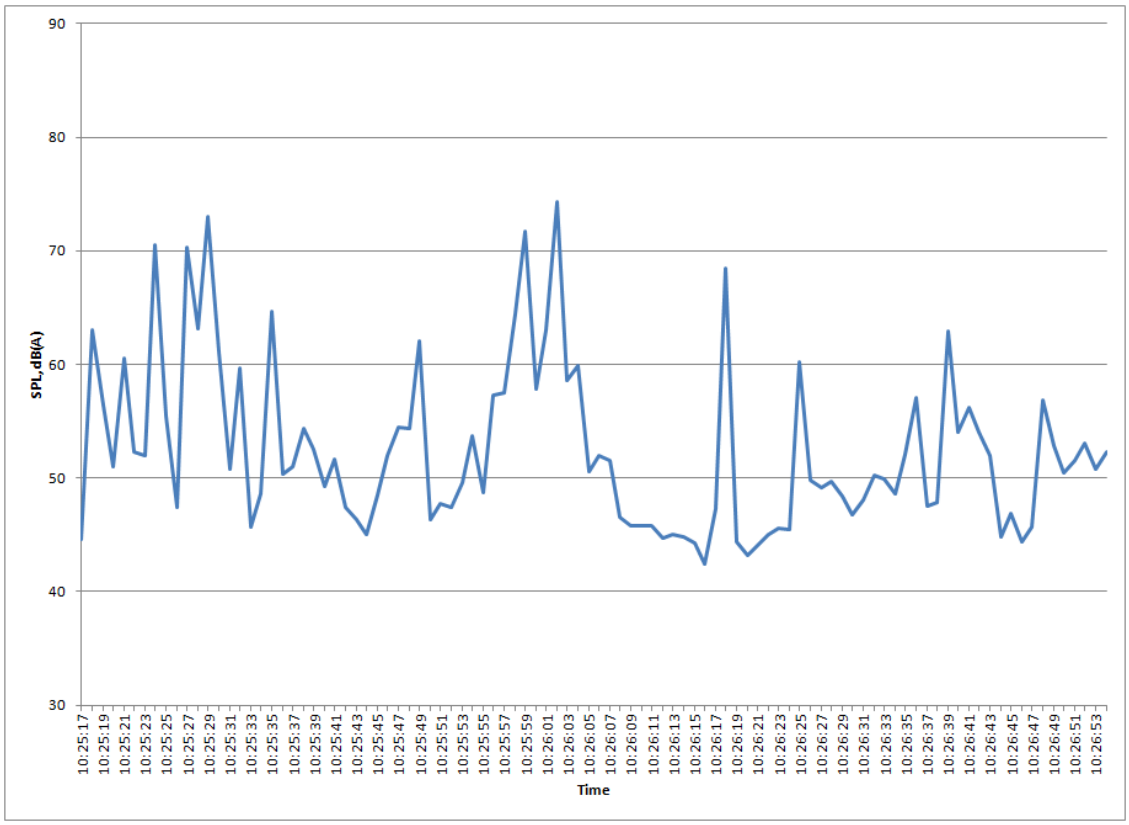



*Figure 3-2 Time History of Trailer Being Unhitched*

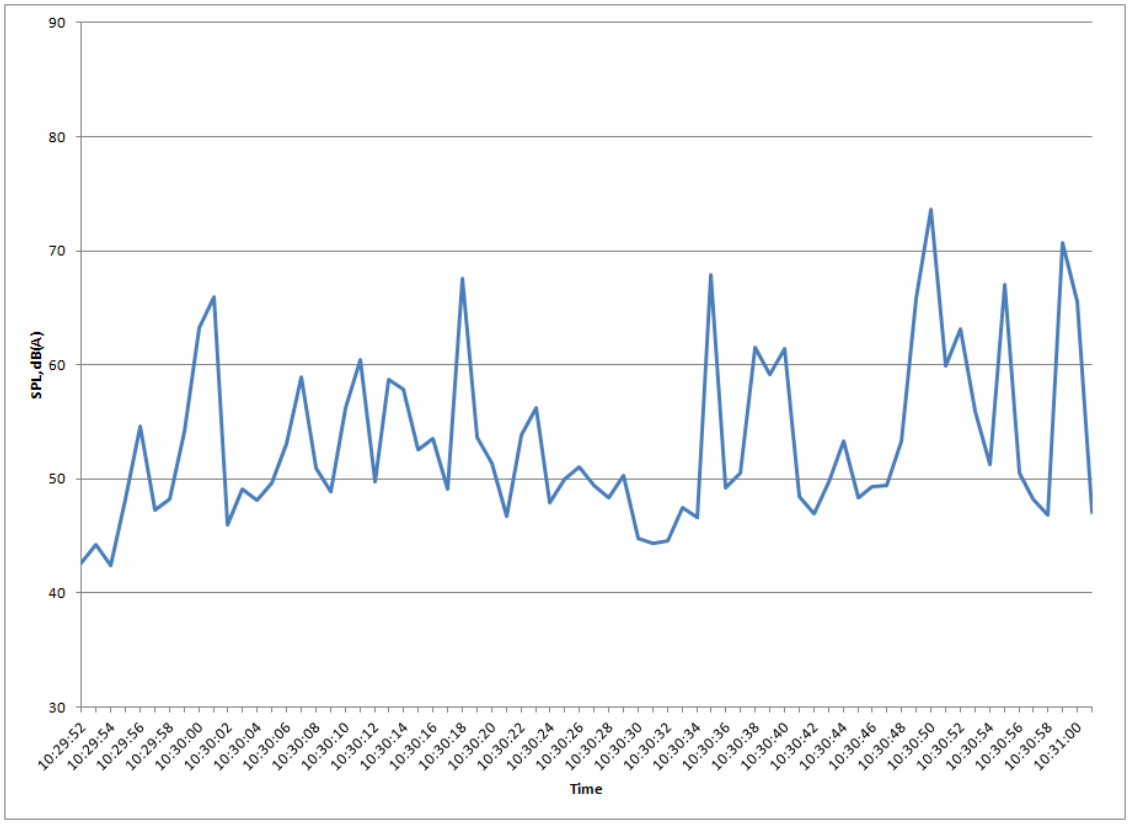



*Figure 3-3 Time History of Trailer Being Connected*

A separate measurement was also undertaken of the engine power tilt/trim being operated. Combining the above, the $L_{Amax}$, $L_{A1}$ and $L_{A10}$ over a 15-minute period were determined with these sound power levels presented in *Table 3-2*. It should be noted that two maximum noise events are considered as whilst this operation was the noisiest and is considered tonal, the next highest noise event of closing the boot was considered impulsive and therefore subject to a greater penalty (refer *Table 2-1*).

*Table 3-2 Source Sound Power Levels, dB*

| Description | Octave Band Centre Frequency (Hz) | | | | | | | | Overall dB(A) |
|---|---|---|---|---|---|---|---|---|---|
| | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | |
| Motor Trim - $L_{max}$ | 68 | 69 | 67 | 77 | 85 | 85 | 81 | 80 | **90** |
| Closing Car Boot - $L_{max}$ | 72 | 70 | 72 | 75 | 84 | 83 | 82 | 77 | **88** |
| Combined Activities – $L_1$ | 69 | 66 | 64 | 70 | 77 | 81 | 82 | 73 | **85** |
| Combined Activities – $L_{10}$ | 78 | 70 | 65 | 63 | 60 | 59 | 57 | 50 | **67** |

# 4 RESULTS

The noise levels have been predicted to the nearest residences by locating each of the *Table 3-2* noise sources within each proposed southern parking bay with *Table 4-1* providing the results.

