THOMASTOWN TERMINAL STATION - BESS
ENVIRONMENTAL NOISE ASSESSMENT

Rp 002 R02 20210988 | 11 October 2022

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Project: **THOMASTOWN TERMINAL STATION - BESS**

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1.0 INTRODUCTION

A new battery energy storage system (BESS) is proposed at the existing Thomastown Terminal Station (TTS). Beca Pty Ltd (Beca), on behalf of AusNet Services Pty Ltd (AusNet), has engaged Marshall Day Acoustics Pty Ltd (MDA) to undertake further works following the completion of an initial noise survey and estimation of environmental noise criteria for the site.

The initial works provided an understanding of the environmental noise conditions in the area of the existing TTS. The measured noise data has informed the initial environmental noise criteria used to assist with reviewing the likely influence of the new BESS assets proposed to be installed at the TTS.

The site and surrounding areas are subject to a complex noise environment that includes noise for the existing TTS facility, Jemena assets, the surrounding road network and commercial/industrial premises/activity. All of these noise sources impact the surrounding area, and influence the noise received at noise sensitive areas i.e. residential dwellings.

The objective of the assessment has been to assess the likely BESS assets noise levels and consider potential approaches to noise mitigation, to demonstrate that the estimated environmental noise criteria at noise sensitive locations can likely be achieved.

It is important to note that the assessment only considers the noise contribution from the proposed BESS assets. The assumption, based on initial measurements, is that the existing TTS meets relevant environmental noise criteria.

Throughout relevant sections of the report assumptions and limitations are discussed.

A glossary of acoustic terminology used in this report is included in Appendix A.

2.0 INITIAL NOISE SURVEY REPORTING

The initial noise surveys undertaken for the project are summarised in report *Rp 001 R01 20210988 - Thomastown BESS – Environmental Noise Criteria* (Rp 001 hereafter). A copy of the report is provided in Appendix B for reference.

Key extracts from Rp 001 are included throughout this report for ease of reference, however Rp 001 should be read in conjunction with this document.

3.0 PROJECT DESCRIPTION

The TTS is located at the junction of Mahoneys Road and High Street. The site is bounded by commercial premises/operations to the north, east and west, with residential properties to the south of the site and Mahoneys Road. A Jemena substation is located to the north-east.

The M80 Western Ring Road is located approximately 500m to the north. Keon suburban rail station is located to the east across High Street.

Based on a review of aerial imagery and attendance at the site, the nearest noise sensitive receivers have been determined to be located south across Mahoneys Road.

The BESS is proposed to be located on the vacant area of land to the north-west of the existing TTS.

The configuration of the site has changed since the initial noise survey and environmental noise criteria. The site layout assessed as part of the noise assessment is shown in Figure 1.

Figure 1: Proposed BESS layout (extract from drawing TTS-CIV-001)

Further information regarding the site and surrounding area are detailed in Rp 001 (see Appendix B).

4.0 PROJECT REQUIREMENTS

The project requirements with regards to legislation, guidelines and environmental noise limits are detailed in Rp 001 (see Appendix B). The following sections include key project requirements that are relevant to the project.

4.1 Environmental noise limits

Noise from the site associated with the equipment must comply with the requirements of Part I of the EPA Victoria Publication 1826 *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues* (the Noise Protocol).

A full description of the Noise Protocol, including the background information used for the derivation of the estimated environmental noise limits are provided in Rp 001 (see Appendix B), the key extracts are provided in Table 1 and Figure 2.

Table 1: Environmental noise criteria

Period	Day	Time	Noise limit at the receiver location, dB L_{eff}
Day	Monday – Saturday	0700 to 1800 hrs	59
Evening	Monday – Saturday	1800 to 2200 hrs	53
	Sunday and Public Holidays	0700 to 2200 hrs	
Night	Monday – Sunday	2200 to 0700 hrs the next day	48 (Location 1 and 2)
			44 (Location 3 and 4)

Figure 2: Locations of estimated environmental noise limits

The noise limits are based on short-term attended measured background noise levels. As noted in Rp 001, the attended background noise levels were influenced by various noise sources including traffic and surrounding industry. It is important to note that Location 1 was influenced by noise from the TTS. The influence of the TTS was not clearly observed at Locations 2 and 3, however similar background noise levels were measured in these locations as reproduced in Table 2.

Table 2: Extract of attended background noise measurements

Day & Time	Period	Location	Description	Measured background noise level, dB L_{A90}
16/2/2022, 00.07-00.17 hrs	Night	1	Junction of Mahoneys Rd and Asquith St	40
16/2/2022, 00.10-00.20 hrs	Night	2	Junction of Merrilands Rd and Asquith St	39
16/2/2022, 00.30-00.40 hrs	Night	3	Junction of Mahoneys Rd and Balfour St	38
16/2/2022, 00.30-00.40 hrs	Night	4	Junction of Merrilands Rd and Balfour St	34

As detailed in Rp 001 (see Appendix B), a conservative approach to setting the noise limit has been used for Location 3 and 4, particularly for Location 3, with the background noise level for Location 4 being used.

The noise limits for Location 1 and 2 are based on the measurement at Location 2, noting that this results in a noise limit that is neutral relative to the zoning level. The background noise level remains similar at Location 2 and 3, across two separate periods of noise measurement.

There is potential that the background noise level could be lower depending on how the environmental noise in the area changes through the night.

As the project progresses to detailed design it is recommended that additional background noise measurements are undertaken in the area to confirm the background noise levels shown in Table 2 and associated noise limits.

4.2 Proposed BESS design environmental noise criteria

The noise survey of the existing equipment showed that compliance is likely achieved under the measured meteorological and operational conditions. However, given the potential change in noise levels from the existing facility, there is a risk that the environmental noise limits for the site could be exceeded under different operating conditions.

Noise from both the existing and new proposed equipment are required to meet the Noise Protocol limits. To account for the noise level of the existing equipment, the maximum allowable noise level contribution from the proposed equipment at the receiver locations have been established, as shown in Table 3.

Table 3: Maximum noise level contribution from proposed new equipment

Period	Overall noise limit at the receiver location, dB L_{eff}	Noise limit from new plant/equipment, to be 10dB lower than noise protocol limit, to account for existing site operations, dB	Maximum contribution noise level at the receiver location from the new plant/equipment, dB L_{eff}
Day	59	-10	49
Evening	53	-10	43
Night	48 (Location 1 and 2)*	-10	38 (Location 1 and 2)*
	44 (Location 3 and 4)*	-10	34 (Location 3 and 4)*

* See Section 4.1 for more information on the locations

5.0 CALCULATION MODELLING

5.1 Noise modelling method

5.1.1 General

A 3-dimensional computer model was created in the environmental noise modelling program SoundPLAN v8.2 to predict noise levels from the proposed development. The noise model has been used to calculate noise levels at the nearest noise-affected premises in accordance with ISO-9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* (ISO 9613-2). The noise model enables the calculation of noise levels over a wide area, and accounts for key considerations including site arrangement, terrain, and atmospheric conditions.

The ISO 9613-2 standard specifies an engineering method for calculating noise at a known distance from a variety of sources under meteorological conditions that are favourable to sound propagation. The standard defines favourable conditions as downwind propagation where the source blows from the source to the receiver within an angle of +/-45 degrees from a line connecting the source to the receiver, at wind speeds between approximately 1 m/s and 5 m/s, measured at a height of 3 m to 11 m above the ground. Equivalently, the method accounts for average propagation under a well-developed moderate ground based thermal inversion.

Accordingly, predictions based on ISO 9613-2 account for the instances when local atmospheric conditions at the site favour the propagation of sound to surrounding receptor locations. Under alternative atmospheric conditions, such as when the wind is blowing from a receiver location to the development site, the noise levels would be lower than calculated.

To calculate far-field noise levels according to the ISO 9613-2, the noise levels of each source are firstly characterised in the form of octave band frequency levels. A series of octave band attenuation factors are then calculated for a range of effects including:

- Geometric divergence
- Air absorption
- Reflecting obstacles
- Screening
- Ground reflections.

The octave band attenuation factors are then applied to the noise data to determine the corresponding octave band and total calculated noise level at relevant receiver locations.

The ISO 9613-2 methodology is limited to octave band data, therefore when using one-third octave band noise data the modelling software assumes the same attenuation factors for the adjacent two bands. This is a limitation of the methodology and may result in a minor variation in the results where one-third octave band data is used.

5.1.2 Geometry data

Geometry data for the model has been provided by a AusNet and from publicly available information including aerial photography and ground contour information from Vicmap. Further, a visual inspection of the site was also undertaken at the time of the noise survey.

The geometry data for the new BESS site has been taken from the proposed layout drawings. The geometry data provided for the existing TTS site by AusNet was from 2008 and was considered outdated for some areas. As such, the data needed significant simplification for this to be useful as part of the modelling. This included meshing various topographical data together. The geometries in the model are simplified representations of the ground and built environment, that have been configured to a level of detail that is appropriate for noise calculation purposes.

Building heights have been defined based on standard assumed heights per floor level. All of the calculations of noise propagation are undertaken equivalent to first floor level at the receiver location i.e. 4.5m above ground, equivalent to the upper floor of a two storey dwelling.

Noise levels have been calculated to the receiver locations shown in Figure 2, and are equivalent to free-field noise levels.

The built form and noise from the existing TTS were not included in the model.

5.1.3 Calculation input noise data

The input noise data for the model has been selected to represent the site operating at its full capacity, as described in the following sections. Emission data for noise source(s) at the site have been provided in various forms via AusNet. In some instances, estimates of the octave band sound power levels were required as data was only provided as single figure information. A summary of the noise data, including the source height used in the calculations are provided in Appendix C.

Batteries

Sound power data was provided by a battery supplier. The noise data was provided as one-third octave bands, A-weighted and for various percentage fan speeds. The data was provided as an interpolation of 9 fans operating for each bank of batteries based on noise measurements of 11 fans.

The data was converted to linear sound power and included in the noise model as a single point source for each bank of batteries.

Low voltage transformers (MV TX), 5 MVA

One transformer is to be installed for each bank of batteries. Only a single figure sound power level of 65 dBA was provided for the transformers, therefore a calculated estimate of the octave band sound power levels was undertaken based on the method set out in the Australian Standard *AS 60076.10: 2009 Power transformers – Part 10: Determination of sound levels.*

The data was calculated for octave bands and included in the noise model as a single point source for each of the transformers.

