STOR Generator Noise Report

Report No. 2603151NR

Client: Mr. Chris Akrill TPS Ltd.

Date of Issue: 13th May 2015

Booths Farm, Cheadle, Stoke-on-Trent

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Executive Summary

A noise assessment has been undertaken for Mr. Chris Akrill of TPS Ltd. This is to assess likelihood of sound impact from a proposed STOR diesel generator system, to be installed at land belonging to Booths Farm, Cheadle, Stoke-on-Trent.

Background noise levels have been measured at the Nearest Sensitive Receptor (NSR) location near the residential property at 204 Froghall Road. Background levels were measured at their lowest at **46.6dB L_{A90}** during the daytime and **44.8dB L_{A90}** at night.

The Specific Sound Level has been calculated based on manufacturers product information, distance attenuation and insertion losses from the 4m fencing system likely to be used at the site. As no sonic features (tones, impulses) are likely to be a factor, the Sound Rating Level is determined to be **41.3dB L_{Aeq}**.

Using the BS4142:2014[2] framework, emissions from the STOR facility would be **3.5dB BELOW** Background Noise Levels, and be described as having **"Low Impact"** at the ***NSR location*****.**

Including a 1m acoustic screen at the earthen bund's apex, noise levels would be reduced to **35.3dB,** therefore **9.5dB BELOW** Background Noise Levels.

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1. Introduction

Peak Acoustics Ltd has been commissioned by Mr. Chris Akrill of Town Planning Services Ltd. to undertake a noise survey at land forming part of Booths Farm, off Froghall Road, Cheadle, Stoke-on-Trent. This is in order to assess noise impact from installation of a proposed Short Term Operating Reserve (STOR) generator facility. The site is currently brownfield land, located on Clamgoose Lane, a minor road leading from the A521/Froghall Road.

Current Background Noise levels have been measured at the Nearest Sensitive Receptor, namely the residential property at 204 Froghall Road. Specific Sound Levels have been calculated following the procedure described in BS4142:1997[1] “Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas” and BS4142:2014[2] “Method for Rating and Assessing Industrial and Commercial Sound”.

The assessment of noise rating at the NSRs are based on guidance in BS4142:2014[2], where the Sound Rating Level from the STOR facility ($L_{Aeq,\,T}$) must be compared to the background noise level ($L_{A90,T}$).

All the standards, legislation, guidance and methods followed to carry out this assessment report are described in Section 0.1.

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1.1 Legislation and Guidance References

[1] BS4142: 1997 – *"Method for rating industrial noise affecting mixed residential and industrial areas"* [British Standards Institution]

BS 4142:1997 provides a method of rating industrial noise affecting mixed residential and industrial areas. It was first published in 1967 and has been extensively used by local authorities and consultants to rate noise from fixed installations. The standard was considerably revised in 1990, clarified in 1997, and advocates the use of $L_{Aeq, T}$ - a level, which is directly measurable and termed the **Specific Noise Level**.

The Specific Noise Level is subject to a +5dB correction if characteristics are present within the noise (intermittent, tonal, impulses) and then is termed the **Noise Rating Level**. When used to assess industrial noise, the Rating Level is determined and the L_{A90} background level is subtracted from it. A difference of around 10dB or higher indicates that complaints are likely. A difference of around +5dB is of marginal significance. A difference of -10dB indicates that complaints are unlikely.

BS4142:1997 states that the measurement locations should be ≥3m away from any other reflecting façade) and at a preferred height of 1.2m – 1.5m above ground level. Should sources be located at 1st floor or above, a 4m measurement should be taken. All prevailing weather conditions should be noted, with a subjective impression of noise levels also included within any documentation.

Daytime measurement periods are defined in BS4142:1997[1] as being between 07:00 and 23:00 hours, with night-time periods being between 23:00 and 07:00.

BS4142:1997 compares the **highest noise rating level** with the **lowest background noise level** and effectively sets out the **worst possible outcome** based on the levels measured.

[2] BS4142:2014 – *"Method for Rating and Assessing Industrial and Commercial Sound"* [British Standards Institution]

BS 4142:2014 provides a method of rating and assessing impact from industrial and commercial sounds. It was first published in 1967 and has been extensively used by local authorities and consultants to rate noise from fixed installations. The standard was considerably revised in 1990, clarified in 1997, and finally significantly altered in 2014. The methods described in this British Standard use outdoor sound levels to assess the likely impacts of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

BS 4142:2014 advocates the use of $L_{Aeq, T}$ - a level, which is directly measurable and termed the **Specific Sound Level**.

