OAKDALE SOUTH INDUSTRIAL ESTATE

Lot 2A
DA Noise Impact Assessment

Prepared for:

Goodman Property Services (Aust) Pty Limited
Level 17, 60 Castlereagh Street
Sydney NSW 2000

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Goodman Property Services (Aust) Pty Limited (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
610.30093.00200-R04-v1.1	8 October 2020	Joshua Ridgway	Antony Williams	Antony Williams
610.30093.00200-R04-v1.0	16 September 2020	Joshua Ridgway	Antony Williams	Antony Williams

CONTENTS

CONTENTS

DOCUMENT REFERENCES

TABLES

FIGURES

APPENDICES

1 Introduction

1.1 Background

The Oakdale South Industrial Estate (Oakdale South) site on Ottelia Road, Kemps Creek is currently being developed. Lot 2A (the project) is proposed to be developed and integrated into Oakdale South.

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Goodman Property Services (Aust) Pty Limited (Goodman) to prepare a Noise Impact Assessment (NIA) for Lot 2A to assess the potential noise impacts associated with the project. This report presents the results of the assessment and forms part of the Development Application (DA) for the project.

1.2 Relevant Guidelines

Noise from the operation of the project has been assessed in accordance with the *NSW Industrial Noise Policy* (INP), NSW EPA, 2000. It is noted that the EPA released the *Noise Policy for Industry* (NPfI) in October 2017, which replaces the INP, however, the project is required to be assessed under the INP as the Development Consent for Oakdale South was issued prior to release of the NPfI.

Construction noise has been assessed in accordance with the *Interim Construction Noise Guideline* (ICNG), DECC, 2009.

Vibration from operation and construction has been assessed in accordance with *Assessing Vibration: A Technical Guideline*, DEC, 2006.

1.3 Terminology

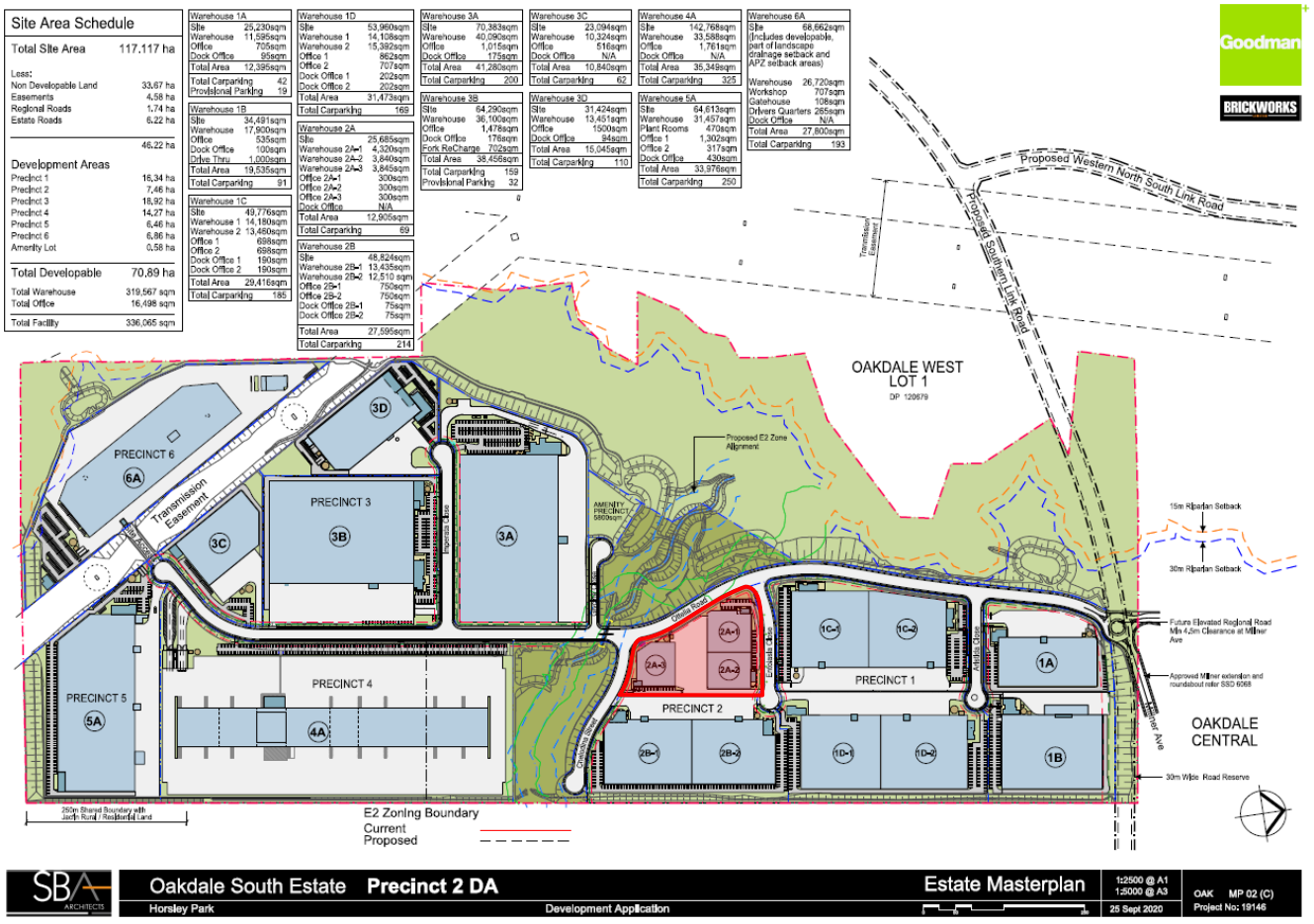
The assessment has used specific acoustic terminology. An explanation of common terms is included as **Appendix A**.

2 Project Description

2.1 Oakdale South Industrial Estate

The Lot 2A development is within the Oakdale South SSD 6917 Masterplan. The Masterplan for Oakdale South is shown in **Figure 1**.

