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**WAURN PONDS ZONE SUBSTATION  
CORNER GHAZEEPORE ROAD & HAMS ROAD  
WAURN PONDS  
VICTORIA**

**Detailed Measurement and Analysis of Noise Sources Present at the Site  
and  
Options for Control of Noise Emission to Proposed Residential Development Site  
West and South of the Zone Substation**

**Prepared for:**  
CitiPower and Powercor Australia  
40 Market St.  
South Melbourne

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## 1. INTRODUCTION

Watson Moss Growcott Acoustics Pty Ltd (WMG) has previously conducted an assessment of noise emission from the Waurm Ponds Zone Substation (WPZSS) located at the corner of Hams and Ghazeepore Roads, to vacant land south and west of the WPZSS. The noise assessment was conducted in order to assess the suitability of this land for residential development, on the basis of noise levels emitted from the WPZSS.

The resultant noise levels at the adjacent vacant land were assessed in terms of the Victorian EPA document: *NOISE FROM INDUSTRY IN REGIONAL VICTORIA Recommended Maximum Noise Levels from Commerce, Industry and Trade Premises in Regional Victoria* (NIRV).

The Waurm Ponds ZSS includes a refrigeration unit, and this was operating during the noise survey on which the noise assessment was based.

The assessment concluded that noise levels emitted from the ZSS, which included significant tonality, exceeded the NIRV Recommended Maximum Noise Level for the night period by a significant margin over a large area of the land adjacent to the WPZSS.

WMG was subsequently engaged to return to the site on a hot day to:

- conduct detailed source noise measurements in one-third octave frequency bands on the three transformers and one refrigeration chiller located on the site;
- conduct subsequent analysis to determine the sound power levels of the noise sources in one-third octave frequency bands in order to be able to conduct calculations of noise emission and attenuation by perimeter barriers;
- consider the effective height of noise sources;
- conduct noise emission calculations to determine feasible noise reductions by perimeter noise barriers.

This report should be read in conjunction with the previous report on the off-site noise assessment, WMG Ref 12142-2ng.docx, 8 November 2017.

## 2. CRITERIA FOR NOISE EMISSION FROM THE SUBSTATION

Noise in regional Victoria is considered in terms of the Victorian EPA document: *NOISE FROM INDUSTRY IN REGIONAL VICTORIA Recommended Maximum Noise Levels from Commerce, Industry and Trade Premises in Regional Victoria* (NIRV).

Under the noise assessment procedures set out in this document, Recommended Maximum Noise Levels (RMNLs) are set using *State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1* (SEPP N-1) within the Urban Centre Boundaries of major urban centres in Victoria (defined as a population greater than 7000), which includes Geelong.

Beyond the Urban Centre Boundary, the Recommended Maximum Noise Levels are obtained from a table in the NIRV document, taking the planning scheme zonings of the land occupied by



the noise source and the land occupied by the noise receiver/s into account, plus the separation between the source and receiver/s and existing background sound level under some circumstances.

The Geelong Urban Centre Boundary runs along Hams Rd from the west and south down Ghazeepore Rd, as indicate in Appendix One. This means that the Waurm Ponds ZSS and the subject land are just outside the Urban Centre Boundary, implying that NIRV RMNLs for the subject site are derived directly from the NIRV document without reference to SEPP N-1.

Existing housing along the northern side of Hams Rd and the eastern side of Ghazeepore Rd are within the Geelong Urban Centre boundary, so have noise limits determined in accordance with SEPP N-1 under NIRV. This results in a higher noise constraint at the existing housing north of Hams Rd and east of Ghazeepore Rd than on the subject land.

For equipment that operates into the night period, defined as 10pm to 7am, the night period provides the limiting criterion.

The ZSS and the subject site occupy land zoned FZ, as indicated on the Planning Scheme map attached at Appendix Two.

Application of the NIRV procedure gives a night period RMNL of 36dB(A) at the subject land south of Hams Rd and west of Ghazeepore Rd. This is derived on the basis of the Zone Level table in the document, which for a noise source in a farming zone and noise receivers in either a farming or residential zone gives a zone level of 36dB(A) for the night period.