Subjectively the Specific Sound Level may be corrected as follows:

- Tonality; +2dB, +4dB or +6dB depending on prominence
- Impulsivity; +3dB, +6dB or +9dB depending on prominence.

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Other sound characteristics that are neither tonal nor impulsive, though otherwise are readily distinctive against the residual acoustic environment, can have a penalty of 3dB applied.

The **one-third octave method** tests for the presence of a prominent, discrete-frequency spectral component (tone) typically compares the $L_{Zeq,T}$ sound pressure level averaged over the time when the tone is present in a one-third-octave band with the time-average linear sound pressure levels in the adjacent one-third-octave bands. For a prominent, discrete tone to be identified as present, the time-averaged sound pressure level in the one-third-octave band of interest is required to exceed the time-averaged sound pressure levels of both adjacent one-third-octave bands by some constant level difference. The level differences between adjacent one-third-octave bands that identify a tone are:

• 15 dB in the low-frequency one-third-octave bands (25Hz to 125Hz);

• 8 dB in the middle-frequency one-third-octave bands (160Hz to 400Hz); and

• 5 dB in the high-frequency one-third-octave bands (500Hz to 10,000Hz).

The **reference (objective)** method. If the presence of audible tones is in dispute, a special measurement procedure can be used to verify their presence. Based on the prominence of the tones this procedure also provides recommended level adjustments. The aim of the reference method is to assess the prominence of tones in the same way as listeners do on average. The method is based on the psychoacoustic concept of critical bands, which are defined so that sound outside a critical band does not contribute significantly to the audibility of tones inside that critical band. The method includes procedures for steady and varying tones, narrow-band sound and low-frequency tones, and the result is a graduated 0dB to 6dB adjustment. It is known as the Joint Nordic Method 2 and is to be found in ISO 1996-2. The reference method is also described in BS4142:2014.

Specific Sound Level with (or without) added contentions is termed the **Rating Level**. When used to assess industrial or commercial sound, the Rating Level is determined and the L_{A90} background level is subtracted from it. Typically, the greater this difference, the greater the magnitude of the **impact**.

A difference of around **+10dB** or more is likely to be an indication of a **significant adverse impact**, depending on the context.

A difference of around **+5dB** is likely to be an indication of an **adverse impact**, depending on the context.

The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact.

Where the rating level does **not exceed the background sound level**, this is an indication of the specific sound source having a **low impact**, depending on the context.

BS4142:2014 compares the **highest sound rating level** with the **lowest background noise level** and effectively sets out the **worst possible outcome** based on the levels measured.

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2. Site Description

2.1 Existing Site Conditions

The site under investigation is a brownfield area of land forming Booths Farm, Clamgoose Lane, Cheadle, Stoke-on-Trent. The Nearest Sensitive Receptor, a residential dwelling-house is located approximately 320m southeast of the site. It exists close to the A521, a high-speed, single-carriage major road between Cheadle and Froghall.

2.2 Proposed Site Conditions

Part of the site is proposed to be developed by installing 30no. industrial Short Term Operating Reserve (STOR) diesel generators, in order to fulfil energy shortfall in the electricity grid supply. The generators are to be arranged in such close proximity that they can be considered a single source. The perimeter of the site is to have a 2m bund, providing both a visual screen and assisting in providing a sound insertion loss, reducing noise levels at the receptor.

The hours of operation are likely to be predominantly over peak energy demand hours (between 07:00-09:00 and 18:00-21:00), although potentially can operate at any time during a 24-hour day.

2.3 Nearest Sensitive Receptor

The Nearest Sensitive Receptor has been identified during measurements as receptors inside the residential property at 204 Froghall Road, approximately 320m southeast of the site boundary.

Appendix C shows location of the NSR.

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3. Environmental noise survey

Daytime background (L_{A90}) noise measurements have been carried out close to the NSR, between 22:00-23:00 on 16th April 2015. Night-time levels have been recorded at the same location between 23:00-00:30 on 16th-17th April 2015.

3.1 Measurement Locations

Free field noise measurements have been carried out at ground floor level, on the inlet road between the grass verge and the NSR.

Site view and details of measurement locations are shown in **Appendix C**.

3.2 Measurement Equipment

A Class 1 Svantek sound level meter and Class 1 microphone have been used to collect noise level data. An all-weather environmental measurement kit was used to mount the microphone to the tripod, in order to reduce the effects of adverse meteorology. The measuring equipment was calibrated before and after the measurements. A summary of measurement equipment and calibration information can be found in **Appendix B**.