Figure 1 Oakdale South Masterplan

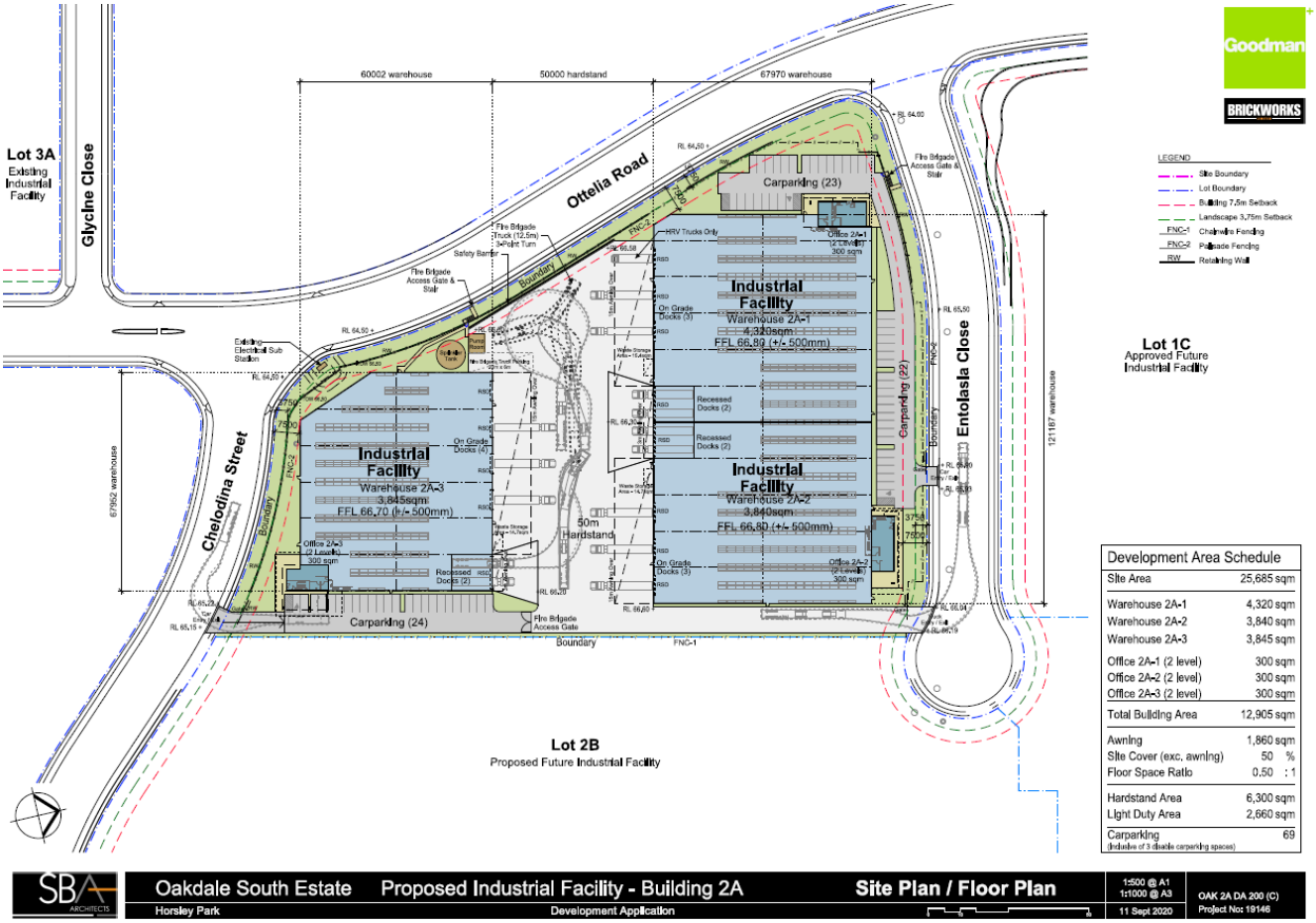


Note 1: Lot 2A indicated in red.

2.2 The Project – Lot 2A

The current DA covers the construction and operation of Lot 2A detailed in drawing OAK 2A DA 200 (C), dated 11 September 2020, as shown in **Figure 2**.

Figure 2 Lot 2A Design Plans



Note 1: Drawing provided by Goodman, dated 11/09/2020.