The background level of 31dB(A)  $L_{90}$  measured during a previous visit to the site and the proximity of the subject land to the ZSS imply no change to the zone level, so 36dB(A) is the Recommended Maximum Noise Level during the night period for the subject site.

Although the night period presents the limiting criterion, when considering noise control options that may include some equipment on the site that needs to operate during the heat of the day but either may not need to operate at night or operate at reduced capacity at night, the 'evening' noise constraint becomes relevant.

The EPA-defined 'evening' period also includes Saturday afternoon and Sunday, when it can be as hot as any other day of the week.

Therefore, the NIRV Recommended Maximum Noise Level for the 'evening' period, 41 dB(A), is a secondary noise constraint in addition to the 'night' period figure of 36 dB(A).

The Recommended Maximum Noise Level is to be met within the boundaries of residential property but outside a dwelling



### 3. DETAILED ON-SITE NOISE MEASUREMENTS

A visit was made to the WPZSS on the afternoon of Sunday 28 January 2018. A noise survey of the three transformers and one chiller on the site was conducted between approximately 2:15 and 4:30 pm.

Weather observations from the Geelong Racecourse Bureau of Meteorology Automatic Weather Station (AWS) approximately 9 km from the site indicated a temperature at 3pm of 36 degrees and a maximum temperature of 38 degrees C.

The 3pm wind speed at the AWS was 20 km/h from the ENE, but observations at the WPZSS indicated that the wind speed would have been lower at that location, which is more sheltered than the racecourse. Wind did not affect the noise measurements, which were conducted typically within 2 m of the noise source.

During the noise survey the WPZSS was running at 72MW, and has a station maximum demand of 83MW.

Noise measurements were conducted with a Rion NA27 Precision Sound Level Meter and One Third Octave Band Analyser. Field calibration of the meter was checked with a Bruel & Kjaer Type 4230 Sound Level Calibrator at the commencement and completion of the noise measurements and found to be correct.

The WPZSS includes three transformers as shown on the plan attached in Appendix One. The transformers are numbered 1 to 3 from west to east. The site also includes a chiller, which was not shown on the plan but its location has been annotated in red. This chiller provides cooling for TX2 only.

TX1 and TX3 are similar, with TX2 being different and apparently older than TX1 and TX3. All of the transformers had ventilation fans but the TX2 fans were clearly the dominant noise source on TX2 and measurements were taken for TX2 with the fans operating initially and then with the fans switched off.

The chiller was a dominating noise source, so was switched off while the transformer measurements were being conducted. Having had the chiller switched off for some time allowed the chiller to be measured at two operating capacities. It is understood that the chiller is oversized for the duty and typically operates at low capacity.

The nominal dimensions were measured and found to be approximately:

- TX1 5 m L x 3 m W x 3.5 m H
- TX2 5 m L x 3 m W x 4.0 m H
- TX3 5 m L x 3 m W x 3.5 m H
- Chiller 12 m L x 2 m W x 3.2 m H

A series of sound pressure level measurements were conducted at approximately 2 m intervals along the four sides of each noise source in one-third octave frequency bands.



These results were subsequently analysed together with the source dimensions in order to derive the sound power level emanating from each side of the equipment and the total sound power level. These detailed results have been tabulated in Appendix Two.

The most prominent one-third octave bands in the A-weighted spectrum have been highlighted in the table. These generally reflected the tonal frequencies noted in the off-site noise survey in November 2017.

The overall total sound power level in dB(A) has been tabulated below, rounded to the nearest whole decibel.

**Table One: Total sound power level for each item of equipment.**

Equipment	Sound Power Level, dB(A) re 1pW
TX1	80
TX2, fans off	82
TX2, fans on	87
TX3	82
Chiller, approx. 8% capacity	93
Chiller, approx. 35% capacity	94

TX1, 3 and TX2 with the fans off were all within 2 dB(A) of each other. TX2 with the fans operating was 5 dB(A) higher than with the fans off, which is a significant margin.

The chiller was by far the highest-level source at the site, with little difference between the results at nominally 8% and 35% capacity.

It is important to note that the sound power levels set out above were established with the equipment operating as at January 2018. Experience has indicated that noise emission from transformers can gradually increase over time due to 'wear and tear'.