3.3 Weather Conditions

Weather Conditions

Climate	15°C, Dry, bright
Wind Speed	3.4m/sec^{-1}
Humidity	66%
Precipitation	0mm

3.4 Measured Background Noise Levels

A summary of the lowest background noise levels measured is shown below.

Detailed measured levels can be found in **Appendix D.**

Measured background noise levels

	$L_{Aeq,T}$ dB	$L_{A90,T}$ dB
Daytime 1hr	52.4	46.6
Night-time 5mins	45.9	44.8

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3.5 Subjective Impressions

Background noise at the site itself is extremely low, with little in the way of contributing sources. Distant traffic tends to be the predominant feature in the noise climate.

Prevailing noise at the NSR on Froghall Road is almost solely from road transit sources (aerodynamic/body noise), with minor/secondary sources from residents' dogs barking and passing pedestrians talking. At the time of measurement, traffic was light and sporadic, and composed of mainly cars, with only two HGV vehicles passing during the site visit.

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4. Assessment

Since at the time of the survey the proposed STOR facility has not yet been installed, it was not possible to measure the Ambient Sound Level or Residual Sound Level. Thus, calculation of the Specific Sound Level has been carried out based on available manufacturer's details.

The Specific Sound Level is the level of noise produced by the generator facility at the Nearest Sensitive Receptor location.

4.1 Noise Level Analysis

Background noise levels at the site appear to be show typical patterns of those found from traffic passing a receptor point. The L_{eq} peak values in the graph in **Appendix D** indicate the passing of vehicles, with the L_{A90} figures representing the climate without the influence of traffic. The narrowing of these two curves over the night-time period again is typical of traffic sources, as the number of provincial road users decreases.

The spectral graphs show a moderate low-frequency component during the lowest daytime hours 22:00-23:00, dropping significantly into the night-time period 23:00-00:30.

4.2 STOR Generator Details

The units proposed for installation are FG Wilson P750-1 CAE acoustically-enclosed generator units, and have an output Sound Pressure Level listed at 85.6dB @1m. As **thirty** units are planned to be in concurrent use, a combined Sound Pressure Level has been calculated thus:

$$L_{p2} = 10\log_{10} [30*(10^{Lp1/10})]$$

$$L_{p2} = \underline{\mathbf{100.4dB}}$$

Where:
L_{p1} = Sound pressure level of individual generator unit, 85.6dB
L_{p2} = Combined sound pressure level of all generators running (dB)

4.3 Specific Sound Level Calculations

This section calculates the sound emission level from the STOR facility at the NSR at 204 Froghall Road. Sound emitted from the facility would be subject to point-source distance and barrier attenuation before reaching any receiver.

4.3.1 Distance Attenuation

Sound from a point source (minimal dimensionality, used here due to distance between source and receiver) decays at a rate of 6dB per doubling of distance. This corresponds to the formula:

$$L_{p2} = L_{p1} - (20\log_{10} r)$$

Where:

L_{p1} = Noise sound pressure levels at the source (dB)

L_{p2} = Noise sound pressure levels at receiver (dB)

r = Distance between source and receiver (m)

A distance of 320m would result in a reduction to any Specific Sound Level of **50.1dB**

4.3.2 Barrier Attenuation

TPS Ltd. plan to install an earthen bund around the perimeter of the site, to aid in reducing visual and auditory impact from the development. This section analyses the likely reductions of this bund, and any improvements that can be made to insertion losses (reductions) as a result of installing a 1m acoustic barrier to the bund's peak.

Maekawa barrier calculations have been used to determine likely reductions, and are shown in detail in **Appendix E.** The Maekawa formula for barrier insertion loss is as follows:

$$\Delta_{barrier} = 10\log_{10}(3+[20N]) \text{ where } \delta > 0\text{, or;}$$

$$\Delta_{barrier} = 10\log_{10}(3-[20N]) \text{ where } \delta \leq 0$$

Where:
$\Delta_{barrier}$ = Insertion Loss of barrier (dB)
δ = Path Difference (m)
N = Fresnel No. $[2\delta/\lambda]$

The **earthen bund alone** would stand at 2m, covering the 2m source height of the generators. This would lead to a **zero path difference**, and a broadband insertion loss of 14.3dB. In practice, this is likely to be reduced to a **9dB insertion loss**, as some low-frequency sound would potentially refract above the barrier.