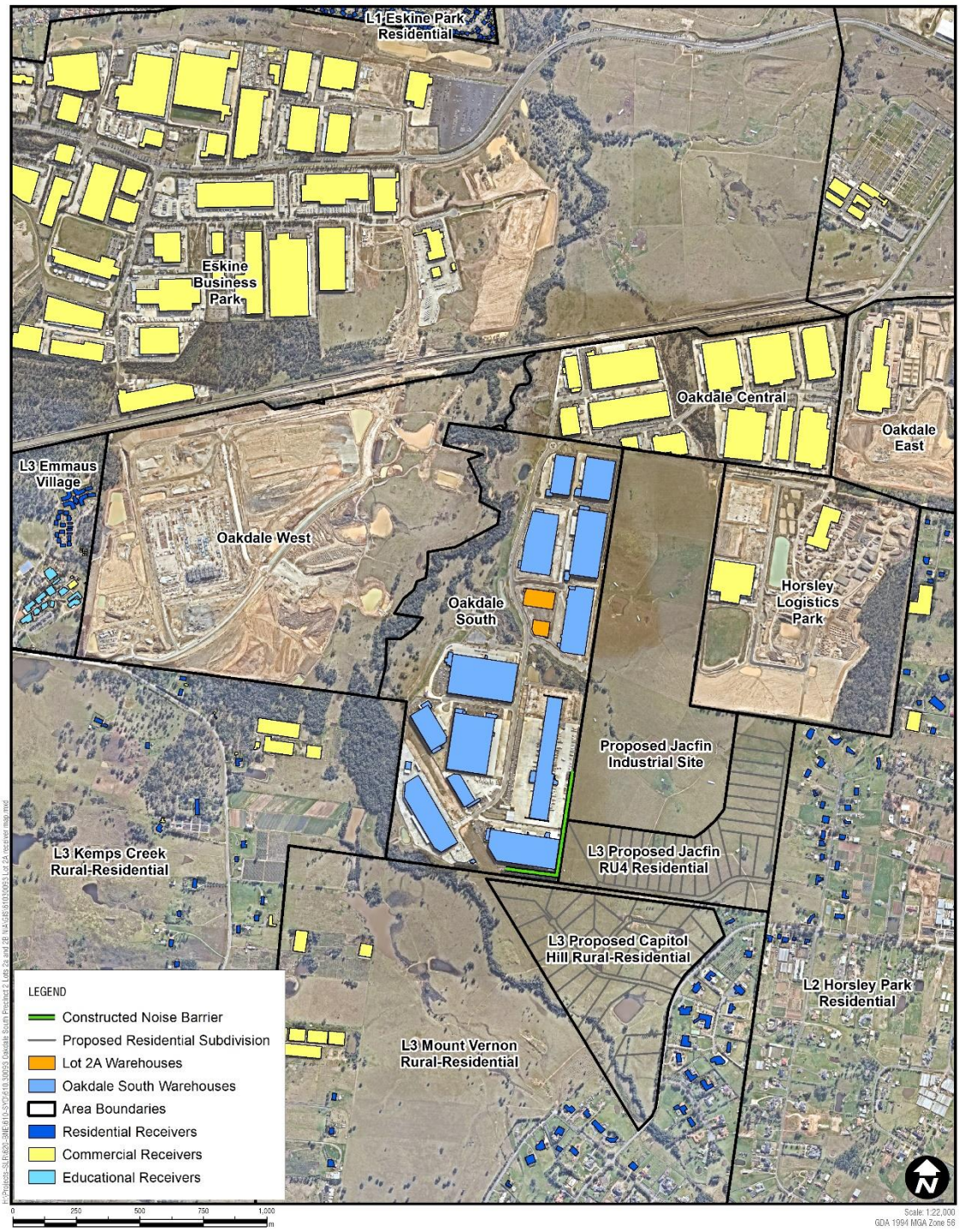
The project includes three industrial warehouses which would be used for warehousing and distribution, with associated offices, hardstand areas and carparking. Potential noise sources include vehicle movements, mobile plant such as forklifts, and fixed plant such as office air handling units. The operating hours of the facility are expected to be 24 hours a day, 7 days a week.

3 Noise Limits and Receiver Locations

3.1 Receiver Locations

The locations of noise sensitive receivers in the vicinity of Oakdale South are shown in **Figure 3**.

Figure 3 Residential Receiver Areas and Modelled Buildings



3.2 Operational Noise Limits

The operational noise limits applicable to Oakdale South are defined in Condition B18 of the site's Development Consent SSD 6917. The operational noise limits are reproduced in **Table 1**.

Table 1 Oakdale South Operational Noise Limits – Residential

Location	Day	Evening	Night	Night
	$L_{Aeq(15minute)}$	$L_{Aeq(15minute)}$	$L_{Aeq(15minute)}$	$L_{A1(1minute)}$
L1 North of Warragamba Pipeline	37	37	37	47
L2 Horsley Park	39	39	39	49
L3 Kemps Creek, Mt Vernon, Jacfin and Capitol Hill	40	40	40	48

Note 1: As per the *NSW Industrial Noise Policy* (INP), the above criteria are applicable at the most-affected point on or within the residential property boundary or, if this is more than 30 m from the residence, at the most-affected point within 30 m of the residence.

3.3 Construction Noise Goals

The Development Consent SSD 6917 for Oakdale South stipulates several conditions relating to noise from construction of the development. The conditions applicable to this report and the proposed development are reproduced below.

E18. Construction activities associated with the Development shall be undertaken during the following hours:
a) 7:00 am to 6:00 pm Mondays to Fridays, inclusive; and
b) 8:00 am to 1:00 pm Saturdays; and
c) At no time on Sundays or public holidays.

E27. The development shall be constructed with the aim of achieving the construction noise management levels detailed in the Interim Construction Noise Guideline *(ICNG, Department of Environment and Climate Change, 2009). All feasible and reasonable noise mitigation measures shall be implemented and any activities that could exceed the construction noise management levels shall be identified and managed in accordance with the management and mitigation measures in the RTS.*

The Noise Management Levels (NMLs) for Oakdale South (as per the ICNG) were detailed in the SSD Masterplan Noise Impact Assessment (SLR *Report 630.11166-R1R3*, dated 28 October 2015) and are reproduced in **Table 2**.

Table 2 Oakdale South Construction Noise Management Levels

Receiver	Time of Day	$L_{Aeq(15minute)}$ Construction Noise Management Levels (dB)	
		Standard Construction Hours	Highly Noise Affected
Residential	Daytime	42	75
	Evening	n/a	75
	Night-time	n/a	75

3.4 Prevailing Weather Conditions

Adverse weather conditions such as wind and temperature inversions have the potential to increase noise levels from industrial or road noise sources at nearby receivers.

The prevailing weather conditions for the site were determined in previous noise impact assessments for Oakdale South using 12 months of weather data from the Bureau of Meteorology automatic weather station at Horsley Park, which is around 5 km to the southeast of the project site. The prevailing weather conditions for Oakdale South are summarised as follows:

- Winds of up to 3 m/s did not exceed the 30% threshold during any season during the daytime and evening periods. However, the 30% threshold was exceeded during the night-time period in autumn, in both the SW and WSW directions.

  On this basis, assessment of noise-enhancing weather is required only during the night-time period.

- Temperature inversions of Class F or Class G occur more than 30% of the night-time period during all four seasons.

  Therefore, noise-enhancing temperature inversions are required to be included in the assessment of noise impacts during the night-time period.

4 Operational Noise Impact Assessment

4.1 Operational Noise Modelling

Noise modelling of the project was undertaken by modifying the SoundPLAN V7.1 noise models prepared for the Masterplan operational noise impact assessment for Oakdale South.