Auxiliary Transformers (Auxiliary TX), 0.315 MVA

Two auxiliary transformers are to be installed as part of the BESS. No noise data was provided for the transformers therefore a calculated estimate of the octave band sound power levels was undertaken based on the method set out in the Australian Standard *AS 60076.10: 2009 Power transformers – Part 10: Determination of sound levels.*

The data was calculated for octave bands and included in the noise model as a single point source for each of the transformers

High Voltage Transformer (HV TX), 180 MVA

Two high voltage transformers will be installed between the BESS and the existing terminal station. The sound power level data was provided as one-third octave bands that was A-weighted, in two data sets.

The data sets were converted to linear sound levels, and the highest level for each frequency across the two data sets were used in the calculation model. Single point sources were used for each of the transformers.

High Voltage Transformer (HV TX), 180 MVA - Enclosure

The calculation for the enclosed transformers required that the data be converted to octave band noise data. This was necessary to calculate the noise level within the enclosure and relate the data to the transmission loss of the enclosure. The calculated noise from each side and the roof of the enclosure were modelled as industrial buildings (i.e. area sources)

Air-conditioner – condenser units

The BESS site will include 15 air conditioner condenser units located next to the switch rooms and control room. The noise data provided for the units needed to be analysed in order to estimate the octave band sound power levels.

The sound pressure level octave spectrum was adjusted based on the single figure, linear sound power level provided for the units. The calculated linear, octave band sound power levels were added to the calculation model. Single point sources were used for each of the units.

5.2 Description of scenarios

A number of iterative calculation models have been undertaken to review the likely propagation of noise from the BESS facility. These various calculations have been refined to provide the two modelled calculation scenarios presented in this report. The first scenario considers the BESS facility and associated assets with no additional noise treatment. This provides a comparison with a proposed treatment scenario that includes barriers between the batteries and enclosures to the transformers.

5.2.1 Scenario 1 - Untreated

For this scenario, no barriers were included in the model. All noise sources were modelled as external, with no enclosures. The general scenario arrangement is shown in Figure 3.

Figure 3: Scenario 1 – General arrangement

5.2.2 Scenario 2 – Barrier to batteries and enclosure to HV Transformers

The following acoustic treatments have been included:

- Both HV transformers are fully enclosed
- 10m high absorptive barriers between the batteries. This equates to 7.5m above the top of the batteries.

The general scenario arrangement is shown in Figure 4.

Figure 4: Scenario 2 - General arrangement

HV transformer enclosures

The transformer enclosures have been included in the noise model to reduce the contribution of noise at the receiver locations. For the purpose of the calculation the dimensions of each of the enclosures are assumed to be: Length 18 m, Width 12 m and Height 7m.

The enclosures have been calculated based on a predicted sound insulation loss shown in Table 4.

Table 4: Sound insulation loss of HV transformer enclosures

Sound insulation (R) at Octave band centre frequencies (Hz)							
63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**Comment**
37	40	37	41	49	57	62	Example material: 100mm thick concrete, with a minimum density 2000 kg/m^3

Each of the enclosures have four sides and a roof, all of the same sound insulation properties shown in Table 4. The access doors to the enclosures will be limited to a pedestrian size (i.e. no roller shutter doors), and will be located on the northern side of the enclosures i.e. away from noise sensitive receiver locations.

5.2.3 Noise barriers

The noise barriers are to be constructed to provide adequate noise attenuation. The barrier material should be constructed from a material of minimum surface density of minimum 12 kg/m^2 and must be free of holes or gaps. Some suitable materials include the following:

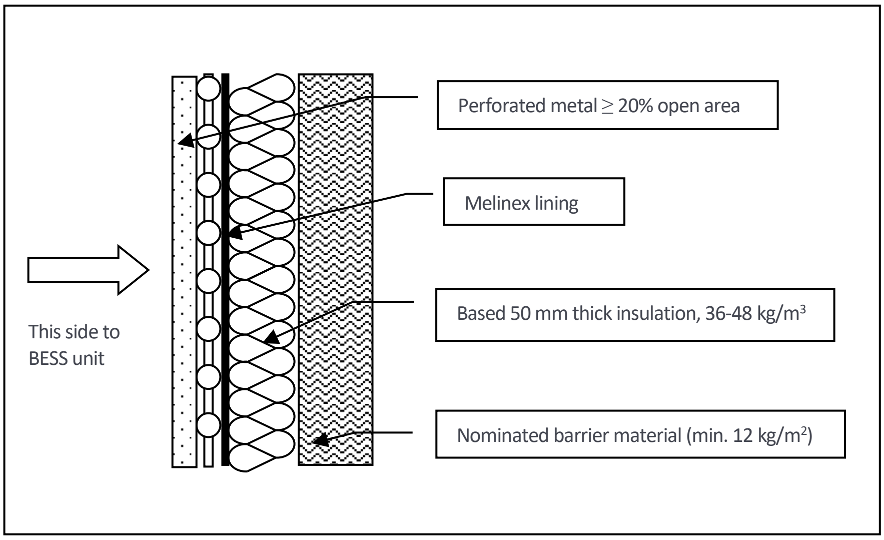
- 30 mm thick timber
- 9 mm thick compressed fibre-cement sheet
- Concrete, brick, proprietary wall panels or any other material that meets the minimum surface density can also be used.

It is recommended the noise barriers are lined on the inside face (facing the units) with a suitable weatherproof sound absorbing material that achieves a minimum noise reduction coefficient (NRC) 0.7. Alternatively, an integrated barrier panel with sound absorbing material (e.g. Flexshield Sonic System, IAC Acoustics Varitone) can be used.

It is particularly important to ensure that there is no gap at the bottom of the noise barrier. It is common practice to require that a portion of the bottom of the barrier (10-20 cm) be buried in the ground.

An example noise barrier is provided in Figure 5, noting that the absorptive treatment will be required to both faces of the barrier where they run between the batteries.

Figure 5: Example barrier construction



6.0 CALCULATION RESULTS AND DISCUSSION

The following section presents the results of the two noise modelling scenarios described. The predicted noise levels are compared to the maximum allowable noise level for the day, evening and night period respectively.

The predicted noise levels described in this section are also included as supplementary noise contours in Appendix D. The noise contours are included to provide an indicative view of the noise propagation for purpose of comparing the two scenarios.

All of the calculated noise levels in the tables in the following sections, as well as the noise contour maps are predicted at first floor level i.e. 4.5m above ground.

6.1 Tonality

The Noise Protocol requires that the noise levels must be corrected for the character of the noise, such as for tonality, intermittency, and impulsiveness.

The objective tonal adjustment method set out in the Noise Protocol is conducted using one-third octave band analysis of measured noise levels. The Noise Protocol does not describe a method for applying tonal corrections to predicted noise levels as is the case in this assessment. As such, the method used in the Noise Protocol does not strictly apply, but can be used as a guidance to inform the likelihood of tonal characteristics in the noise sources.

Another limitation of the Noise Protocol objective tonal adjustment method is that it applies to one-third octave band data. As noted in Section 5.1.1, the calculation model is based on ISO 9613-2, which uses octave bands rather than one-third octave bands to enable calculation of the total A-weighted noise levels. In addition, ISO 9613-2 is not intended to provide reliable calculation of the individual value of each band and as such there is increased uncertainty to the accuracy of the spectral data. The tonality assessment used in this report is thus just an indicative assessment of tonality, and does not make a definitive assessment of predicted compliance or otherwise based on the exact value of the calculated tonality penalty i.e. there is a margin available for the tonality penalty to vary in practice.

As a tone is apparent in the calculation results at the receiver locations (noting the limitations of the calculation methodology), for the purpose of the assessment a 5 dB tonal adjustment has been included. This is to assist in not underpredicting the potential noise at receiver locations.

6.2 Day period

6.2.1 Scenario 1 - Untreated

Table 5 presents the results of the noise modelling.

Table 5: Scenario 1 – Untreated

Receiver	Predicted noise level, dB L_{Aeq}	Including adjustment for tonality (+5 dB)	Max. allowable noise level, dB L_{Aeff}	Exceedance, dB
Location 1	38	43	49	0
Location 2	36	41	49	0
Location 3	38	43	49	0
Location 4	36	41	49	0

As shown in the table above, the maximum allowable noise level is predicted to be achieved at all receiver locations.

6.2.2 Scenario 2 - Barrier to batteries and enclosure to HV Transformers

Table 6 presents the results of the noise modelling including the acoustic treatment, i.e. the barriers around the batteries and the enclosure around the HV transformers.

Table 6: Scenario 2 – Barrier to batteries and enclosure to HV Transformers

Receiver	Predicted noise level, dB L_{Aeq}	Including adjustment for tonality (+5 dB)	Max. allowable noise level, dB L_{Aeff}	Exceedance, dB
Location 1	34	39	49	0
Location 2	32	37	49	0
Location 3	31	36	49	0
Location 4	29	34	49	0

As shown in the table above, the maximum allowable noise level is predicted to be achieved at all receiver locations.

6.3 Evening period

6.3.1 Scenario 1 - Untreated

Table 7 presents the results of the noise modelling.

Table 7: Scenario 1 – Untreated

Receiver	Predicted noise level, dB L_{Aeq}	Including adjustment for tonality (+5 dB)	Max. allowable noise level, dB L_{Aeff}	Exceedance, dB
Location 1	38	43	43	0
Location 2	36	41	43	0
Location 3	38	43	43	0
Location 4	36	41	43	0

As shown in the table above, the maximum allowable noise level is predicted to be achieved at all receiver locations.

6.3.2 Scenario 2 - Barrier to batteries and enclosure to HV Transformers

Table 8 presents the results of the noise modelling including the acoustic treatment, i.e. the barriers around the batteries and the enclosure around the HV transformers.

Table 8: Scenario 2 – Barrier to batteries and enclosure to HV Transformers

Receiver	Predicted noise level, dB L_{Aeq}	Including adjustment for tonality (+5 dB)	Max. allowable noise level, dB L_{Aeff}	Exceedance, dB
Location 1	34	39	43	0
Location 2	32	37	43	0
Location 3	31	36	43	0
Location 4	29	34	43	0

As shown in the table above, the maximum allowable noise level is predicted to be achieved at all receiver locations.