Peak Acoustics recommends adding a 1m acoustic barrier screen, as this would raise path difference to **0.158m**, improve reductions to 25.1dB, and perform better at lower frequency bands. A **15dB insertion loss** is a realistic reduction in this scenario.

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4.3.3 Specific Sound Level

Noise at the source is calculated at **100.4dB L_{Aeq}**

Distance attenuation over 320m is calculated at **50.1dB $\Delta_{distance}$**

Reductions due to the earthen bund (with additional barrier) around the perimeter is calculated at **15dB $\Delta_{barrier}$** or **9dB $\Delta_{barrier}$** without.

The Specific Sound Level **without** the additional acoustic barrier is calculated at **41.3dB** or 35.3dB with the additional barrier.

4.4 Sound Rating Level

According to BS4142:2014[2], a correction may be applied to the calculated specific sound level to account for certain acoustic characteristics that may make the noise more noticeable, this is the called the **Rating Level**.

Noise from the units is unlikely to have tonal or impulsive character, therefore the Sound Rating Level is equivalent to the Specific Sound Level.

The Sound Rating Level is therefore set as **35.3dB** at the NSR with the acoustic screen, or **41.3dB** without.

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4.5 Assessment Criteria

With regards to BS4142, the difference between the rating and background levels is assessed as follows:

*A difference of around +10dB or more indicates that complaints are likely. A Rating Level of ≥54.8dB at the nearest sensitive receptor would result in an outcome of **"Significant Adverse Impact"**.*

*A difference of around +5dB is described in BS4142:2014, as being deemed an indication of an **"Adverse Impact"**.*

*If the rating level is below that of the measured background noise level of 44.8dB, BS4142:2014 describes the impact of sound as being **"Low Impact"**. The further below background level, the lower the impact at the receptor.*

Please note that the lowest *night-time* background noise level has been used to set the above criteria.

4.6 Assessment Outcome

Subtracting the measured background noise level at the nearest receiver from the rating level corrected for the distance determines the noise level at the NSR location point. This level will determine likelihood of complaints.

Outcome = Rating Level – Background Level

Noise levels resulting from the extraction system would reach the NSR with a noise rating level calculated at 35.3dB, providing mitigation is followed.

The lowest night-time background noise levels was measured at 44.8dB L_{A90}.

Sound Rating levels (including the acoustic barrier) are **9.5dB BELOW background noise levels**, resulting in a BS4142:2014[2] assessment outcome of **"Low Impact"**.

With the earthen bund alone, noise would **3.5dB BELOW background noise levels**, and could also be categorised as **"Low Impact"**.

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5. Conclusion

A noise assessment has been undertaken on behalf of Mr. Chris Akrill of TPS Ltd., in order to assess the impact from sound emissions of a STOR generator facility. The site is proposed to be at Booths Farm, Cheadle, Stoke-on-Trent, with the Nearest Sensitive Receptor located at 320m to the site's southeast border.

Considering point-source distance attenuation and barrier insertion losses from the proposed barrier/bund structure, levels from the STOR units will likely reach the NSR with a Sound Rating level of **41.3dB**. Background noise levels were measured close to the NSR at their lowest at **44.8dB L_{A90}**.

BS4142:2014[2] assessment methodology shows that the Sound Rating Level from the STOR facility will reach the NSR at a level **3.5dB LOWER than current background levels**. This will likely achieve an outcome of **"Low Impact"**. An additional acoustic screen would improve this further to **9.5dB LOWER than background noise levels.**

Impact on the environment is likely to be lower than this report predicts, as power grid shortfalls are likely to coincide during rush-hour periods, meaning levels of background noise would be higher than those measured.

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6. References

[1] BS4142:1997 – Method for Rating industrial noise affecting mixed residential and industrial areas. British Standards Institute, 1997.

[2] BS4142:2014 – Method for Rating and Assessing Industrial and Commercial Sound. British Standards Institute, 2014.

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APPENDIX A – Glossary of Acoustic Terminology

To aid the understanding of acoustic terminology and the relative difference between noise levels the following background information is provided.

We perceive sound when the ear detects fluctuations in air pressure (sound waves), which are then processed by the brain and perceived as sound. Humans can hear an incredibly wide range of sound intensities ranging from jet engines to fingertips lightly brushing against each other. This range is quantified using a logarithmic scale called the decibel scale (dB). The comfortable range of the decibel scale typically ranges from 0dB (the threshold of hearing) to around 140dB. Here are some examples common environments and their typical noise levels.