The three-dimensional models were updated to reflect the current design of Lot 2A, based on the provided design plans.

The noise model includes the noise barrier that has been constructed along the south-eastern boundary of Oakdale South (refer to **Figure 3**).

Forecast vehicle volumes (light and heavy vehicles) for the development have been provided by Goodman.

4.1.1 Daytime and Evening Periods

In order to assess the daytime and evening operational noise impacts from Lot 2A, the worst-case peak vehicle movements for Lot 2A have been modelled across the development. Light vehicles have been modelled on the estate roads and in the car parking areas. Heavy vehicles have been modelled on the estate roads and manoeuvring in the hardstand areas. The modelled vehicle volumes are shown in **Table 3**.

Table 3 Daytime / Evening Peak Vehicle Volumes for Lot 2A

Lot	Light Vehicles – 1-Hour Peak	Heavy Vehicles – 1-Hour Peak
2A	15	6

Note 1: Vehicle volumes provided by the traffic consultants for the project (Ason Group).

External forklift movements within Lot 2A have been modelled in the at-grade dock areas of the hardstands. One forklift has been modelled externally in each of the three hardstand areas operating continuously during the worst-case 15-minute period.

Sound power levels and speed assumptions for the modelled vehicle movements are shown in **Table 4**.

Table 4 Sound Power Levels for Onsite Vehicle Movements

Noise Source	Sound Power Level (SWL)	Average Speed
Heavy Vehicles	103 dBA[1]	25 km/h
Light Vehicles	96 dBA	40 km/h
Gas-powered Forklifts[2]	93 dBA	n/a

Note 1: Based on SLR's noise measurement database, this sound power level is typical of trucks travelling at low speeds, such as within industrial estates.

Note 2: If electric forklifts are proposed for the development, noise emissions from forklifts would be considerably lower than gas-powered forklifts.

External fixed plant has been conservatively modelled on the office rooftops with an assumed cumulative SWL of 80 dBA per office. External fixed plant is assumed to operate continuously.

It should be noted that during detailed design, noise emitted by the fixed mechanical plant items should be confirmed and, if required, mitigated to achieve the required noise emission levels. This can be achieved through standard acoustic measures such as appropriate selection of mechanical plant and localised shielding around fixed plant, where necessary.

4.1.2 Night-time Period

Consistent with previous noise impact assessment for Oakdale South, the night-time peak vehicle movements are assumed to be approximately 30% of the daytime/evening peak vehicle movements. Night-time movements have been modelled in order to assess the noise impacts under adverse weather conditions during this period (refer to **Section 3.4**). The modelled vehicle volumes are provided in **Table 5**.

Table 5 Night-time Peak Vehicle Volumes for Lot 2A

Lot	Light Vehicles – 1-Hour Peak	Heavy Vehicles – 1-Hour Peak
2A	5	2

Note 1: Vehicle volumes provided by the traffic consultants for the project (Ason Group).

One forklift has been modelled externally in each of the three hardstand areas operating at 50% duty during the worst-case 15-minute period.

It been conservatively assumed that all fixed plant modelled for the daytime would also be operating at 100% duty during the night-time period.

In order to assess the potential for sleep disturbance, in addition to the above noise sources, heavy vehicle brake releases and reverse alarms (non-tonal) have been modelled in the hardstand areas of the development with a sound power level (SWL) of 115 dBA.

4.2 Predicted Operational Noise Impacts

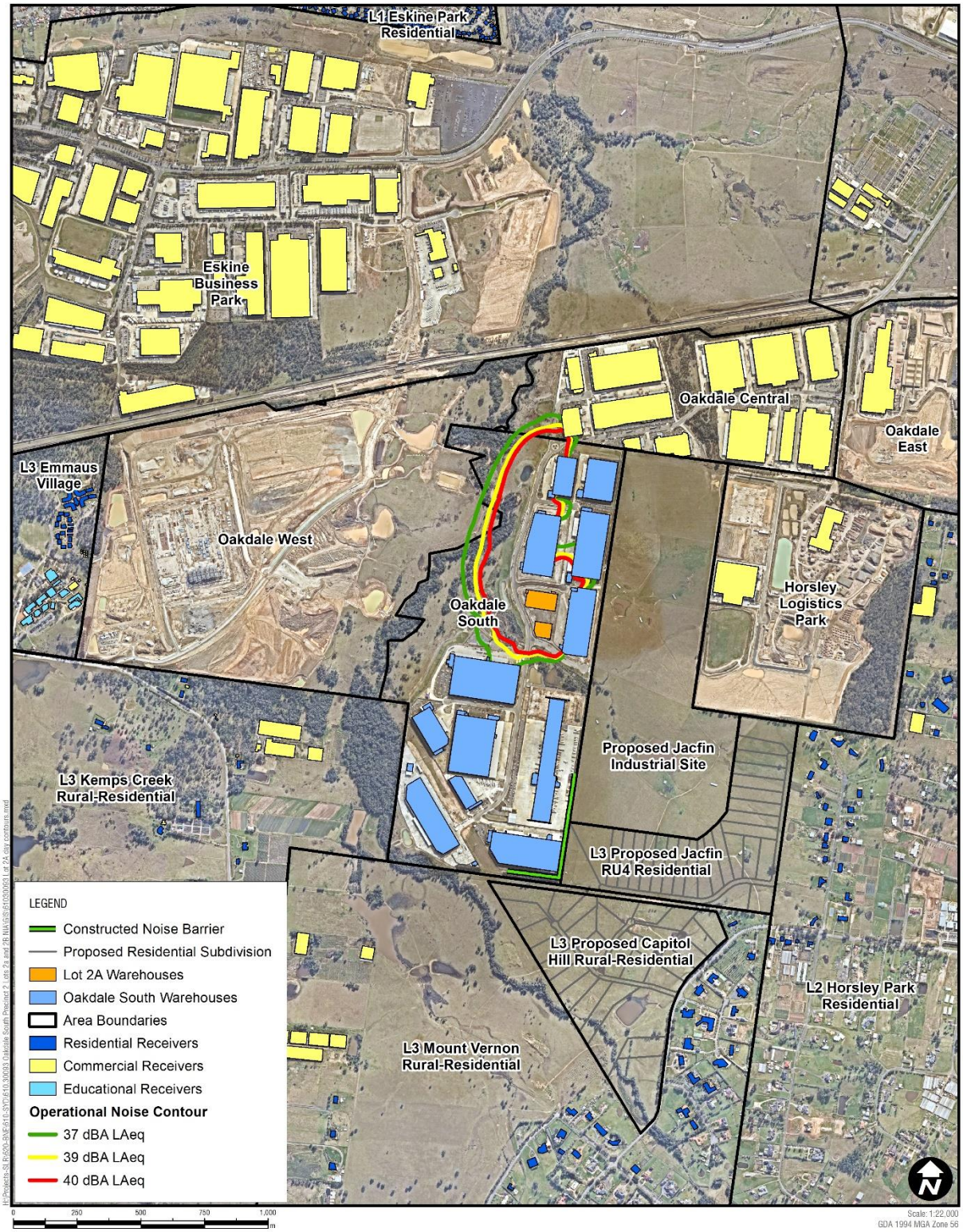
The predicted operational noise levels for the project are summarised in **Table 6**. Noise contour maps of the operational results during the daytime and evening periods under neutral weather conditions are shown in **Figure 4**, and during the night-time period under neutral weather conditions and adverse weather conditions in **Figure 5** and **Figure 6**, respectively.