There is therefore a possibility that over a period of many years the level of noise emission may increase compared with what was measured.

#### 4. NOISE EMISSION MODELLING

Having derived the sound power levels for the equipment at the site under a range of operating conditions, a noise model was set up to check noise emission and consider the attenuation achievable by perimeter noise barriers. The noise model was set up using ENM, the Environmental Noise Model, which has been used to successfully model noise emission from numerous industrial sites around Victoria.

Noise source heights have been adopted as 2.5, 3.0, 2.5 and 2.5 m for TX1, TX2, TX3 and the chiller respectively. These source heights represent the upper half of the noise source, expected to be dominant in considering noise barriers.



The model was initially run without noise barriers in order to see how closely it replicated the off-site noise levels measured in November 2017. To provide a basis of comparison, the October 2017 results have been included at Appendix Three.

**It is important to note that the October 2017 results in Appendix Three include a +5 dB(A) tonal adjustment to the measured 'raw' level in accordance with NIRV/SEPP N-1 procedures, but the modelled noise contours are the 'raw' level without the tonal adjustment.**

WMG was advised that the chiller was operating during the November 2017 off-site noise survey, but no information was provided regarding transformer fan status or chiller operating capacity. A number of combinations of operating equipment have therefore been modelled.

In-principle options for reducing noise emission from the ZSS and protecting possible future residential development from noise above the NIRV RMNLs are:

- Reduce noise at the source, such as by removing the chiller or not using it at night; replacing the fans on Transformer 2 with quieter fans if possible; replacing Transformer 2 with a new transformer that has quieter fans and does not require a chiller; replacing the chiller with a noise-reduced model.
- Installing noise barriers around the perimeter of the ZSS. Noise barriers have a finite noise reduction capability and 5 m has been taken to be a height beyond which it is unlikely that approval would be gained for noise barriers. Municipalities are often reluctant to allow noise barriers higher than 3 m in the vicinity of residential development, but 4 m may be feasible if residential dwellings are not directly adjacent.
- Provide a buffer outside the ZSS boundary, which may be in the form of landscaping or a public recreation area rather than a residential allotment.

Noise contour plots corresponding to a number of combinations of source noise characteristics and perimeter barriers around the ZSS have been included in Appendix Four to assist in reaching conclusions regarding feasible noise control options.

The November 2017 off-site noise survey obtained effective levels (including tonal adjustment) of 50 dB(A) nominally 20 m from the boundary west of the noise sources and 42 dB(A) further west in the vicinity of the marshy waterway. These effective levels correspond to 'raw' level of 45 and 37 dB(A) respectively.

Comparison with the noise contour plots in Appendix Four indicates that the best match between the off-site levels measured in October 2017 and the noise modelling contours to the west of the site is with the TX2 fans not running but the chiller running.

A point of disagreement between the off-site survey results and the noise modelling contours is that distinctly lower levels were measured south of the site than west of the site during the off-site survey, but the noise modelling results are more symmetrical.

No explanation for this difference has yet been established.

The contour plots in Figures Four to Eight of Appendix Four have been obtained with perimeter barriers in place.



The significance of the low sound frequencies to noise emission from the ZSS means that even a substantial 5 m high barrier provides limited noise reduction with all sources operating at the ZSS, including the fans on TX2 and the chiller.

It is important to note that barrier attenuation does not remove tonality, so a tonal adjustment of +5 dB(A) would need to be added to these figures, implying effective levels still above the NIRV night period Recommended Maximum Noise Level over a large area.

The presence of a light breeze or temperature inversion was found to affect sound propagation less than is sometimes the case, principally due to the relatively close proximity of the noise sources, barriers and receptor locations.

## 5. OPTIONS FOR NOISE CONTROL

Based on the considerations discussed in section 4 above and review of the noise contour plots in Appendix Four, the noise control options will include the following.

It is anticipated that barrier heights beyond 5 m would be considered unrealistic and unacceptable from an aesthetic standpoint, so higher barriers have not been pursued in relation to achieving compliance with the NIRV night period Recommended Maximum Noise Level with the transformer 2 fans and chiller operating during the night period.