Noise Level	Environment
0 dB(A)	Threshold of hearing
20 to 30 dB(A)	Quiet bedroom at night
30 to 40 dB(A)	Living room during the day
40 to 50 dB(A)	Typical office
50 to 60 dB(A)	Inside a moving car
60 to 70 dB(A)	Typical high street
100 to 110 dB(A)	Fire alarm at 1 metre away
140 dB(A)	Threshold of pain

Terminology

dB (decibel) – A unit used to quantify the pressure level of sound. Defined as 20 times the logarithm of the ratio between the root-mean-square pressure of a given sound field and a reference pressure level ($2x10^{-5}$ Pa – threshold of hearing).

dB(A) – A-weighted decibel. A-weighting is a correction factor applied to decibel values in order to give a more accurate representation of human hearing which compensates for the varying sensitivity of the human ear with frequency.

$L_{Aeq, h}$ – The equivalent continuous sound level over a stated period. Quantifies a fluctuating sound level over a given period as the equivalent continuous sound level in which the same amount of acoustic energy is contained over.

L_{A90} – The sound level exceeded 90% of the time. Typically used to describe background noise the L_{90} is regarded as the 'average minimum level' and quantifies the common sound level of a fluctuation sound field i.e. the sound level that occurs 90% of the time. Alternatively L_{10} describes the sound level exceeded 10% of the time and therefore quantifies the 'average maximum level' of sound which is often used during the calculation of road traffic noise.

L_{AFmax} – The maximum, fast A-weighted sound pressure level. This effectively describes the highest noise level recorded at an instant in time, over a given time period. It is used to measure individual, short lived noise events that may not have a significant effect on the L_{Aeq} of that period.

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APPENDIX B - Measurement Equipment and Calibration Information

Measurement equipment details

Manufacturer	Type	Name	Serial No.
Svantek	Sound Level Meter	958A	34525
Svantek	Calibrator	SV31	2438870
Svantek	Microphone	Mk255	10358

Calibration Information

Calibrator Reference Level	114.0 dB
Pre-measurement Level	114.5dB/-0.5dB
Post-measurement Level	114.6/-0.6dB

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APPENDIX C – Plans & Site Measurement Locations

Site view and noise measurement location

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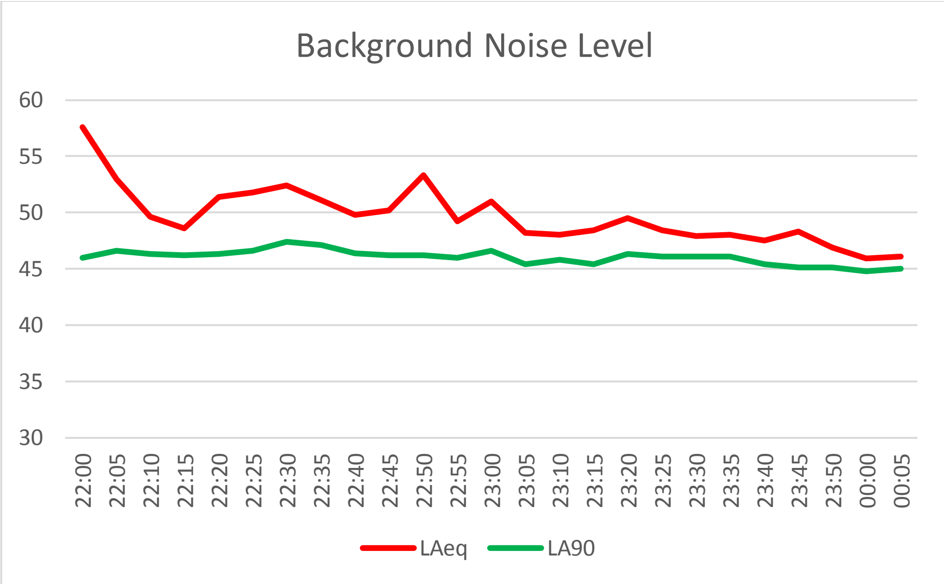
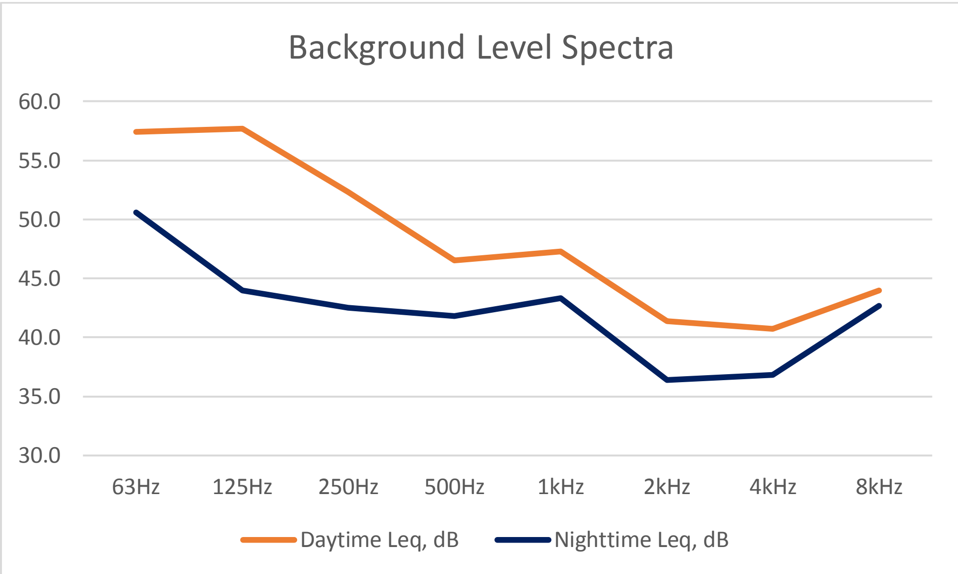
APPENDIX D – Noise Measurements Details