Table 6 Predicted Operational Noise Levels – Lot 2A

Sensitive Receiver Area	Noise Limits (dBA)				Predicted Noise Levels (dBA) – Most-Affected Receiver				
	$L_{Aeq(15minute)}$			$L_{A1(1minute)}$	$L_{Aeq(15minute)}$			$L_{A1(1minute)}$	
	Day	Eve	Night	Night	Day/Eve	Night		Night	
					Neutral Weather	Neutral Weather	Adverse Weather[1]	Neutral Weather	Adverse Weather[1]
L1 Erskine Park Residential	37	37	37	47	<30	<30	<30	<30	<30
L2 Horsley Park Residential	39	39	39	49	<30	<30	<30	<30	31
L3 Proposed Jacfin Residential	40	40	40	48	<30	<30	<30	<30	33
L3 Proposed Capitol Hill Residential	40	40	40	48	<30	<30	<30	<30	31
L3 Mount Vernon Residential	40	40	40	48	<30	<30	<30	<30	<30
L3 Kemps Creek Residential	40	40	40	48	<30	<30	<30	<30	<30
L3 Emmaus Village Residential	40	40	40	48	<30	<30	<30	<30	<30

Note 1: Applicable parameters for adverse weather are discussed in **Section 3.4** and are outlined in the INP, ie 3 m/s source to receiver wind or F class temperature inversion with 2 m/s source to receiver drainage flow during the night-time period.

Figure 4 Predicted Operational Noise Contours – Lot 2A Daytime / Evening Periods – Neutral Weather Conditions