*Table 4-1 Predicted Noise Levels, dB(A)*

| Address | Noise Source | | | |
|---|---|---|---|---|
| | Motor Trim - $L_{max}$ | Closing Boot - $L_{max}$ | Combined Activities – $L_1$ | Combined Activities – $L_{10}$ |
| 4 Alexandria View | 50 | 47 | 45 | 26 |
| 6 Alexandria View | 49 | 46 | 43 | 25 |
| 8 Alexandria View | 49 | 46 | 44 | 25 |
| 10 Alexandria View | 50 | 47 | 44 | 25 |
| 12 Alexandria View | 49 | 46 | 44 | 25 |

# 5 ASSESSMENT

Assuming the boat storage facility is used during the night period, the most stringent assigned noise levels are 35 dB $L_{A10}$, 45 dB $L_{A1}$ and 55 dB $L_{Amax}$.

The $L_{A10}$ and $L_{A1}$ noise sources were not found to contain intrusive characteristics. The $L_{Amax}$ noise sources were found to be tonal for the power trim operation and impulsive for closing car boots and therefore the predicted noise levels are to be adjusted by + 5 dB and + 10 dB respectively.

For the motor trim operation, the worst-case predicted noise level is 50 dB $L_{Amax}$, which is adjusted to 55 dB $L_{Amax}$. This complies with the assigned noise levels at all times.

For the closing of a car door/boot, the worst-case calculated noise level is 47 dB $L_{Amax}$, which is adjusted to 57 dB $L_{Amax}$. This marginally exceeds the night and evening assigned noise level by 2 dB.

The worst-case $L_{A1}$ and $L_{A10}$ noise levels are calculated to be 45 dB $L_{A1}$ and 26 dB $L_{A10}$, both of which are compliant at all times.