### 5.1 TO COMPLY WITH NIRV RMNL DURING SATURDAY AFTERNOON AND ALL DAY SUNDAY WITH TRANSFORMER 2 FANS AND CHILLER OPERATING

- 5 m high noise barriers on the western and southern boundaries of the ZSS.
- No requirement for buffer zone.

### 5.2 WITH ALLOWANCE FOR CONTINUED OPERATION OF THE CHILLER AND TRANSFORMER 2 FANS DURING THE NIGHT PERIOD

- 5 m high noise barriers on the western and southern boundaries of the ZSS.
- Significant buffer zone excluding housing from the area between the '31' contour on Figure 5 of Appendix Four and the ZSS boundary.

### 5.3 WITH ALLOWANCE FOR IMPLEMENTATION OF MEASURES SO THAT TRANSFORMER 2 FANS AND CHILLER EITHER DO NOT NEED TO OPERATE DURING THE NIGHT PERIOD OR ARE ATTENUATED BY AT LEAST 10 dB(A)

- 5 m high noise barriers on the western and southern boundaries of the ZSS.
- No requirement for buffer zone.



## 6. SUMMARY

Watson Moss Growcott Acoustics has conducted a detailed survey of source noise levels at the Waurm Ponds Zone Substation in order to determine the sound power levels of the four noise sources at the site in one-third octave frequency bands.

These sound power levels have been set out in the report, and the results of initial noise modelling presented.

The derived sound power levels in one-third octave bands have been incorporated into a noise model for the site.

The noise modelling indicates that installation of boundary noise barriers 5 m high would enable compliance with the NIRV Recommended Maximum Noise Levels for the 'day' and 'evening' periods seven days per week, which encapsulates the typical periods of elevated temperatures when operation of the transformer 2 fans and the chiller could be reasonably anticipated.

If allowance needs to be made for the fans on transformer 2 and the chiller to operate as they currently exist during the night period, it would not be possible to achieve compliance with the NIRV night period Recommended Maximum Noise Level over the full extent of the subject land by the use of boundary noise barriers of reasonable dimensions (considered to be no more than 5 m high).

Therefore, if the transformer 2 fans and the chiller are required to operate and night and are to remain in their present form, even with 5 m high boundary noise barriers in place there would need to be a significant buffer area from which houses are excluded adjacent to the ZSS.

There remains some uncertainty as to whether the transformer 2 fans and the chiller need to operate during the night period, 10pm to 7am.

If it were to be established that the transformer 2 fans and the chiller do not need to operate during the relatively cooler conditions of the night period, then 5 m high boundary noise barriers would enable compliance with the NIRV Recommended Maximum Noise Level for the night period over the whole of the subject site.

Alternatively, attenuation and/or replacement of the transformer 2 fans and the chiller can be considered, which would allow for a reduced buffer area. In the limit, if noise emission from the transformer fans and the chiller can be reduced to no more than with the existing transformer 2 fans and chiller not operating, then the buffer area could be reduced to zero.

It is important to note that the sound power levels on which these conclusion have been based were established with the equipment operating as at January 2018. Experience has indicated that noise emission from transformers can gradually increase over time due to 'wear and tear'.

There is therefore a possibility that over a period of many years the level of noise emission may increase compared with what was measured and formed the basis of these conclusions.