6.4 Night period

6.4.1 Scenario 1 - Untreated

Table 9 presents the results of the noise modelling.

Table 9: Scenario 1 – Untreated

Receiver	Predicted noise level, dB L_{Aeq}	Including adjustment for tonality (+5 dB)	Max. allowable noise level, dB L_{Aeff}	Exceedance, dB
Location 1	38	43	38	5
Location 2	36	41	38	3
Location 3	38	43	34	9
Location 4	36	41	34	7

As shown in the table above, the maximum allowable noise level is predicted to be exceeded at all receiver locations by up to 9 dB. The main contribution to the received noise levels is from the cumulative noise from the operation of the batteries and the HV transformers.

6.4.2 Scenario 2 - Barrier to batteries and enclosure to HV Transformers

Table 10 presents the results of the noise modelling including the acoustic treatment, i.e. the barriers around the batteries and the enclosure around the HV transformers.

Table 10: Scenario 2 – Barrier to batteries and enclosure to HV Transformers

Receiver	Predicted noise level, dB L_{Aeq}	Including adjustment for tonality (+5 dB)	Max. allowable noise level, dB L_{Aeff}	Exceedance, dB
Location 1	34	39	38	1
Location 2	32	37	38	0
Location 3	31	36	34	2
Location 4	29	34	34	0

With the acoustic treatment incorporated, the predicted noise levels at all receiver locations have been notably reduced.

The maximum allowable noise level may be exceeded at two locations by 1-2 dB, these calculated noise levels are marginal exceedances. The maximum allowable noise level is predicted to be achieved at all receiver locations if no tonality correction is applied.

6.5 Discussion

When considering the calculated exceedances, it is important to note the uncertainties and limitations discussed throughout the report, these include:

- Complex noise environment at the existing TTS which could lead to a variation in the background noise levels that may influence the calculated noise limits.
- The maximum contribution noise level at the receiver location from the new plant/equipment was set to be 10 dB below the estimated noise limits. This approach serves to avoid the new facility contributing to the noise limit. This approach should provide a conservative approach, on the basis that the existing site operations are below the noise limit. However, there is the risk that under different environmental and/or operational conditions the existing TTS may be at or exceed the environmental limits. In these instances, the BESS should not contribute to the noise levels at the receiver locations.

- The ISO 9613-2 methodology is limited to octave band data. The modelling software assumes the same attenuation factors for the adjacent two bands when using third octave band noise data. It therefore provides a degree of uncertainty when assessing one-third octave band noise data.
- The tonality procedure in the Noise Protocol does not strictly apply to predicted noise levels, rather its main function is the application to measured noise. The tonality applied for the assessment is indicative given the presence of the tone identified in the source noise data for the batteries. The calculation approach is therefore not a definitive assessment of tonality experienced at the receiver locations. Further, if no tone is identified at the receiver locations at the time of measurement, then no tonality adjustment would be applied. If a tonality adjustment is not applied then the night noise limit (see Table 10) would be calculated to be achieved, rather than being marginal.
- Spectral sound data has not been provided for all equipment and as such have been estimated for some plant.

When considering the above factors, it is likely that the calculated effective noise levels are conservative and could be lower than predicted.

6.6 General Environmental Duty (GED)

The GED applies to all Victorians and is a key component of the EP Act 2017, a general description is included in Rp 001 in Appendix B.

As the design progresses, the new installation will need to be assessed to review whether the obligations of the GED have been met, that is, to minimise the risks to prevent harm as far as reasonably practicable, even if compliance with the Noise Protocol can be demonstrated.

In addition to calculating the noise levels at noise sensitive receiver locations, a high-level review of predicted noise levels at the northern and western boundaries of the site has been undertaken. The aim is to provide an indication of the noise levels that may be experienced at the neighbouring industrial premises. The calculated noise levels for Scenario 2 at the northern and western boundaries are summarised in Table 11.

Table 11: Indicative noise levels at the northern and western site boundaries

Location	Predicted noise level, dB L_{Aeq}
Northern BESS site boundary	59
Western BESS site boundary	52 - 62

There are no objective noise criteria for considering external environmental noise impact on industrial premises, however comparing the noise levels with the *Occupational Health and Safety Regulations 2017, S.R No.22/2017* (Victorian OHS Regulations), the calculated levels are well below the noise exposure standard of $L_{Aeq, 8hr}$ 85 dB.

7.0 SUMMARY

A new battery energy storage system (BESS) is proposed at the existing Thomastown Terminal Station (TTS).

Marshall Day Acoustics Pty Ltd (MDA) has previously undertaken a high-level noise study of the existing Terminal Station, and determined the likely design environmental noise criteria for the site (*Rp 001 R01 20210988 - Thomastown BESS – Environmental Noise Criteria*, attached in Appendix B for reference).

Subsequently, a review of the likely BESS assets noise levels has been undertaken. Two calculation scenarios have been presented:

- Scenario 1 - no additional noise treatment to the proposed facility
- Scenario 2 - with noise treatment

The following noise treatments have been included as part of Scenario 2:

- The two HV transformers are fully enclosed
- 10m high absorptive barriers between the batteries. This equates to 7.5m above the top of the batteries.

The assessment showed that the inclusion of the noise mitigation treatment resulted in notable reductions in predicted noise levels at all noise sensitive receiver locations. The predicted noise levels for the mitigated scenario during the day and evening can meet the maximum allowable noise level at the noise sensitive receiver locations.

For the night period, the maximum allowable noise level may be marginally exceeded at two locations by 1-2 dB. However, it is likely that the calculated noise levels are conservative based on the uncertainties discussed throughout the report associated with the tonality adjustment, the noise limits, and the decision to design to 10 dB below the estimated noise limits. If the tonality adjustment is not required at the time of measurement, then the noise levels during the night period, based on calculation, would meet the maximum allowable noise level.

A discussion on the expected noise levels at the industrial interfaces to the north and west has also been included.

APPENDIX A GLOSSARY OF TERMINOLOGY

Ambient	The ambient noise level is the noise level measured in the absence of the intrusive noise or the noise requiring control. Ambient noise levels are frequently measured to determine the situation prior to the addition of a new noise source.
A-weighting	A set of frequency-dependent sound level adjustments that are used to better represent how humans hear sounds. Humans are less sensitive to low and very high frequency sounds. Sound levels using an "A" frequency weighting are expressed as dB L_A. Alternative ways of expressing A-weighted decibels are dBA or dB(A).
dB	Decibel: The unit of sound level. Expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of Pr=20 μPa i.e. dB = 20 x log(P/Pr)
Frequency	The number of pressure fluctuation cycles per second of a sound wave. Measured in units of Hertz (Hz).
Hertz (Hz)	Hertz is the unit of frequency. One hertz is one cycle per second. One thousand hertz is a kilohertz (kHz).
$L_{Aeq(t)}$	The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level. The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
L_{A90}	The A-weighted sound level exceeded for 90 % of the measurement period, measured in dB. Commonly referred to as the background noise level.
L_{eff}	The effective noise level from commercial, industrial or trade premises determined in accordance EPA Publication 1826.4 *Noise limit and assessment protocol for the control of noise from commercial, industry and trade premises and entertainment venues*. This is the L_{Aeq} noise level over a 30-minute period, adjusted for the character of the noise. Adjustments are made for tonality, intermittency and impulsiveness.
L_w	Sound Power Level. The calculated level of total sound power radiated by a sound source. Usually A-weighted i.e. L_{WA}.
NRC	Noise Reduction Coefficient. A single number rating of a material's ability to absorb sound. Calculated by averaging its absorption coefficients in the 250 – 2000 Hz octave bands. An NRC of 0 means it is fully reflective and an NRC of 1 means it is fully absorptive at those frequencies
Octave Band	A range of frequencies where the highest frequency included is twice the lowest frequency. Octave bands are referred to by their logarithmic centre frequencies, these being 31.5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 8 kHz, and 16 kHz for the audible range of sound.
R_w	Weighted Sound Reduction Index. A single number system for quantifying the transmission loss through a building element. The measured transmission loss, in third octave bands from 100 Hz to 3.15 kHz, is compared to a standard reference contour to determine the single number value. Can only be measured in laboratory conditions
Sound insulation	The ability of a material or construction to reduce sound travelling through it.
Transmission loss (TL)	The reduction in sound level resulting from sound passing through a material or construction.

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Melbourne VIC 3004

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1.0 INTRODUCTION

A new battery energy storage system (BESS) is proposed at the existing Thomastown Terminal Station (TTS).

Beca Pty Ltd (Beca), on behalf of AusNet Services Pty Ltd (AusNet), has engaged Marshall Day Acoustics Pty Ltd (MDA) to undertake a high-level noise study of the existing Terminal Station, and determine the likely design environmental noise criteria.

This report provides a summary of the relevant noise legislation for the site, and discussion is provided regarding the relevant design environmental noise criteria applicable to the facilities operation. Commentary is also provided regarding the high-level noise measurement surveys conducted on site.

A glossary of acoustic terms used throughout this report is provided in Appendix A.

2.0 SITE AND PROJECT DESCRIPTION

2.1 Site location and description

The TTS is located at the junction of Mahoneys Road and High Street. The site is bounded by commercial premises/operations to the north, east and west, with residential properties to the south of the site and Mahoneys Road. A Jemena substation is located to the north-east.

The M80 Western Ring Road is located approximately 500m to the north. Keon suburban rail station is located to the east across High Street.

Based on a review of aerial imagery and attendance at the site, the nearest noise sensitive receivers have been determined to be located south across Mahoneys Road.

An aerial photo of the site and surrounding area is shown in Figure 1.