# 6 RECOMMENDATIONS

Compliance is generally calculated to be achieved. The only exception to this was a calculated exceedance of up to 2 dB from a car door/boot closing. This is considered a minor exceedance as:

- The amount of exceedance is small;
- The amount of exceedance includes a 10 dB adjustment for impulsiveness;
- Such events already occur in the area and would in fact occur closer to the residences in the public parking areas.

The carpark gates have not been specifically assessed, however the supplier is to be made aware of their obligation to comply with the assigned noise levels of the *Environmental Protection (Noise) Regulations 1997*.

The analysis shows that for the most part, compliance will be achieved and will be no worse than what can currently occur in the public carpark. Nevertheless, users of the facility are to be advised to:

- minimise noise generally whilst in the area, given the proximity of houses;
- not operate their boat motors in the area;
- reversing alarms on work type vehicles to be turned off and spotters used where necessary;
- not to leave vehicle engines running;
- not to leave car radios on.

**Appendix A**

# Terminology

The following is an explanation of the terminology used throughout this report.

***Decibel (dB)***
The decibel is the unit that describes the sound pressure and sound power levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

***A-Weighting***
An A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. An A-weighted sound level is described as $L_A$ dB.

***Sound Power Level ($L_w$)***
Under normal conditions, a given sound source will radiate the same amount of energy, irrespective of its surroundings, being the sound power level. This is similar to a 1kW electric heater always radiating 1kW of heat. The sound power level of a noise source cannot be directly measured using a sound level meter but is calculated based on measured sound pressure levels at known distances. Noise modelling incorporates source sound power levels as part of the input data.

***Sound Pressure Level ($L_p$)***
The sound pressure level of a noise source is dependent upon its surroundings, being influenced by distance, ground absorption, topography, meteorological conditions etc and is what the human ear actually hears. Using the electric heater analogy above, the heat will vary depending upon where the heater is located, just as the sound pressure level will vary depending on the surroundings. Noise modelling predicts the sound pressure level from the sound power levels taking into account ground absorption, barrier effects, distance etc.

***$L_{ASlow}$***
This is the noise level in decibels, obtained using the A frequency weighting and the S (Slow) time weighting as specified in IEC 61672-1:2002. Unless assessing modulation, all measurements use the slow time weighting characteristic.

***$L_{AFast}$***
This is the noise level in decibels, obtained using the A frequency weighting and the F (Fast) time weighting as specified in IEC 61672-1:2002. This is used when assessing the presence of modulation only.

***$L_{APeak}$***
This is the greatest absolute instantaneous sound pressure in decibels using the A frequency weighting as specified in IEC 61672-1:2002.

***$L_{Amax}$***
An $L_{Amax}$ level is the maximum A-weighted noise level during a particular measurement.

***$L_{A1}$***
An $L_{A1}$ level is the A-weighted noise level which is exceeded for one percent of the measurement period and is considered to represent the average of the maximum noise levels measured.

***$L_{A10}$***
An $L_{A10}$ level is the A-weighted noise level which is exceeded for 10 percent of the measurement period and is considered to represent the "*intrusive*" noise level.

***$L_{Aeq}$***
The equivalent steady state A-weighted sound level ("equal energy") in decibels which, in a specified time period, contains the same acoustic energy as the time-varying level during the same period. It is considered to represent the "average" noise level.

***$L_{A90}$***
An $L_{A90}$ level is the A-weighted noise level which is exceeded for 90 percent of the measurement period and is considered to represent the "*background*" noise level.

***One-Third-Octave Band***
Means a band of frequencies spanning one-third of an octave and having a centre frequency between 25 Hz and 20 000 Hz inclusive.

***$L_{Amax}$ assigned level***
Means an assigned level which, measured as a $L_{A\ Slow}$ value, is not to be exceeded at any time.

***$L_{A1}$ assigned level***
Means an assigned level which, measured as a $L_{A\ Slow}$ value, is not to be exceeded for more than 1% of the representative assessment period.

***$L_{A10}$ assigned level***
Means an assigned level which, measured as a $L_{A\ Slow}$ value, is not to be exceeded for more than 10% of the representative assessment period.

***Tonal Noise***
A tonal noise source can be described as a source that has a distinctive noise emission in one or more frequencies. An example would be whining or droning. The quantitative definition of tonality is:

the presence in the noise emission of tonal characteristics where the difference between -

(a) the A-weighted sound pressure level in any one-third octave band; and

(b) the arithmetic average of the A-weighted sound pressure levels in the 2 adjacent one-third octave bands,

is greater than 3 dB when the sound pressure levels are determined as $L_{Aeq,T}$ levels where the time period T is greater than 10% of the representative assessment period, or greater than 8 dB at any time when the sound pressure levels are determined as $L_{A\ Slow}$ levels.