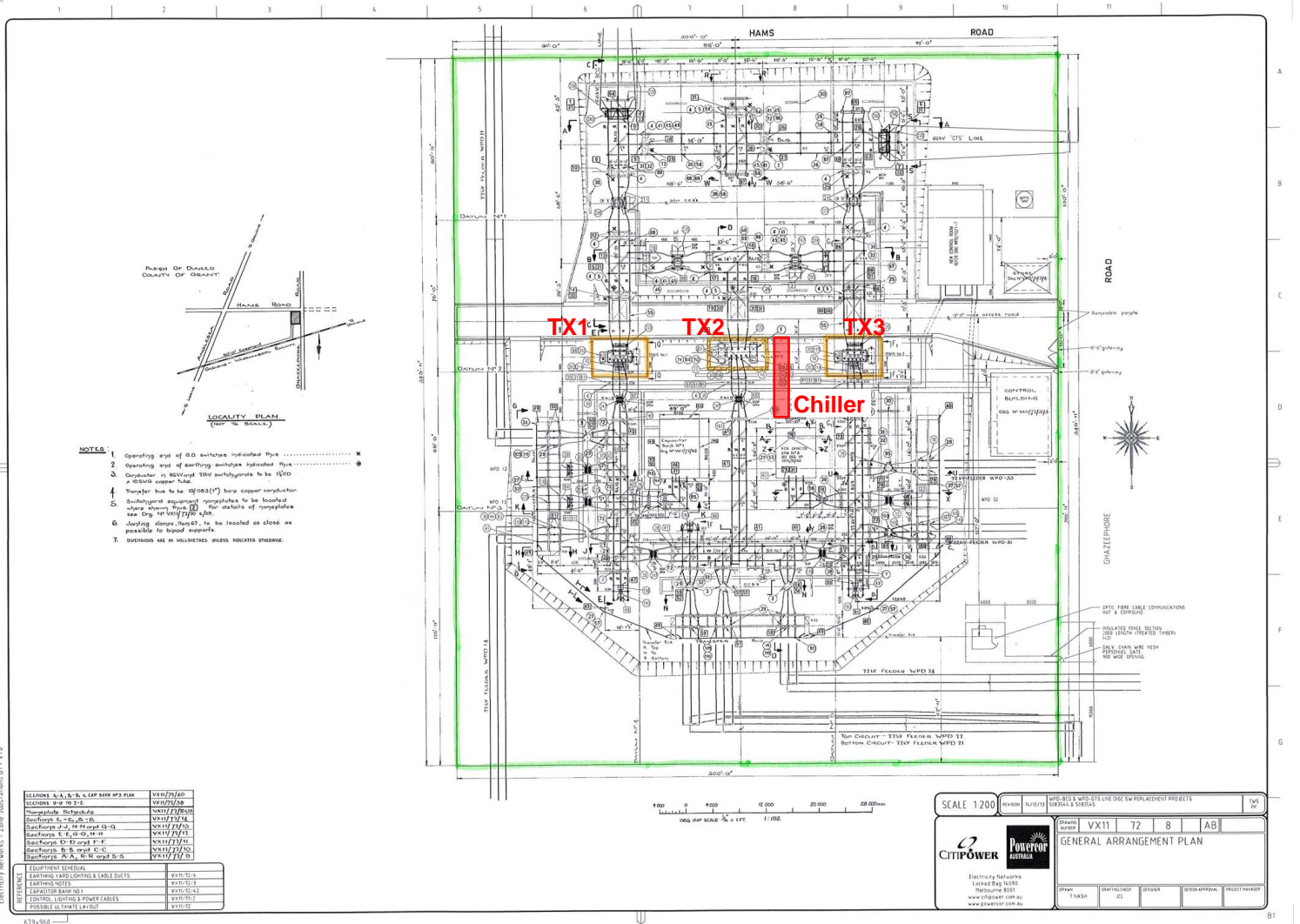


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WATSON MOSS GROWCOTT  
Acoustics Pty Ltd