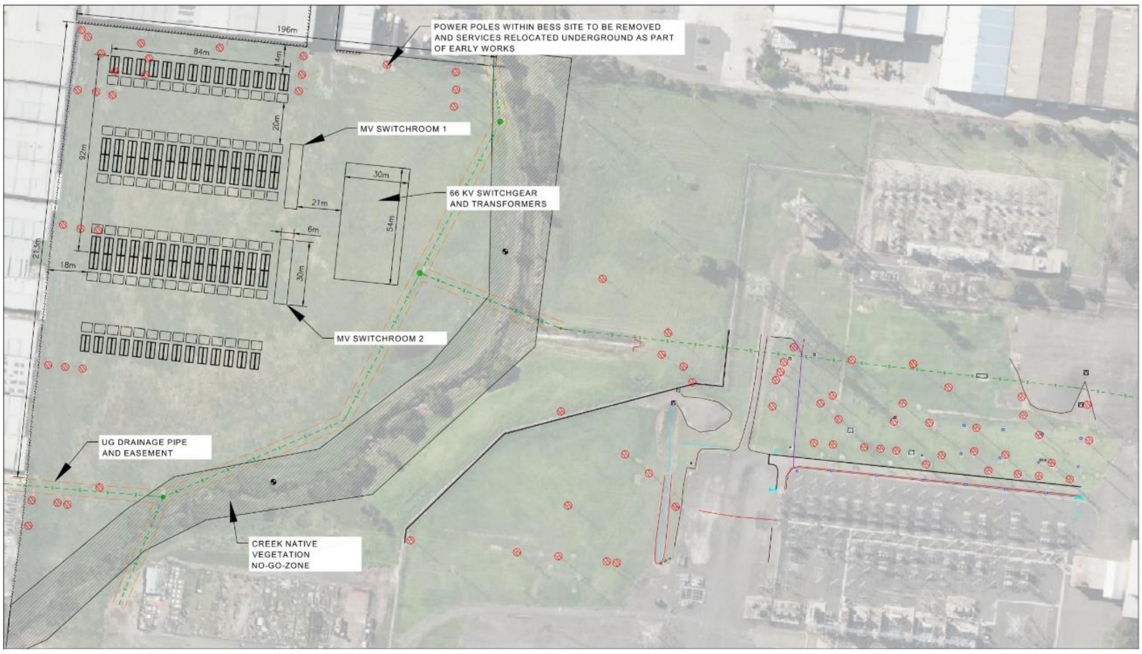
Figure 1: Proposed site and surroundings (Source: Nearmap.com)

The TTS is located in an Industrial 1 Zone (IN1Z). The nearest noise sensitive receivers are in a General Residential Zone 1 (GRZ1). The planning map is attached in Appendix B.

2.2 Project description

The BESS is proposed to be located on the vacant area of land to the north-west of the existing TTS. An indicative concept layout issued by AusNet on 3 February 2022 is provided in Figure 2.

Figure 2: Concept layout



The terrain at this location is uneven, with the north-western corner being the highest point. AusNet advised the current slope across the proposed BESS location is approximately 6m. The terrain will be levelled out prior to the installation of the BESS, but the finished terrain level is not known and this stage.

3.0 PROJECT REQUIREMENTS

3.1 Legislation and guidelines

A range of guidelines and legislation are used in Victoria to help manage and control potential impacts from environmental noise. An overview of the key documents and legislation applicable to the project is provided in Table 1. Refer to Appendix C for further details.

Table 1: Relevant Victorian noise legislation

Document	Overview
Environment Protection Act 2017 (the Act)	The Act provides the overarching legislative framework for the protection of the environment in Victoria. The Act does not specify noise limit values, but prohibits the emission of unreasonable or aggravated noise from non-residential premises. Part 3.2 of the Act outlines the General Environmental Duty (see below), which requires anyone engaging in an activity posing a risk of harm to human health and/or the environment from pollution or waste, including noise, to minimise those risks to prevent harm as far as reasonably practicable. Section 93 of the Act provides for the creation of an environmental reference standard to be used to assess and report on environmental conditions in the whole or any part of Victoria.
Environmental Noise Regulations 2021 (Regulations)	The objectives of the Regulations are to further the purposes of, and give effect to, the Act. Part 5.3, Division 1 states that prediction, measurement, assessment or analysis of noise within a noise sensitive area for the purposes of the Act or these Regulations, must do so in accordance with the Noise Protocol (see below). Division 3 stipulates requirements that are specific to commercial, industrial and trade premises. The Division defines assessment time periods, minimum noise limit values, management of cumulative noise from multiple premises, noise sensitive areas where assessment requirements apply, definition of frequency spectrum as a prescribed factor, and a definition for unreasonable and aggravated noise.
EPA Victoria Publication 1826 *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues* (Noise Protocol)	The Noise Protocol defines the method for setting the noise limits for new and existing commercial, industrial and trade premises and entertainment venues in Victoria. It also outlines the steps that must be followed to undertake an assessment (measurement or prediction) of the effective noise level within a noise sensitive area or at an alternative assessment location.

Document	Overview
General Environmental Duty (GED)	The General Environmental Duty (GED) is outlined in Part 3.2 of the Act. The GED requires anyone engaging in an activity posing a risk of harm to human health and/or the environment from pollution (including noise) and waste, to minimise those risks to prevent harm as far as reasonably practicable. Commercial premises are therefore required to continue to review and eliminate or reduce the risk of harm from any emission of noise as far as reasonably practicable, even if they are compliant with the Noise Protocol. The GED applies wherever there is a risk of harm, regardless of whether the noise emitted has caused complaints or caused harm to people or the environment. The GED is applied first to eliminate or reduce the risk of harm to human health and the environment from noise so far as reasonably practicable. Any residual noise remaining after actions are taken to meet the GED is then managed as per the unreasonable noise definitions in section 166 of the Act (i.e. complying with the Noise Protocol).

3.2 Environmental noise limits

Noise from the site associated with the equipment must comply with the requirements of Part I of the EPA Victoria Publication 1826 *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues* (the Noise Protocol).

The Noise Protocol sets outdoor noise limits at noise sensitive areas for the day, evening and night period. The noise limits are calculated based on the land zoning and background level at the noise sensitive receivers.

Given the high variability of background noise in the area the night-time noise limit varies across the noise sensitive receiver locations. Receivers close to the TTS and Mahoneys Road are subject to higher noise limits compared to the receivers further south that are shielded from noise propagation. Further information regarding the background noise levels is provided in Section 4.2.2.

Table 2 details the Noise Protocol limits applicable to noise from the site. A full derivation of the noise limits is provided in Appendix C. The criteria is based on the locations measured during the noise survey (see Section 4.2.2). The criteria could be subject to change depending on where the measurements are undertaken, based on the effect of shielding and influence of traffic noise. This is particularly relevant for Merrilands Road.

Table 2: Environmental noise criteria

Period	Day	Time	Noise limit at the receiver location, dB L_{eff}
Day	Monday – Saturday	0700 to 1800 hrs	59
Evening	Monday – Saturday	1800 to 2200 hrs	53
	Sunday and Public Holidays	0700 to 2200 hrs	
Night	Monday – Sunday	2200 to 0700 hrs the next day	48 (Location 1 and 2)*
			44 (Location 3 and 4)*

* See Section 4.2.2 for more information on the locations

4.0 NOISE SURVEYS

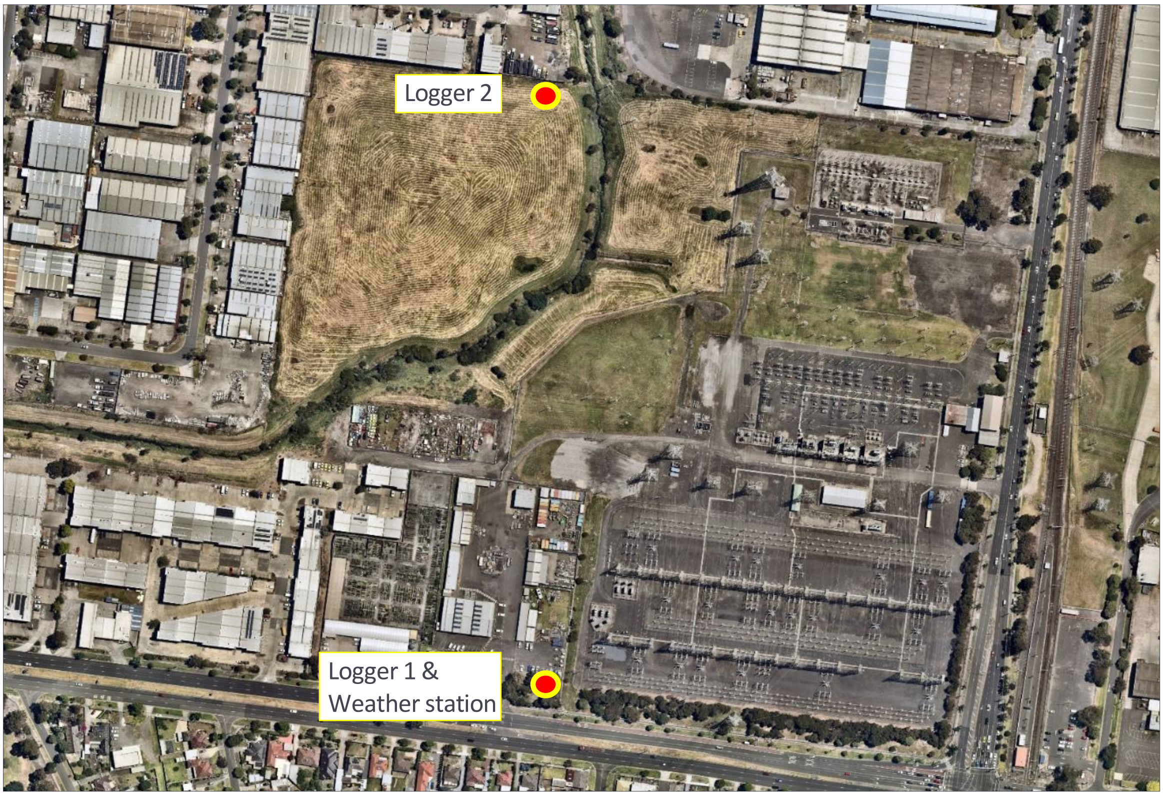
Attended and unattended noise measurements have been undertaken at the TTS and surrounding area. These noise measurements have been used to assist with providing an indication of existing conditions at the site, noting however that this only provides an indication of the noise conditions for a short period of time, under the meteorological conditions reported at the time.

4.1 Unattended measurements

Unattended measurements have been conducted at the northern site boundary near the commercial interface, and at the southern site boundary near Mahoneys Road. The logger locations are shown in Figure 3.

Measurements were undertaken between 9 February and 21 February 2022. A weather station was deployed at the southern site boundary (Logger 1 position) to measure the local meteorological conditions during the survey i.e. windspeed, direction and temperature.