This is relatively common in most noise sources.

***Modulating Noise***
A modulating source is regular, cyclic and audible and is present for at least 10% of the measurement period. The quantitative definition of modulation is:

a variation in the emission of noise that —

(a) is more than 3 dB $L_{A\ Fast}$ or is more than 3 dB $L_{A\ Fast}$ in any one-third octave band;

(b) is present for at least 10% of the representative.

***Impulsive Noise***
An impulsive noise source has a short-term banging, clunking or explosive sound. The quantitative definition of impulsiveness is:

a variation in the emission of a noise where the difference between $L_{A\ peak}$ and $L_{A\ Max\ slow}$ is more than 15 dB when determined for a single representative event;

***Major Road***
Is a road with an estimated average daily traffic count of more than 15,000 vehicles.

***Secondary / Minor Road***
Is a road with an estimated average daily traffic count of between 6,000 and 15,000 vehicles.

***Influencing Factor (IF)***

$$= \frac{1}{10}(\%\ \text{Type A}_{100} + \%\ \text{Type A}_{450}) + \frac{1}{20}(\%\ \text{Type B}_{100} + \%\ \text{Type B}_{450})$$

*where*:

$\%\ \text{Type A}_{100}$ = the percentage of industrial land within a 100m radius of the premises receiving the noise

$\%\ \text{Type A}_{450}$ = the percentage of industrial land within a 450m radius of the premises receiving the noise

$\%\ \text{Type B}_{100}$ = the percentage of commercial land within a 100m radius of the premises receiving the noise

$\%\ \text{Type B}_{450}$ = the percentage of commercial land within a 450m radius of the premises receiving the noise

+ Traffic Factor (maximum of 6 dB)

= 2 for each secondary road within 100m

= 2 for each major road within 450m

= 6 for each major road within 100m

***Representative Assessment Period***
Means a period of time not less than 15 minutes, and not exceeding four hours, determined by an inspector or authorised person to be appropriate for the assessment of a noise emission, having regard to the type and nature of the noise emission.

***Background Noise***
Background noise or residual noise is the noise level from sources other than the source of concern. When measuring environmental noise, residual sound is often a problem. One reason is that regulations often require that the noise from different types of sources be dealt with separately. This separation, e.g. of traffic noise from industrial noise, is often difficult to accomplish in practice. Another reason is that the measurements are normally carried out outdoors. Wind-induced noise, directly on the microphone and indirectly on trees, buildings, etc., may also affect the result. The character of these noise sources can make it difficult or even impossible to carry out any corrections.

***Ambient Noise***
Means the level of noise from all sources, including background noise from near and far and the source of interest.

***Specific Noise***
Relates to the component of the ambient noise that is of interest. This can be referred to as the noise of concern or the noise of interest.

***Peak Component Particle Velocity (PCPV)***

The maximum instantaneous velocity in mm/s of a particle at a point during a given time interval and in one of the three orthogonal directions (x, y or z) measured as a peak response. Peak velocity is normally used for the assessment of structural damage from vibration.

***Peak Particle Velocity (PPV)***

The maximum instantaneous velocity in mm/s of a particle at a point during a given time interval and is the vector sum of the PCPV for the x, y and z directions measured as a peak response. Peak velocity is normally used for the assessment of structural damage from vibration.

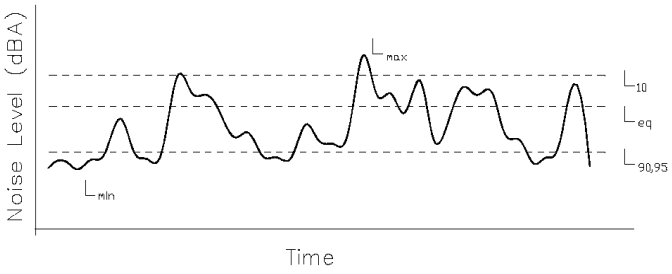
***RMS Component Particle Velocity (PCPV)***

The maximum instantaneous velocity in mm/s of a particle at a point during a given time interval and in one of the three orthogonal directions (x, y or z) measured as a root mean square (rms) response. RMS velocity is normally used for the assessment of human annoyance from vibration.

***Peak Particle Velocity (PPV)***

The maximum instantaneous velocity in mm/s of a particle at a point during a given time interval and is the vector sum of the PCPV for the x, y and z directions measured as a root mean square (rms) response. RMS velocity is normally used for the assessment of human annoyance from vibration.

***Chart of Noise Level Descriptors***




***Typical Noise Levels***