APPENDIX ONE: WAURN PONDS ZONE SUBSTATION SITE PLAN



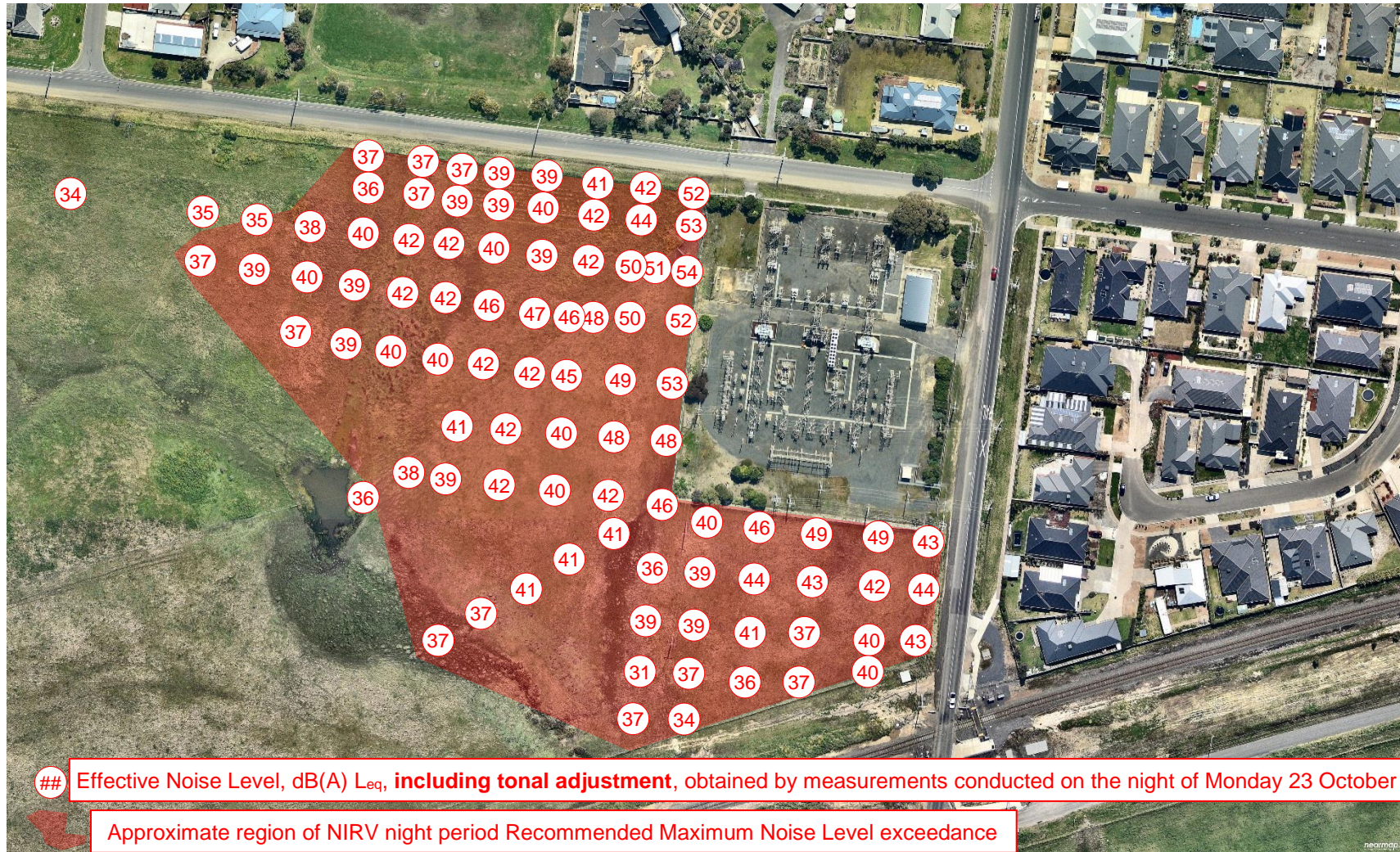
**APPENDIX TWO: SOUND POWER LEVELS DERIVED FROM SITE NOISE MEASUREMENTS**

Item	Face	Sound Power Level, dB re 1 pW																						dB(A)
		One-Third Octave Band Centre Frequency,																						
		Hz	Hz	Hz	Hz	Hz	Hz	Hz	Hz	Hz	Hz	Hz	Hz	Hz	Hz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	
50	63	80	100	125	160	200	250	315	400	500	630	800	1	1.25	1.6	2	2.5	3.15	4	5				
TX1, fans on but not contributory	North	69.4	68.3	72.0	87.0	71.6	70.1	78.2	68.8	69.1	72.0	67.9	68.2	64.9	62.3	59.9	58.0	55.7	52.6	49.7	46.4	43.1	75.2	
	West	65.3	63.5	68.5	82.8	67.8	65.5	68.6	61.9	64.1	67.0	64.3	64.4	59.6	57.8	54.7	52.5	49.3	46.9	44.9	41.9	38.7	70.1	
	South	68.0	67.2	71.5	85.5	70.8	68.9	77.4	68.5	68.1	70.8	67.4	67.4	64.7	61.9	59.5	57.3	55.0	52.1	49.2	46.3	42.7	74.4	
	East	66.9	65.2	69.8	83.7	67.8	65.4	74.5	65.9	66.1	71.9	66.3	67.1	64.4	61.3	59.1	57.5	55.2	52.6	49.5	46.4	43.2	73.6	
	Total	73.7	72.5	76.7	91.1	75.9	74.0	81.9	73.0	73.3	76.9	72.7	73.0	69.9	67.2	64.8	62.8	60.4	57.6	54.7	51.6	48.3	79.7	
TX2, fans off	North	67.9	65.9	70.9	86.6	66.5	69.0	86.4	68.8	74.2	67.9	64.2	65.3	62.6	60.3	57.3	54.6	51.7	50.0	47.3	44.8	41.5	77.5	
	West	64.4	64.0	69.9	82.9	63.7	66.4	83.2	65.1	71.4	65.6	61.2	62.8	59.4	58.2	55.0	52.7	49.7	48.3	44.9	43.4	39.7	74.4	