Figure 3: Logger locations



The measurement results are shown in Figure 4, Figure 5 and Figure 6. Note that there is a short period with no noise data, when the southern logger (Logger 1) battery failed between 13 February and 15 February.

Figure 4: Unattended noise measurements results - Logger 1 (1h interval)

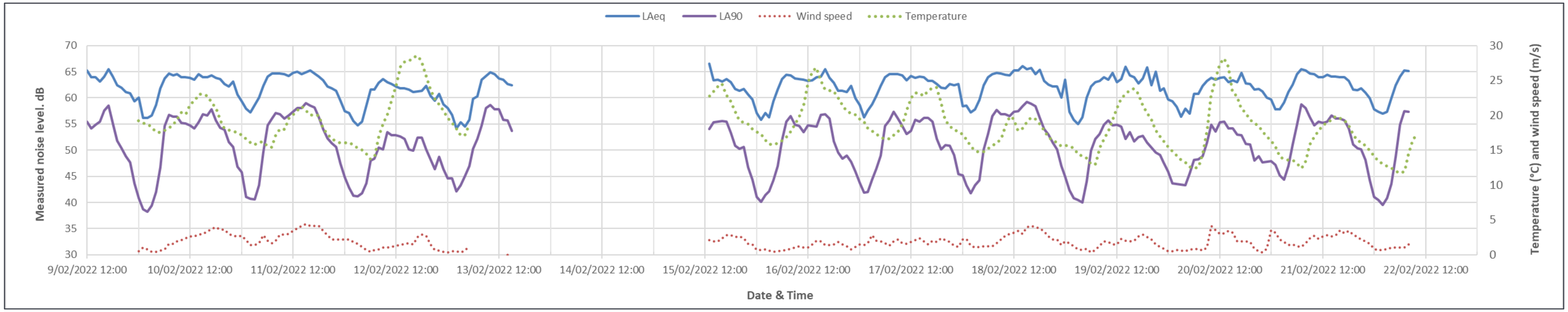


Figure 5: Unattended noise measurements results - Logger 1 – Detailed result (1sec interval)

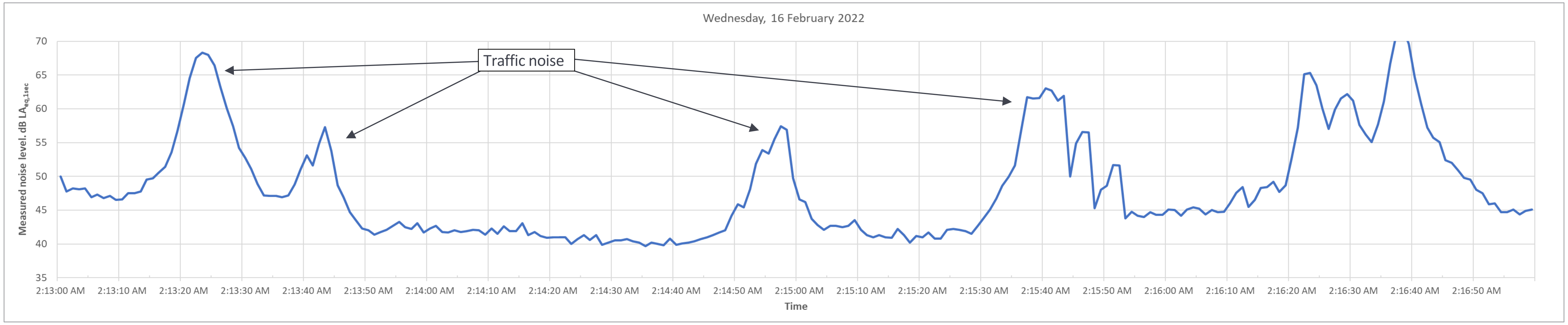
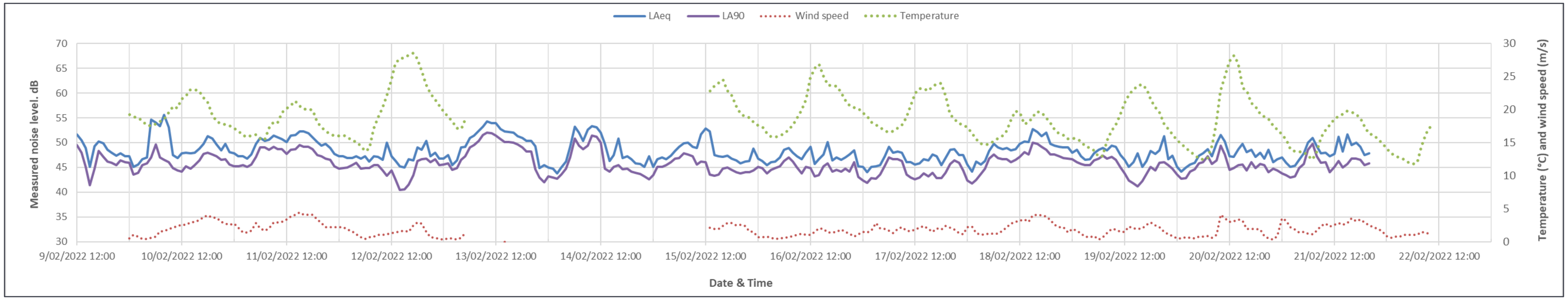


Figure 6: Unattended noise measurements results - Logger 2 (1h interval)



4.1.1 Logger 1

The noise environment at Logger 1 was mainly influenced by traffic noise from Mahoneys Road, which resulted in clear day/night cycles. The noise level charts show the influence of road traffic noise across the measurement location. Although traffic volume was low during the night compared to the day, there was constant traffic movement on Mahoneys Road throughout the entire night.

To illustrate the traffic noise influence on the soundscape, a four-minute extract from a midweek night at 0213 hrs is shown in Figure 5 with annotations. Audio samples from the logger confirmed that the noise events were related to traffic noise.

Analysing the noise data recorded at Logger 1 across the full monitoring period, the lowest background noise levels during the night during traffic lulls were approximately 38-42 dB $L_{A90,}$, see Figure 4. Considering the location of the logger and the influence of traffic noise, it was expected that the noise levels from the TTS at the noise sensitive receivers south of Mahoneys Road would be similar to those measured at the logger location. This was confirmed with short-term attended measurements at the receiver locations during the night, noting the attended measurements were slightly lower.

The influence of noise from the TTS has the greatest contribution to the soundscape during the lulls in traffic, this can be seen from the chart in Figure 5.

4.1.2 Logger 2

The diurnal change in background noise level for Logger 2 is not as clear as the data from Logger 1. As such, the graph does not show a clear baseline noise level that can be associated with just the operation of TTS.

The surrounding industrial premises did not appear to be operating during the night, therefore this night noise is not attributed to their activity. The dominant source at the Logger 2 location during the night-time attended survey was noise from the Jemena Substation.

During the day period when in attendance at the site, the consultants noted that the dominant sources were from traffic noise and noise from the industrial premises.

Further details on the measurement method, daily average measurement results and additional information on the metrological conditions are contained in Appendix D.

4.2 Attended measurements

4.2.1 Noise at the TTS

A series of noise measurements were undertaken to provide data for an indicative assessment of the noise from the various key items of equipment at the TTS.

Traffic noise was audible across the site, except close to the transformers. The transformers, specifically transformer B4, were the loudest items at the site during our attended noise surveys. Noise measurements of other items of equipment near the transformers were not possible without being influenced by noise from transformer B4.

AusNet advised that corona noise is generally highest during periods of rain. The corona noise was audible during the survey in the southern half of the TTS site, however, it was not possible to accurately measure due to the influence of the B4 transformer to the north, and traffic noise to the south.

At the time of the measurements, transformer B4 was the only unit with the fan operating. AusNet advised that transformer B4 is the oldest, and subjectively the loudest transformer on site. The following information regarding the Mega Volt-Amp (MVA) of the transformers has been provided by AusNet:

- B1 - 150MVA ODAF (Oil Directed Air Forced)
- B2 - 165MVA ONAF (Oil Natural Air Forced)
- B3 - 150MVA OFAF (Oil Forced Air Forced)
- B4 - 150MVA OFAF (Oil Forced Air Forced)
- B5 - 150 MVA ODAF (Oil Directed Air Forced).

The noise levels across the TSS ranged from 55-78 dB L_{Aeq}, depending on the measurement location. The measured noise levels may be used at a later design stage. Detailed results are attached in Appendix D3.

4.2.2 Noise at the noise sensitive receivers

Attended noise measurements were undertaken at the noise sensitive receiver locations south of Mahoneys Road. The measurements were conducted during the following times:

- 9 February 2022 between 1005 – 1030 hrs
- 16 February 2022 between 0005 – 0110 hrs.

The measurement locations are shown in Figure 7.

Figure 7: Attended noise surveys locations

A summary of the measurement results is provided in Table 3.

Table 3: Attended ambient and background noise measurements at the receiver locations

Day & Time	Period	Location	Description	Measured background noise level, dB L_{A90}	Measured ambient noise level, dB L_{Aeq}
9/2/2022, 10.05-10.15 hrs	Day	1	Junction of Mahoneys Rd and Asquith St	60	70
16/2/2022, 00.07-00.17 hrs	Night	1	Junction of Mahoneys Rd and Asquith St	40	58
9/2/2022, 10.18-10.23 hrs	Day	2	Junction of Merrilands Rd and Asquith St	47	51
16/2/2022, 00.10-00.20 hrs	Night	2	Junction of Merrilands Rd and Asquith St	39	46
16/2/2022, 00.30-00.40 hrs	Night	3	Junction of Mahoneys Rd and Balfour St	38	55
16/2/2022, 00.30-00.40 hrs	Night	4	Junction of Merrilands Rd and Balfour St	34	40

The dominant noise source during the measurements was traffic noise during the day, and noise from crickets and intermittent traffic during the night. The TTS was audible at location 1, but was not clearly discernible at the other three locations.

As shown in Table 3, the background noise levels vary significantly across the receiver locations. The receiver locations close to the TTS have higher background noise levels compared to the receivers further away from the TTS. This is mainly due to the influence of noise from the TTS and noise from traffic on Mahoneys Road. The surrounding industry did not add to the noise environment during the time of the attended survey.

The cumulative measured ambient noise levels are relatively high, and in some cases higher than the environmental noise criteria. However, this is due to the influence of traffic noise, noting that the contribution from the TTS only became apparent during lulls in traffic at Location 1. The measured noise levels during traffic lulls were around 36-40 dB L_{Aeq}.