Position	$L_{Aeq,\,T}$ dB	$L_{A90,\,T}$ dB
Daytime 1hr	52.4	46.6
Night-time 5min	45.9	44.8

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APPENDIX E – Barrier Calculations

N.B. Maekawa Calculations based on formula:

$$\Delta_{barrier} = 10\log_{10}(3+[20N]) \text{ where } \delta > 0\text{, or;}$$

$$\Delta_{barrier} = 10\log_{10}(3-[20N]) \text{ where } \delta \leq 0$$

Where:
$\Delta_{barrier}$ = Insertion Loss of barrier (dB)
δ = Path Difference (m)
N = Fresnel No. $[2\delta/\lambda]$

Maekawa Barrier Calculation – 1m Screen Atop 2m Earthen Bund

Source Height (m)	2
Receiver Height (m)	4
Barrier Height (m)	3
Distance S-R (m)	320
Distance S-B (m)	3
Path Difference (m)	0.158

Frequency (Hz)	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Wavelength (m)	10.889	5.444	2.744	1.372	0.686	0.343	0.172	0.086	0.043
Fresnel No.	0.029	0.058	0.115	0.230	0.461	0.921	1.843	3.685	7.370
$\Delta_{barrier}$ (dB)	5.5	6.2	7.2	8.8	10.9	13.3	16.0	18.8	21.8

Maekawa Barrier Calculation – 2m Earthen Bund Only

Source Height (m)	2
Receiver Height (m)	4
Barrier Height (m)	2
Distance S-R (m)	320
Distance S-B (m)	3
Path Difference (m)	0.0

Frequency (Hz)	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Wavelength (m)	10.889	5.444	2.744	1.372	0.686	0.343	0.172	0.086	0.043
Fresnel No.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta_{barrier}$ (dB)	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8

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APPENDIX F – Limitations

This report requires a physical investigation of the site with an appropriate number of measurements in order to provide quantifiable information concerning the type and magnitude of noise affecting the site. The objectives have been limited to identifying sources of noise in order to carry out a suitable assessment for the proposed development.

The number and duration of noise measurements have been strategically selected to give reasonably representative information on the environment within the agreed time. Also, measurement locations have been limited to the areas unoccupied by any building that are easily accessible without imposing any form of risk to Peak Acoustics staff.

With any sampling, the number of samples and methods of sampling and measuring cannot exclude the existence of 'hotspots' where noise or vibration levels may transpire to be significantly more than those actually measured due to previously unknown or unrecognised sources of noise and vibration. Additionally, sources of noise or vibration may be irregular or fluctuate in intensity to an unpredictable degree and consequently may not be present in full intensity for some of the survey period or the entire survey period.

The report does not consider the effects of long-distance meteorological effects such as refraction (due to temperature inversions, wind propagation). All measurements taken on site are subject to a margin of uncertainty of ±1dB due to manufacturer's specification of equipment.

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