	South	64.9	66.5	71.6	86.4	66.5	69.0	85.9	69.6	76.7	68.0	62.7	63.3	62.2	60.5	57.9	55.3	52.1	50.0	48.0	45.7	42.7	77.5	
	East	63.9	69.2	68.5	83.9	64.3	67.6	84.4	68.4	73.2	65.3	61.5	61.7	59.5	58.4	55.8	54.1	50.5	49.3	46.6	44.1	41.0	75.5	
	Total	71.6	72.8	76.4	91.3	71.5	74.2	91.2	74.3	80.3	72.9	68.6	69.5	67.2	65.5	62.6	60.3	57.1	55.5	52.9	50.6	47.4	82.5	
TX2, fans on	North	75.6	79.5	75.5	82.7	76.7	76.3	84.5	80.4	80.4	76.6	74.9	73.2	71.7	70.7	68.0	65.5	63.3	61.6	59.8	63.6	53.5	81.1	
	West	78.6	73.4	74.6	84.2	74.7	74.4	83.5	76.1	75.0	74.1	74.3	73.5	71.8	69.6	67.1	65.2	62.4	61.0	57.8	55.0	51.5	80.2	
	South	76.0	72.8	74.6	86.9	75.3	74.4	86.8	78.8	79.1	74.2	74.6	73.5	71.4	69.1	66.7	64.7	62.4	60.2	57.8	59.4	51.3	81.4	
	East	76.7	74.1	73.6	84.3	73.7	73.4	85.8	79.1	76.6	72.8	72.5	71.6	69.7	67.5	65.3	63.2	61.0	59.0	56.7	63.1	50.6	80.1	
	Total	82.9	81.9	80.6	90.8	81.2	80.8	91.3	84.8	84.3	80.7	80.2	79.0	77.2	75.4	72.9	70.7	68.4	66.5	64.2	67.4	57.9	86.8	
TX3, fans on but not contributory	North	65.9	66.7	72.5	87.6	71.5	67.9	77.8	68.3	75.1	70.8	71.9	71.2	66.0	61.6	58.5	56.1	53.2	51.3	49.3	48.1	44.7	76.7	
	West	64.2	66.8	75.1	89.5	69.3	70.3	77.7	80.4	71.5	65.9	68.5	69.7	66.4	65.5	60.6	57.6	55.6	54.5	52.5	52.3	46.4	77.4	
	South	64.9	67.5	73.8	83.7	68.1	67.7	78.3	67.1	74.6	69.7	69.1	72.2	68.0	63.1	60.1	57.6	54.6	52.1	50.3	47.6	46.2	76.4	
	East	63.1	62.9	68.7	82.9	64.8	63.1	75.3	61.8	66.4	67.3	68.4	70.8	66.7	60.9	57.6	55.9	53.0	50.8	49.3	48.0	44.6	74.5	