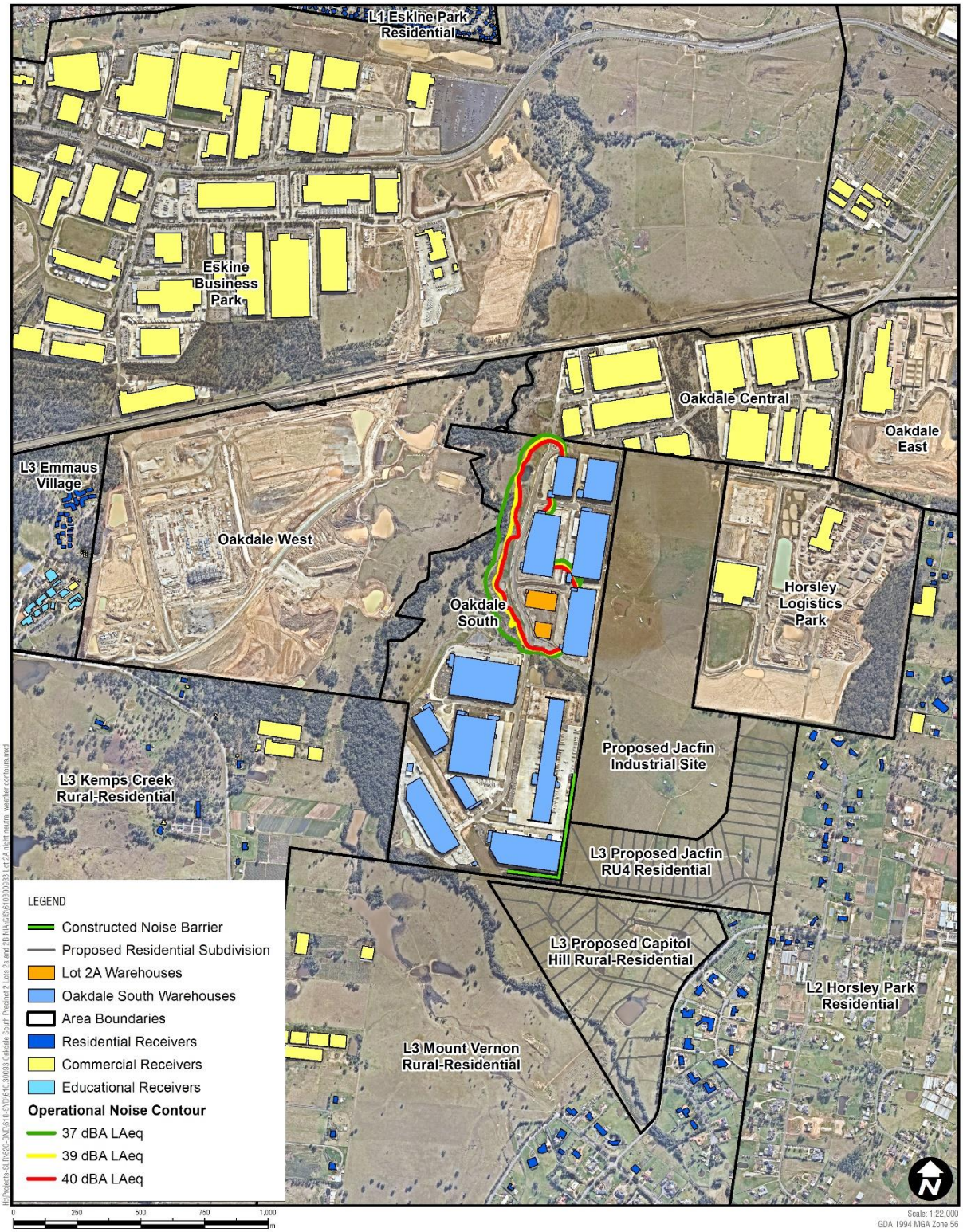


Note 1: 37 dBA LAeq noise contour (green) corresponds to the noise limit for residences in L1.

Note 2: 39 dBA LAeq noise contour (yellow) corresponds to the noise limit for residences in L2.

Note 3: 40 dBA LAeq noise contour (red) corresponds to the noise limit for residences in L3.

Figure 5 Predicted Operational Noise Contours – Lot 2A Night-time Period – Neutral Weather Conditions



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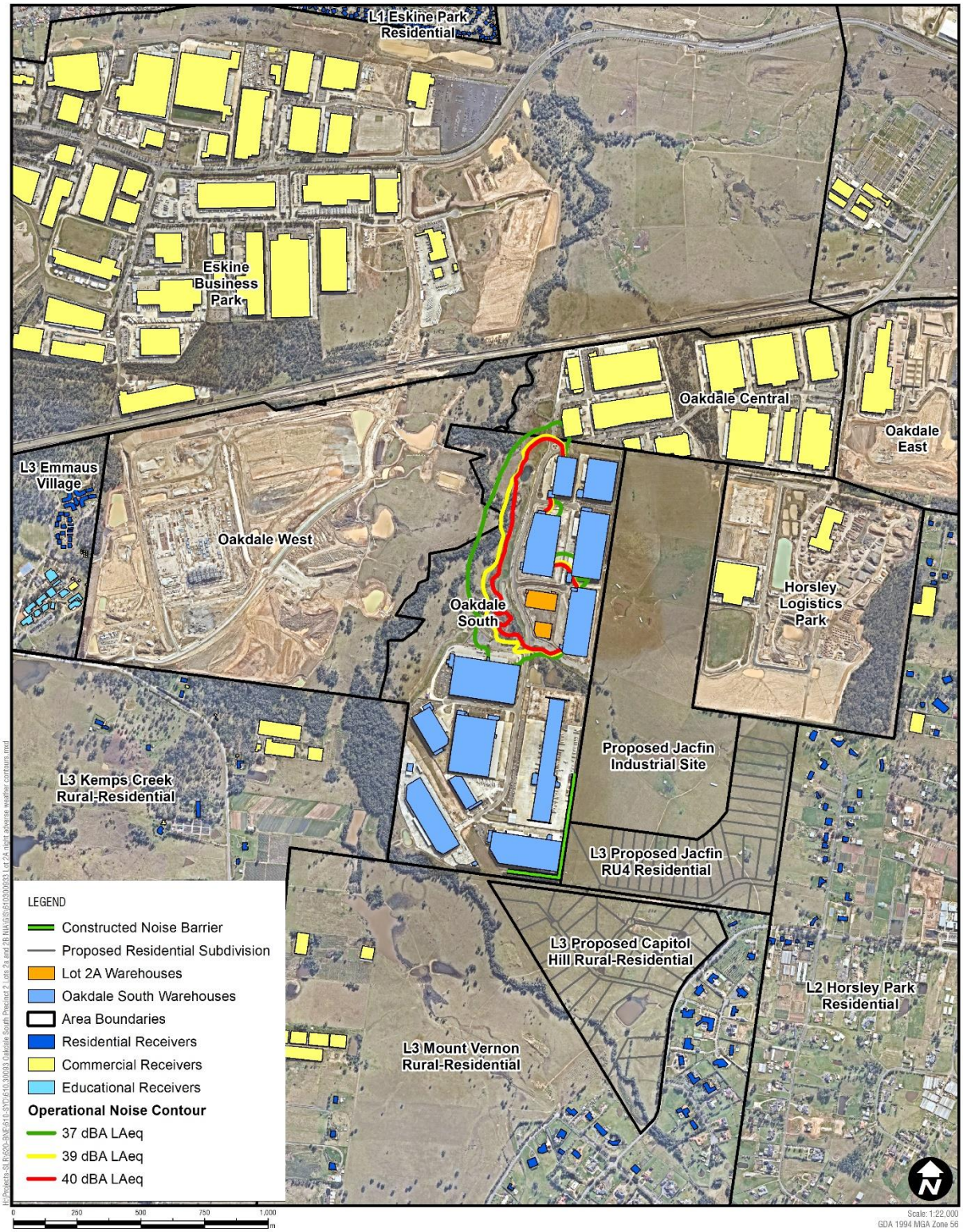
Note 2: 39 dBA LAeq noise contour (yellow) corresponds to the noise limit for residences in L2.

Note 3: 40 dBA LAeq noise contour (red) corresponds to the noise limit for residences in L3.

Figure 6 Predicted Operational Noise Contours – Lot 2A Night-time Period – Adverse Weather Conditions



Note 1: 37 dBA LAeq noise contour (green) corresponds to the noise limit for residences in L1.

Note 2: 39 dBA LAeq noise contour (yellow) corresponds to the noise limit for residences in L2.

Note 3: 40 dBA LAeq noise contour (red) corresponds to the noise limit for residences in L3.

The above results indicate that operational noise levels from Lot 2A are predicted to be below the nominated noise criteria at all identified residential receivers under both neutral and adverse weather conditions during the applicable periods.