The noise measurements indicate that the existing TTS likely complies with the environmental noise criteria, under the measured operating conditions. However, it is important to note that the results are limited to the meteorological and operational conditions present at the time of the survey. The likely change in noise level with the increase in load and/or during changes in meteorological conditions e.g. hot weather, high moisture levels etc. is not known.

The wind direction during the survey was mainly from the south, i.e. from the receiver locations to the TTS. It is possible that the noise levels under downwind conditions (from the TTS to the receivers) would be higher than the measured noise level.

5.0 PROPOSED BESS DESIGN ENVIRONMENTAL NOISE CRITERIA

The noise survey of the existing equipment showed that compliance is likely achieved under the measured meteorological and operational conditions. However, given the potential change in noise levels from the existing facility, there is a risk that the environmental noise limits set out in Table 2 could be exceeded under different operating conditions

Noise from both the existing and new proposed equipment must meet the Noise Protocol noise limits. To account for the noise level of the existing equipment, the maximum allowable noise level contribution from the proposed equipment at the receiver locations have been established, as shown in Table 4.

Table 4: Maximum allowable noise level contribution from proposed new equipment

Period	Overall noise limit at the receiver location, dB L_{eff}	Noise limit from new plant/equipment, to be 10dB lower than noise protocol limit, to account for existing site operations, dB	Maximum contribution noise level at the receiver location from the new plant/equipment, dB L_{eff}
Day	59	-10	49
Evening	53	-10	43
Night	48 (Location 1 and 2)*	-10	38 (Location 1 and 2)*
	44 (Location 3 and 4)*	-10	34 (Location 3 and 4)*

* See Section 4.2.2 for more information on the locations

Note that the proposed design criteria are based on the assumption that noise from the existing site can achieve the Noise Protocol noise limits.

6.0 GED

The GED applies to all Victorians and is a key component of the EP Act 2017, a general description is included in Table 1. MDA has experience of EPA requesting further information of planning applications to clarify how the proposal achieves the GED.

As the design progresses, the new installation will need to be assessed to review whether the obligations of the GED have been met, that is, to minimise the risks to prevent harm as far as reasonably practicable, even if compliance with the Noise Protocol can be demonstrated. This may include, but is not limited to, equipment selection, noise attenuation treatment, location etc. Further, consideration should also be given to noise impacting surrounding industrial premises.

7.0 NEXT STEPS

It is understood that a single supplier is being approached at this stage to tender for installation at the site.

While it is the responsibility of the supplier to meet the environmental noise criteria, it is recommended that the supplier noise data for the BESS and associated equipment is provided for review by AusNet. It is anticipated that this would be undertaken as input data to the calculation model for the site.

The noise data for each item of equipment shall be provided by the supplier as linear octave band sound power, for the minimum frequency range of 63 Hz to 4 kHz. Each item of equipment will require supporting documentation describing the test methodology, and interpretation of the noise data and drawings/sections of equipment items.

8.0 SUMMARY

A new battery energy storage system (BESS) is proposed at the existing Thomastown Terminal Station (TTS).

Noise from the site associated with the equipment must comply with the requirements of the Noise Protocol. The environmental noise criteria for the site have been calculated based on the existing noise environment at the receiver locations.

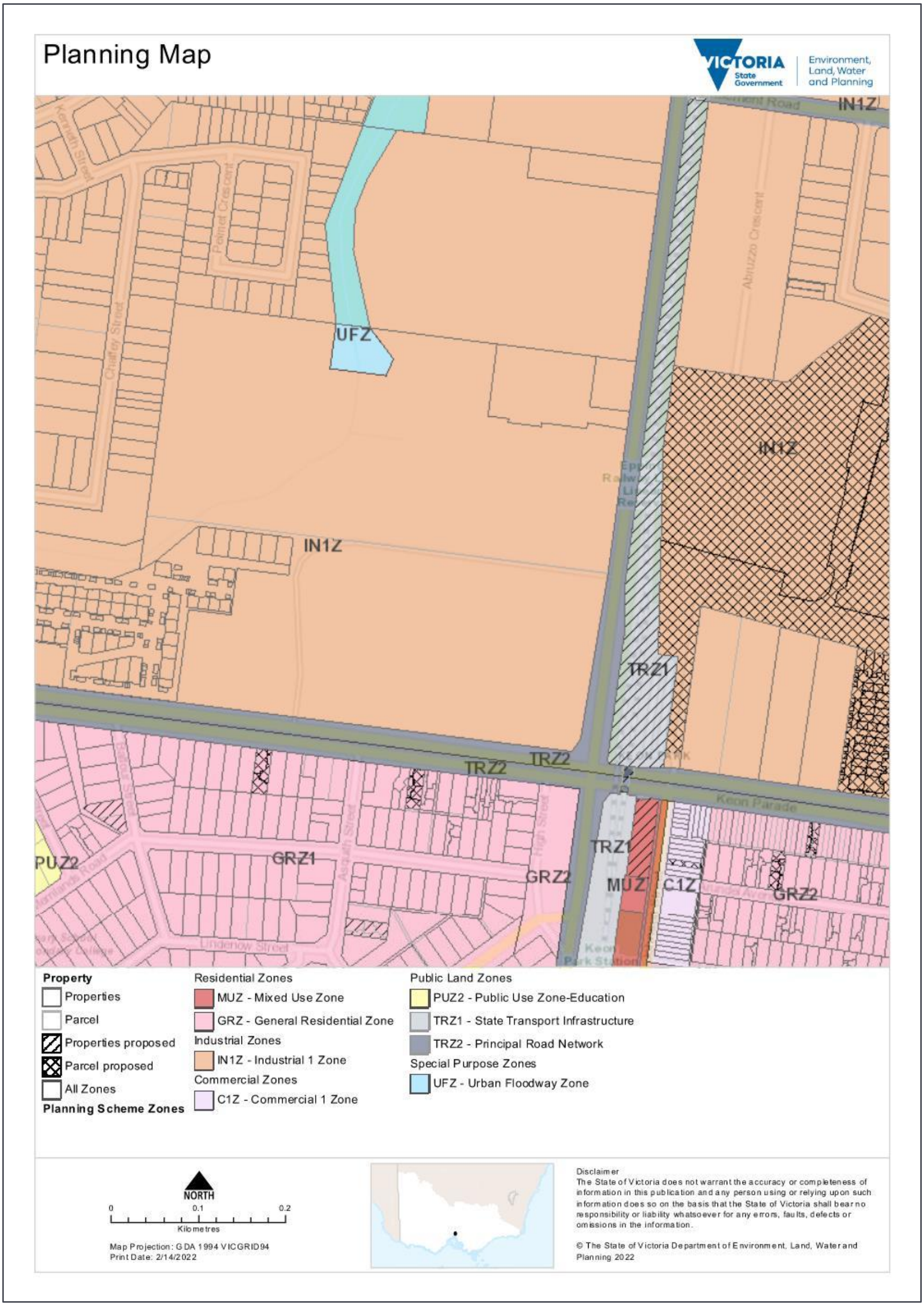
Noise criteria has then been determined for the BESS and associated equipment that, essentially, will not contribute to the overall noise level from the site when considered at the identified sensitive receiver locations. Due to the high variability of background noise in the area, the noise criteria is dependent on capturing periods when the influence from extraneous sources is reduced. The influence of extraneous noise from road traffic was particularly apparent during the night period, noting the multiple night-time limits derived across the noise sensitive receiver locations.

To provide an indicative assessment of current operation of the TTS with regards to the criteria requirements set out in the Noise Protocol, a noise survey has been undertaken. The short-term indicative noise measurements indicated that the existing site likely meets the Noise Protocol, under the meteorological and operational conditions at the time of the survey. However, there is likely to be variation in the site operations that may result in the Noise Protocol being exceeded.

APPENDIX A GLOSSARY OF TERMINOLOGY

A-weighting	A set of frequency-dependent sound level adjustments that are used to better represent how humans hear sounds. Humans are less sensitive to low and very high frequency sounds. Sound levels using an "A" frequency weighting are expressed as dB L_A. Alternative ways of expressing A-weighted decibels are dBA or dB(A).
Ambient sound	The totally encompassing sound in a given situation at a given time, from all sources near and far, including the Specific Sound. Ambient noise levels are frequently measured to determine the situation prior to the addition of a new noise source.
Background sound	The sound that is continuously present in a room our outdoor location. Often expressed as the A-weighted sound level exceeded for 90 % of a given time period i.e. L_{A90}.
dB	Decibel. The unit of sound level.
Hertz (Hz)	The unit of frequency, named after Gustav Hertz (1887-1975). One hertz is one pressure cycle of sound per second. One thousand hertz – 1000 cycles per second – is a kilohertz (kHz).
L_{A90}	The A-weighted sound level exceeded for 90 % of the measurement period, measured in dB. Commonly referred to as the background noise level.
L_{Aeq}	The equivalent continuous A-weighted sound level. Commonly referred to as the average sound level and is measured in dB.
L_{eff}	The effective noise level from commercial, industrial or trade premises determined in accordance EPA Publication 1826.4 *Noise limit and assessment protocol for the control of noise from commercial, industry and trade premises and entertainment venues*. This is the L_{Aeq} noise level over a 30-minute period, adjusted for the character of the noise. Adjustments are made for tonality, intermittency and impulsiveness.
L_w	Sound Power Level. The calculated level of total sound power radiated by a sound source. Usually A-weighted i.e. L_{WA}.
Noise	A subjective term used to describe sound that is unwanted by, or distracting to, the receiver.
Octave band	The interval between one frequency and its double. Sound is divided into octave bands for analysis. The typical octave band centre frequencies are 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz and 4 kHz.

APPENDIX B PLANNING MAP



APPENDIX C LEGISLATION

C1 Environmental Protection Regulations 2021

The Act does not specify noise limit values or technical aspects of environmental noise, but sets out legal requirements to comply with the Environment Protection Regulations described below. Clause 166 of the Act essentially places the onus of achieving compliance with noise limits on the commercial premises.