Item	Face	Sound Power Level, dB re 1 pW																					
		One-Third Octave Band Centre Frequency,																				dB(A)	
		Hz	Hz	Hz	Hz	Hz	Hz	Hz	Hz	Hz	Hz	Hz	Hz	Hz	Hz	kHz	kHz	kHz	kHz	kHz	kHz		kHz
50	63	80	100	125	160	200	250	315	400	500	630	800	1	1.25	1.6	2	2.5	3.15	4	5			
	Total	70.7	72.3	79.1	92.8	75.1	74.0	83.4	80.9	79.0	74.9	75.8	77.1	72.9	69.2	65.4	62.9	60.2	58.5	56.6	55.5	51.6	82.4
Chiller, nom. 8% capacity	North	65.4	66.3	67.1	70.3	67.6	82.8	80.3	75.3	83.9	69.0	67.7	69.0	70.1	68.9	64.8	62.2	61.2	60.4	60.5	69.5	58.6	80.8
	West	75.1	79.8	79.2	87.6	79.7	88.2	88.0	92.6	85.8	80.6	80.3	80.3	80.6	81.2	77.8	74.9	74.4	73.8	72.5	75.6	66.4	90.2
	South	63.0	64.4	65.6	77.0	65.2	70.5	68.3	72.0	73.2	65.1	66.5	64.3	66.3	65.2	59.6	57.9	55.4	54.6	52.5	55.2	45.2	73.7
	East	73.1	76.2	77.5	85.3	79.4	87.6	83.5	89.7	85.4	78.1	78.7	78.2	79.2	78.5	75.8	73.7	72.5	72.0	70.0	72.1	62.9	88.1
	Total	77.6	81.6	81.7	89.9	82.8	91.6	89.9	94.5	90.0	82.8	82.8	82.7	83.2	83.3	80.1	77.5	76.7	76.1	74.6	77.9	68.5	92.7
Chiller, nom. 35% capacity	North	65.0	66.6	66.7	75.5	68.1	81.5	79.7	78.5	84.9	69.1	68.7	69.2	68.7	68.8	65.1	62.8	61.9	61.3	60.6	69.9	61.0	81.4
	West	77.6	80.1	80.1	87.7	82.5	88.0	88.7	91.2	85.2	82.0	82.1	82.1	82.1	81.9	78.4	76.4	76.3	75.7	74.5	77.4	68.6	90.8
	South	67.4	70.8	73.7	77.0	74.7	78.4	76.3	76.1	76.3	74.1	75.2	73.6	75.5	73.9	69.9	67.9	67.8	67.4	65.8	63.6	57.9	82.0
	East	76.8	80.0	79.6	87.3	82.5	88.4	86.6	90.9	85.6	82.0	81.7	81.9	83.0	81.3	77.9	75.5	74.7	74.0	72.6	72.8	65.7	90.3
	Total	80.6	83.4	83.5	90.9	85.9	91.9	91.3	94.2	90.2	85.4	85.5	85.4	86.1	85.0	81.6	79.4	79.0	78.4	77.1	79.3	71.0	94.1

##.# indicates most prominent one-third octave bands in the A-weighted spectrum

**APPENDIX THREE: NOISE SURVEY RESULTS OBTAINED ON THE NIGHT OF MONDAY 23 OCTOBER 2017 FOR REFERENCE PURPOSES**



## APPENDIX FOUR: NOISE EMISSION CONTOUR PLOTS



Figure One: modelled noise contours with no barriers, all transformers operating, no fans on TX2, with chiller not running



Figure Two: modelled noise contours with no barriers, TX1 and TX3, no fans on TX2, with chiller running at 8%



Figure Three: modelled noise contours with no barriers, TX1 and TX3, fans operating on TX2, with chiller @ 35%



**Figure Four: modelled noise contours with 5 m high barriers, TX1 and TX3, fans operating on TX2, with chiller @ 35%, no breeze or temperature inversion**





Figure Six: modelled noise contours with 4 m high barriers, TX1 and TX3, fans not operating on TX2, with no chiller, no breeze or temperature inversion



Figure Seven: modelled noise contours with 4 m high barriers, TX1 and TX3, fans operating on TX2, chiller operating at 35%, no breeze or temperature inversion



Figure Eight: modelled noise contours with 4 m high barriers, TX1 and TX3, fans operating on TX2, chiller operating at 35%, 3 m/s NE breeze