The $L_{A1(1minute)}$ noise emissions are also predicted to be below the nominated noise criteria at all identified receivers under both neutral and adverse weather conditions during the applicable periods.

4.3 Cumulative Noise Impacts

In order to assess the potential cumulative operational noise impacts from Lot 2A with Oakdale South as a whole, worst-case peak light and heavy vehicle movements have been modelled across the development, along with mobile and fixed plant, as detailed below.

Modelled vehicle volumes for the other lots of Oakdale South are provided in **Table 7**. These have been modelled in addition to the noise sources outlined for Lot 2A in **Section 4.1**.

Table 7 Daytime/Evening Peak Vehicle Volumes for Oakdale South Estate

Lot	Vehicles per Hour (Peak)	Heavy Vehicle Percentage
1A	36	15%
1B	40	15%
1C	46	15%
1D	49	15%
2B[1]	45	30%
3A	68	15%
3B	62	15%
3C	18	15%
3D	25	15%
4A	144	17%
5A	57	15%
6A[2]	35-40	varies

Note 1: Lot 2B vehicle volumes provided by the traffic consultants for the project (Ason Group) at the time of this assessment.

Note 2: Lot 6A vehicle volumes are split into light, medium and heavy vehicles with different peak periods for each (refer to SLR Report *630.11166.R10-v1.1 Oakdale South Estate Precinct 6 MOD9 Noise Impact Assessment*, dated September 2018). This assessment uses the worst-case predicted levels from Lot 6A for each receiver area.

Note 3: Vehicle volumes taken from the respective noise impact assessments for each lot.

Consistent with previous noise impact assessment for Oakdale South, the night-time peak vehicle movements are assumed to be approximately 30% of the daytime/evening peak vehicle movements. Mobile and fixed plant assumptions for these lots have been taken from their respective noise impact assessments or onsite data where known to SLR.

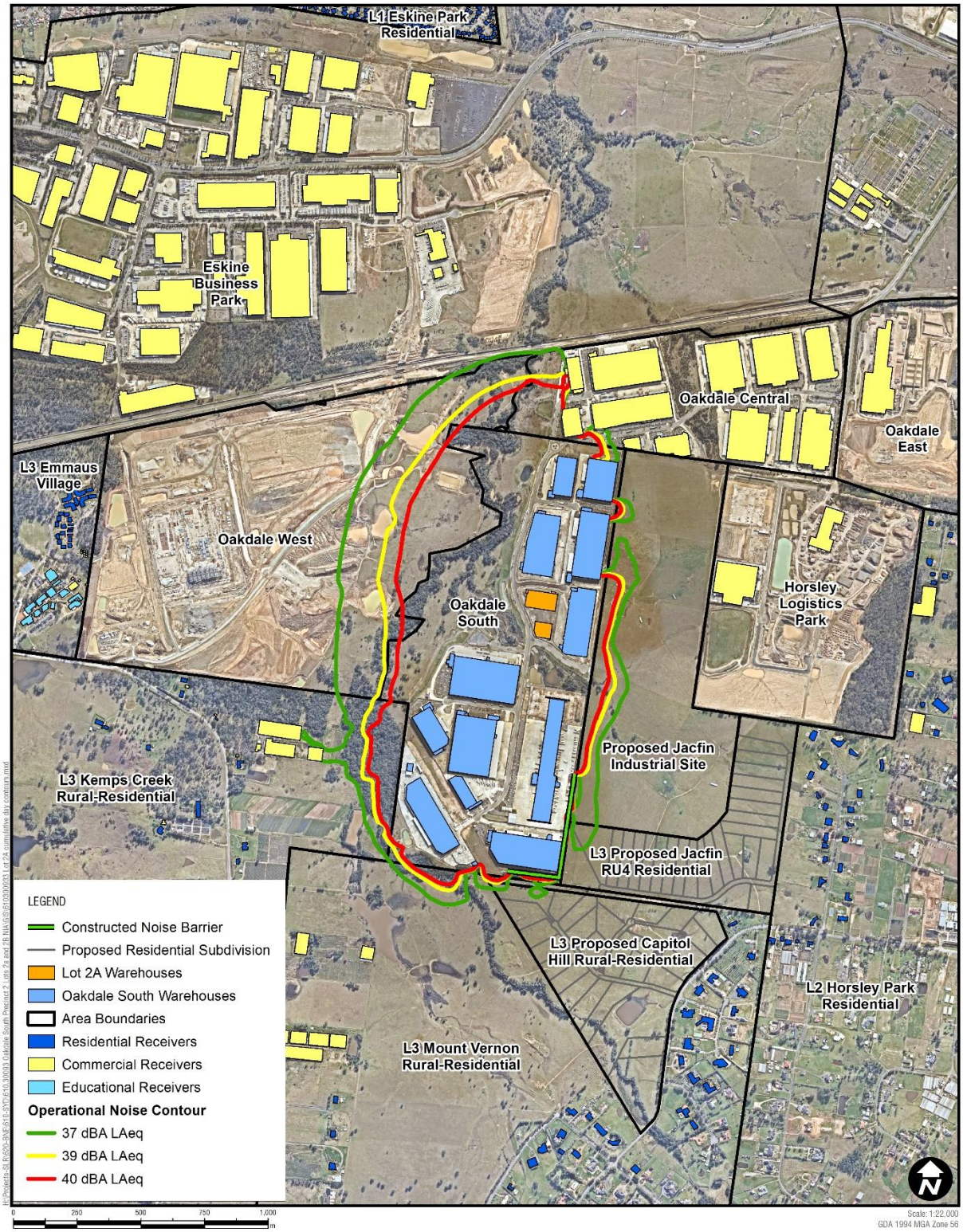
Cumulative noise impacts of Lot 2A and the Oakdale South Masterplan design have been modelled and the predicted operational noise levels are summarised in **Table 8**. Noise contour maps of the cumulative operational results during the daytime and evening periods under neutral weather conditions are shown in **Figure 7**, and during the night-time period under neutral weather conditions and adverse weather conditions in **Figure 8** and **Figure 9**, respectively.