The Environment Protection Regulations 2021 (the Regulations) are made under section 465 of the Act and impose obligations in relation to environmental protection, including noise. The Regulations state that a person who conducts a prediction, measurement, assessment or analysis of noise within a noise sensitive area must do so in accordance with the Noise Protocol. In particular, noise from industrial, commercial and trade premises or entertainment venues or events is prescribed as unreasonable if it exceeds a noise limit or alternative criterion determined in accordance with the Noise Protocol.

Key matters addressed in the regulations include:

- Definition of commercial, industrial and trade premises, which is essentially any premises that is not a residential premises, a road or a railway. It is noted that noise from common building services equipment (such as shared condensing units and kitchen exhaust fans) is assessable
- Definition of an indoor music entertainment venue
- Definition of noise sensitive areas where the noise limits are assessed, which broadly include:
  - a residential building
  - temporary accommodation
  - hospital corrective institution
  - retirement or residential village
  - A room for learning in a child care centre, kindergarten or school
  - A tourist establishment, campground or caravan park
- Assessment time periods
- Noise sources that must not be taken into account
- Minimum noise limit values
- Management of cumulative noise from multiple premises.

C2 EPA Victoria Publication 1826 – The Noise Protocol

As per the Division 1, Regulation 113 of the Regulations, assessment of noise within a sensitive area must be conducted in accordance with EPA Victoria Publication 1826 *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment* venues (the Noise Protocol). The Noise Protocol outlines the EPA's required approach to the determination of noise limits and to the measurement, prediction and analysis of noise.

C2.1 Noise limits for commercial, industrial and trade premises

The Noise Protocol provides two methods for deriving the relevant noise limits, the Urban area method and the Rural area method. The Urban area method is applicable to the proposed development.

The noise limits are calculated taking into account planning scheme land 'zoning types' within a 70 m and 200 m radius of a noise sensitive receiver. The Noise Protocol categorises land zones as type 1, 2 or 3. Zone type designations consider the nature of the permitted land uses and are generally as follows:

- areas such as residential, rural and open space are type 1;
- areas such as commercial, business and light industry are type 2; and
- areas such as general industry and major roads are type 3.

A prescribed formula is used to calculate a corresponding Zoning Level. Greater areas of type 2 and 3 land within a 200 m radius of a noise sensitive site result in higher Zoning Levels than a site with respectively larger areas of type 1 land.

The noise limit is equal to the 'zoning level' unless the background level at the noise sensitive site is categorised as low or high according to clause 4 of the Policy. If the background level is low or high, the Noise Limit is calculated from a formula taking into account both the Zoning Level and the Background Level.

The current land use zones around the subject site are shown in the planning map in Appendix B.

The limits are separately defined for the day, evening and night periods. The relevant noise limits applicable to this development are shown in Table 5. Given the high variability of background noise in the area, the night-time noise limit varies across the noise sensitive receiver locations.

Table 5: Environmental noise limits

Period	Day	Time	Zoning level, dB	Background noise level, dB L_{A90}	Background relative to zoning level	Noise limit, dB L_{eff}
Day	Monday – Saturday	0700 to 1800 hrs	59	47	Neutral	59
Evening	Monday – Saturday	1800 to 2200 hrs	53	44	Neutral	53
	Sunday and Public Holidays	0700 to 2200 hrs				
Night	Monday – Sunday	2200 to 0700 hrs the next day	48	39 (Location 1 and 2)*	Neutral	48 (Location 1 and 2)*
			48	34 (Location 3 and 4)*	Low	44 (Location 3 and 4)*

* See Section 4.2.2 for more information on the locations

C2.2 Assessing noise from commercial, industrial and trade premises

Noise from the facility that exceeds the noise limits is prescribed to be unreasonable by the Regulations. Part 7.6 of the Act in conjunction with Regulation 166 places the onus of compliance on industry by prohibiting the emission of unreasonable or aggravated noise.

For the purposes of this report and assessments of predicted noise levels, the noise limits apply up to 10 m from a dwelling, but within the property boundary.

Once a noise limit is established, an equivalent noise level (L_{Aeq}) due to the operation of the commercial premises is measured or predicted for a 30 minute operating period during the day, evening and night period as appropriate. If necessary, the L_{Aeq} noise level is adjusted for duration and noise character (tonality, impulsiveness and intermittency) to give the effective noise level (L_{eff}). If the L_{eff} level exceeds the noise limit, then remedial action will be required.

Consideration must be given to existing and future noise sensitive areas, factors that influence the propagation of sound (including atmospheric effects) and the cumulative contribution of noise from multiple existing and proposed sites.

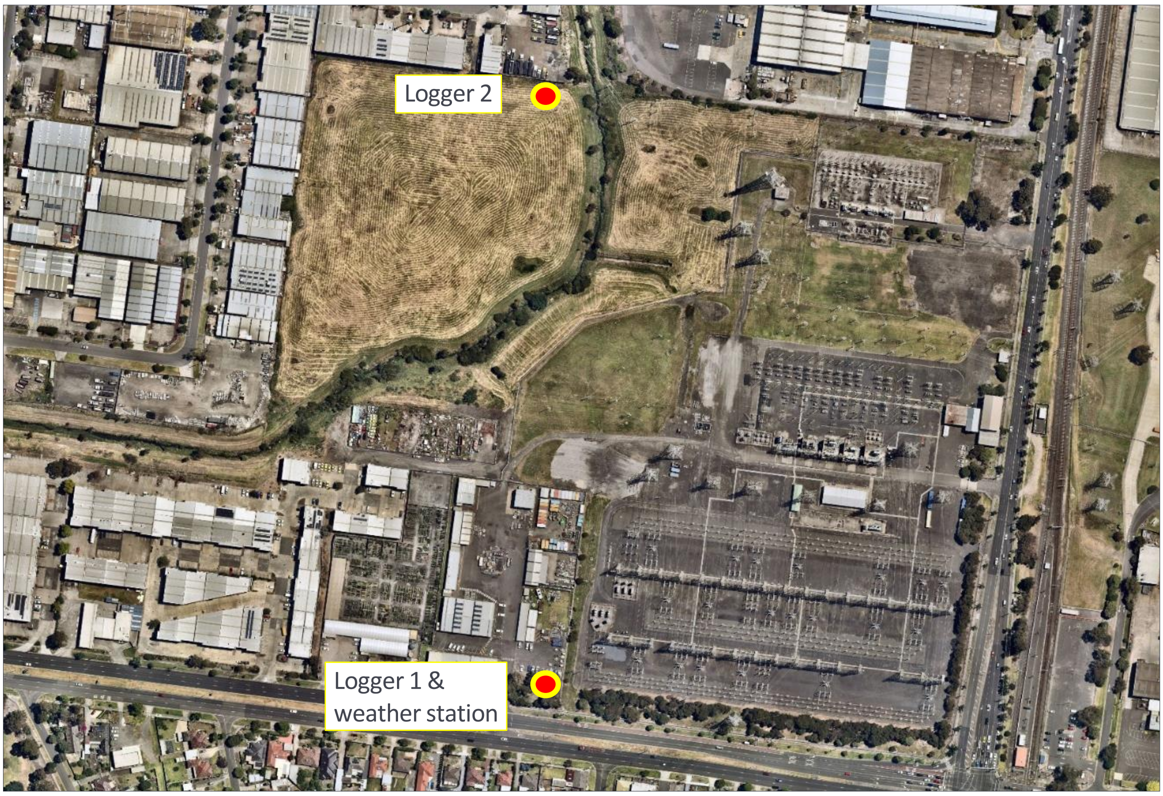
APPENDIX D NOISE MEASUREMENT METHOD

D1 Unattended measurements

Unattended measurements have been conducted between 9 February and 21 February 2022, at the northern site boundary near the commercial interface, and at the southern site boundary near Mahoneys Road. The noise logger locations are shown in Figure 8.

Noise levels were measured using 01dB Duo smart noise monitors (S/N: 10339 & 10496) fitted with a windshield. The microphone was mounted on a tripod at a height of approximately 1.5 m above local ground level and under free field conditions. Measurements were obtained using the 'F' response time and A-weighting frequency network. The equipment was checked before and after the survey and no significant drift in calibration was observed.

Figure 8: Logger locations



The daily averaged background noise levels for each period are shown in Table 6 and Table 7.

Table 6: Average measured background level, dB L_{A90} – Logger 1

	Period		
Date	Day	Evening	Night
Wednesday, 9 February 2022	-	52	44
Thursday, 10 February 2022	56	54	46
Friday, 11 February 2022	57	53	45
Saturday, 12 February 2022	51	49	46
Sunday, 13 February 2022	-	56	-
Monday, 14 February 2022	-	-	-

	Period		
Date	**Day**	**Evening**	**Night**
Tuesday, 15 February 2022	55	51	44
Wednesday, 16 February 2022	55	50	46
Thursday, 17 February 2022	55	51	46
Friday, 18 February 2022	58	54	44
Saturday, 19 February 2022	54	51	46
Sunday, 20 February 2022	-	52	48
Monday, 21 February 2022	56	51	
Minimum	**51**	**49**	**44**

Table 7: Average measured background level, dB L_{A90} – Logger 2

	Period		
Date	**Day**	**Evening**	**Night**
Wednesday, 9 February 2022	-	46	46
Thursday, 10 February 2022	46	47	46
Friday, 11 February 2022	49	48	45
Saturday, 12 February 2022	43	46	46
Sunday, 13 February 2022	-	50	44
Monday, 14 February 2022	48	44	45
Tuesday, 15 February 2022	46	44	45
Wednesday, 16 February 2022	45	44	44
Thursday, 17 February 2022	44	45	44
Friday, 18 February 2022	48	48	46
Saturday, 19 February 2022	44	45	44
Sunday, 20 February 2022	-	46	45
Monday, 21 February 2022	46	46	-
Minimum	**43**	**44**	**44**

For Logger 2, the minimum average background noise level for all periods is the same (43-44 dB L_{A90}). This indicates that there is likely a baseline noise level contributing to the measured noise level. This could be associated with the operation of the TTs and Jemena substation.

D2 Meteorological conditions

A weather station was deployed to measure the local weather conditions at the site. Measured wind speeds during the noise survey ranged between 0.3 and 4.4 m/s at the microphone location. Wind was predominantly from the south. The temperature was between 12 °C and 29 °C, with a relative humidity of 26 – 93 %. There was practically no rain during the noise survey.

D3 Attended measurements of the TTS

Attended noise measurements of equipment at the TTS have been conducted at the following times:

- 9 February 2022 between 0930 – 1030 hrs
- 22 February 2022 between 1040 – 1100 hrs.

Noise levels were measured using a Brüel & Kjær Type 2250 Class 1 precision integrating sound level meter (Serial No. 3009588) fitted with a windshield.

A summary of the measurement results is shown in Table 8. The noise levels for each measurement were relatively constant and each measurement lasted approximately 30 seconds.

The measurement locations are shown in Figure 9 and Figure 10.

Table 8: Sound pressure level measurements

Day & Time	Location	Description	Measured noise level, dB $L_{Aeq\ 30\ sec}$
9/02/2022 9:31	2	Approx. 4m from transformer B5	65
9/02/2022 9:33	3	Approx. 4m from transformer B4	78
9/02/2022 9:34	4	Approx. 18m from transformer B4	69
9/02/2022 9:37	5	Approx. 4m from transformer B1	61
9/02/2022 9:38	6	Approx. 18m from transformer B1	62
9/02/2022 9:40	7	Approx. 6m from to side of transformer B1	57
9/02/2022 9:42	8	Approx. 0.5m from to side of transformer B1	61
9/02/2022 9:45	9	Approx. 60m from transformers to the south. Transformers still dominant. Corona noise audible	60
9/02/2022 9:46	10	Approx. 90m y from transformers to the south. Transformers still dominant. Corona noise audible	56
22/02/2022 10:44	11	Approx. 25m south of Jemena transformer. Corona audible	61
22/02/2022 10:47	12	Approx. 60m north of transformers	59
22/02/2022 10:50	13	Approx. 7m behind transformer B3	68
22/02/2022 10:51	14	Approx. 7m behind transformer B4	74
22/02/2022 10:53	15	Approx. 35m west of transformers. Noise from industry audible	55

Figure 9: Measurement location 9/02/2022

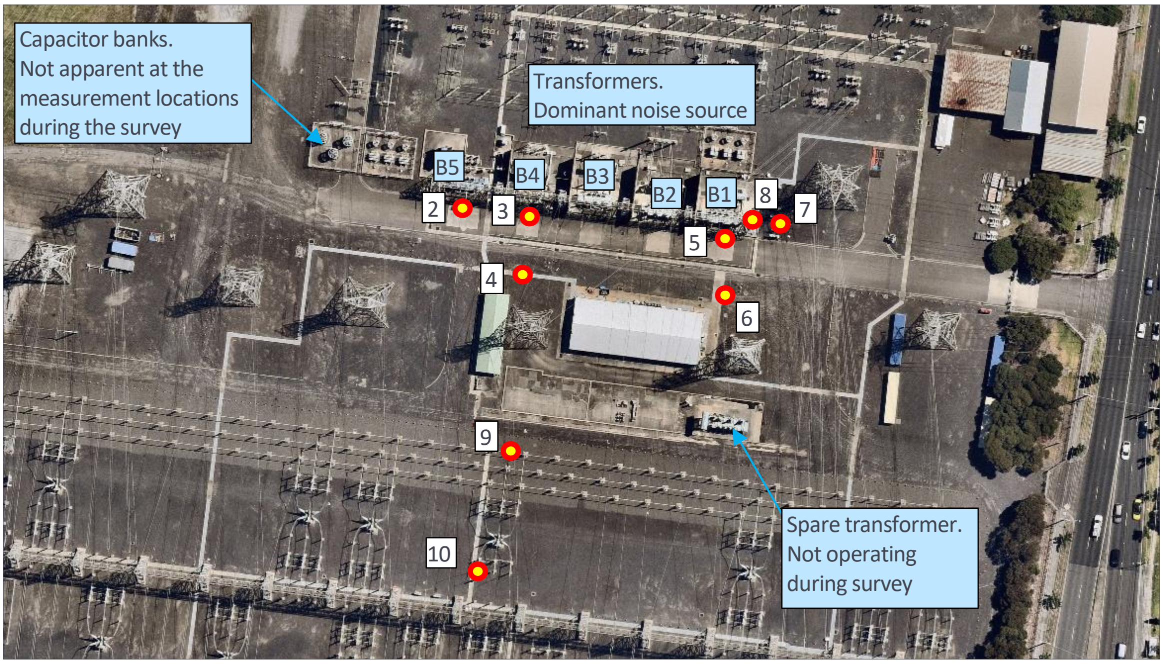


Figure 10: Measurement location 22/02/2022

APPENDIX C SOURCE NOISE DATA

The following two tables of data provide the linear octave/one-third octave band spectrum noise data, number of units and the height of the noise source (above ground level), that have been used in the calculations.

C1 Octave band noise data, linear dB

			Octave band centre frequency (Hz)											
Unit type	**Number of units**	**Noise Data**	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**dBA**	**dB**	**Source height above ground level (m)**
MV TX	82	SWL	-	64	72	69	64	56	49	44	-	65	75	2.52
Auxiliary TXs	2	SWL	-	58	66	63	58	50	43	38	-	59	69	1.9
HV TX (enclosure)	2	Lprev		91	103	78	71	66	60	51		87	103	Enclosure dimensions
Air Conditioners	15	SWL	-	74	75	70	68	65	61	58	-	70	79	1.9

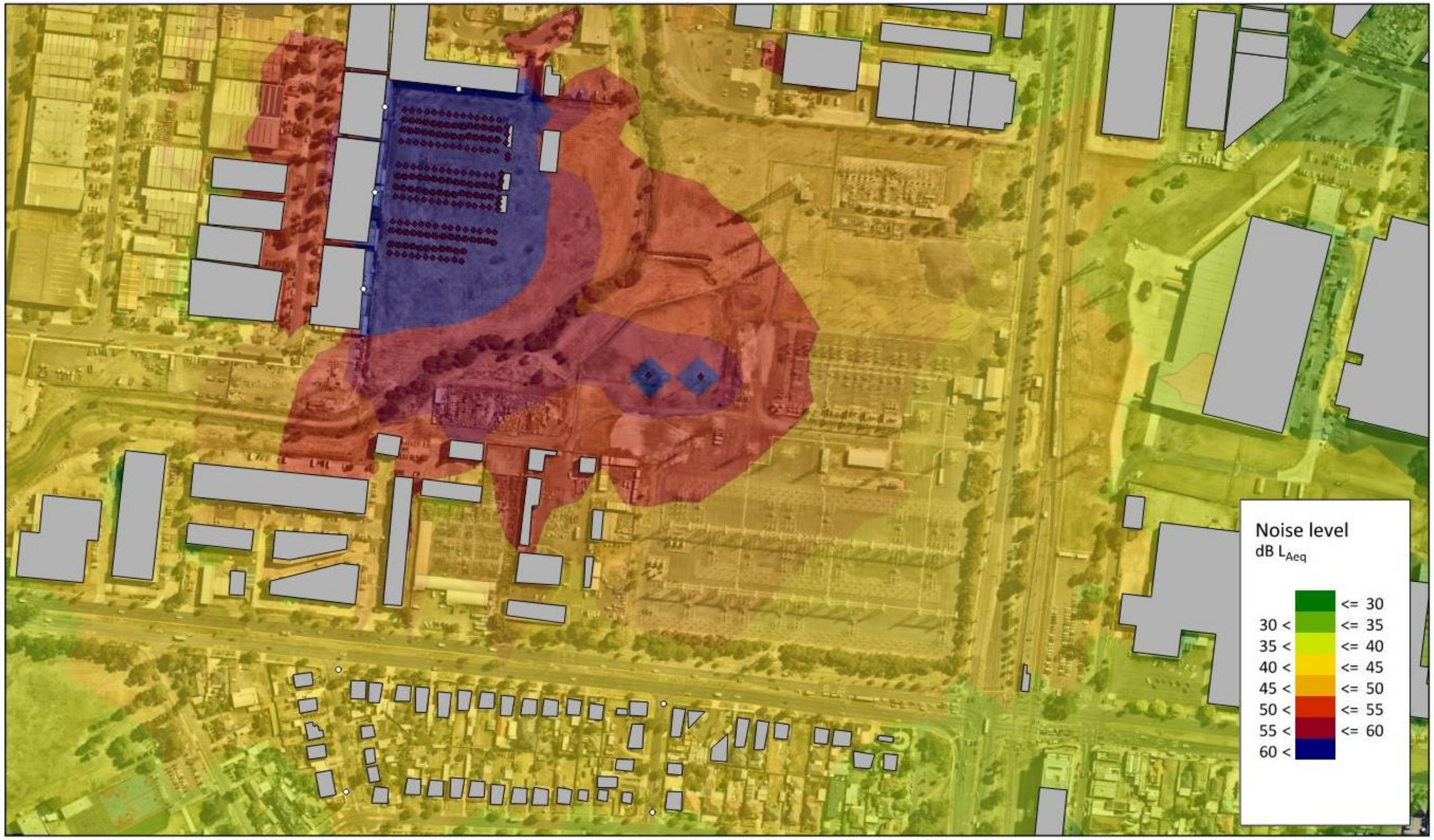
C2 One-third octave band noise data, linear dB

Unit type	Number of units	Noise Data	One-third octave band centre frequency (Hz)															
			25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800
Batteries 40% fan speed	164	SWL				76	73	73	81	78	78	78	85	71	71	78	76	74
HV TX	2	SWL	61	64	77	93	76	89	106	83	78	79	76	76	76	71	70	69

Unit type	Noise Data	One-third octave band centre frequency (Hz)											dBA	dB	Source height above ground level (m)
		1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k			
Batteries 40% fan speed	SWL	68	73	69	68	66	68	67	64	61	58	55	83	90	2.5
HV TX	SWL	68	66	64	61	59	57	55	51	53	51	46	88	107	5.6

APPENDIX D INDICATIVE NOISE CONTOURS

D1 Scenario 1 - Untreated



LEGEND
- Point source
- Point receiver
- Building

Version: SoundPLAN 8.2
Prediction method: ISO 9613-2
Model number: Model 3
Run No & Title: GNM(220) + 5dB for tonality
File: BESS no barriers
Prediction Height: 4.5 m

Project: Thomastown BESS
Project number: 20210988
Client name: Beca

SCALE
0 20 40 80 120 160 m

N

Thomastown BESS
Without treatment

MARSHALL DAY Acoustics

D2 Scenario 2 - Barrier to batteries and enclosure to HV Transformers