Table 8 Predicted Operational Noise Levels – Lot 2A and Oakdale South Cumulative Impacts

Sensitive Receiver Area	Noise Limits (dBA)				Predicted Noise Levels (dBA) – Most-Affected Receiver				
	$L_{Aeq(15minute)}$			$L_{A1(1minute)}$	$L_{Aeq(15minute)}$			$L_{A1(1minute)}$	
	Day	Eve	Night	Night	Day/Eve	Night		Night	
					Neutral Weather	Neutral Weather	Adverse Weather[1]	Neutral Weather	Adverse Weather[1]
L1 Erskine Park Residential	37	37	37	47	<30	<30	31	30	36
L2 Horsley Park Residential	39	39	39	49	30	<30	33	31	38
L3 Proposed Jacfin Residential	40	40	40	48	40	38	40	46	48
L3 Proposed Capitol Hill Residential	40	40	40	48	39	36	39	44	46
L3 Mount Vernon Residential	40	40	40	48	31	<30	33	31	38
L3 Kemps Creek Residential	40	40	40	48	35	30	37	30	40
L3 Emmaus Village Residential	40	40	40	48	<30	<30	32	30	36

Note 1: Applicable parameters for adverse weather are discussed in **Section 3.4** and are outlined in the INP, ie 3 m/s source to receiver wind or F class temperature inversion with 2 m/s source to receiver drainage flow during the night-time period.

Figure 7 Predicted Operational Noise Contours – Lot 2A and Oakdale South Cumulative Impacts Daytime / Evening Periods – Neutral Weather Conditions

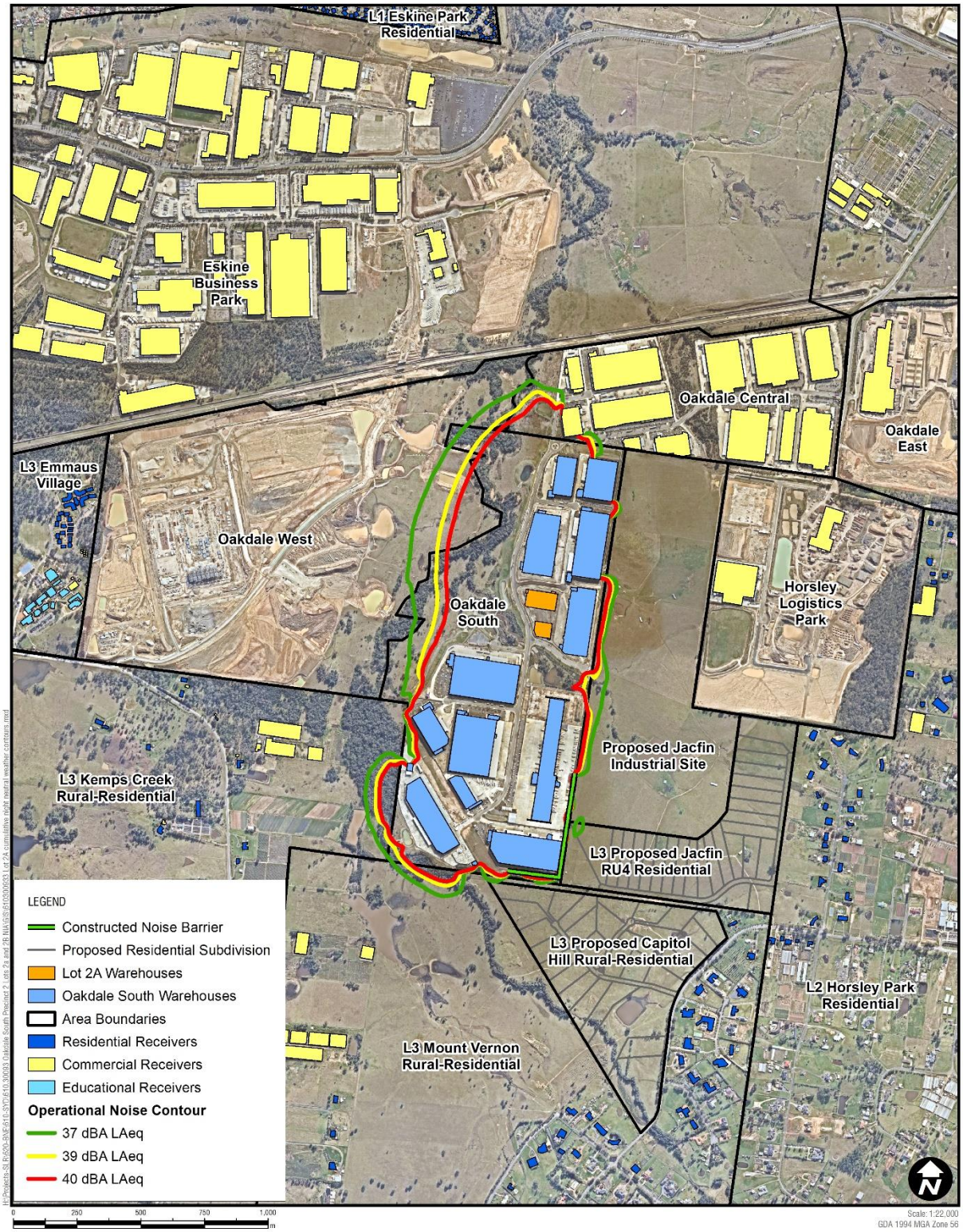


Note 1: 37 dBA LAeq noise contour (green) corresponds to the noise limit for residences in L1.

Note 2: 39 dBA LAeq noise contour (yellow) corresponds to the noise limit for residences in L2.

Note 3: 40 dBA LAeq noise contour (red) corresponds to the noise limit for residences in L3.

Figure 8 Predicted Operational Noise Contours – Lot 2A and Oakdale South Cumulative Impacts Night-time Period – Neutral Weather Conditions



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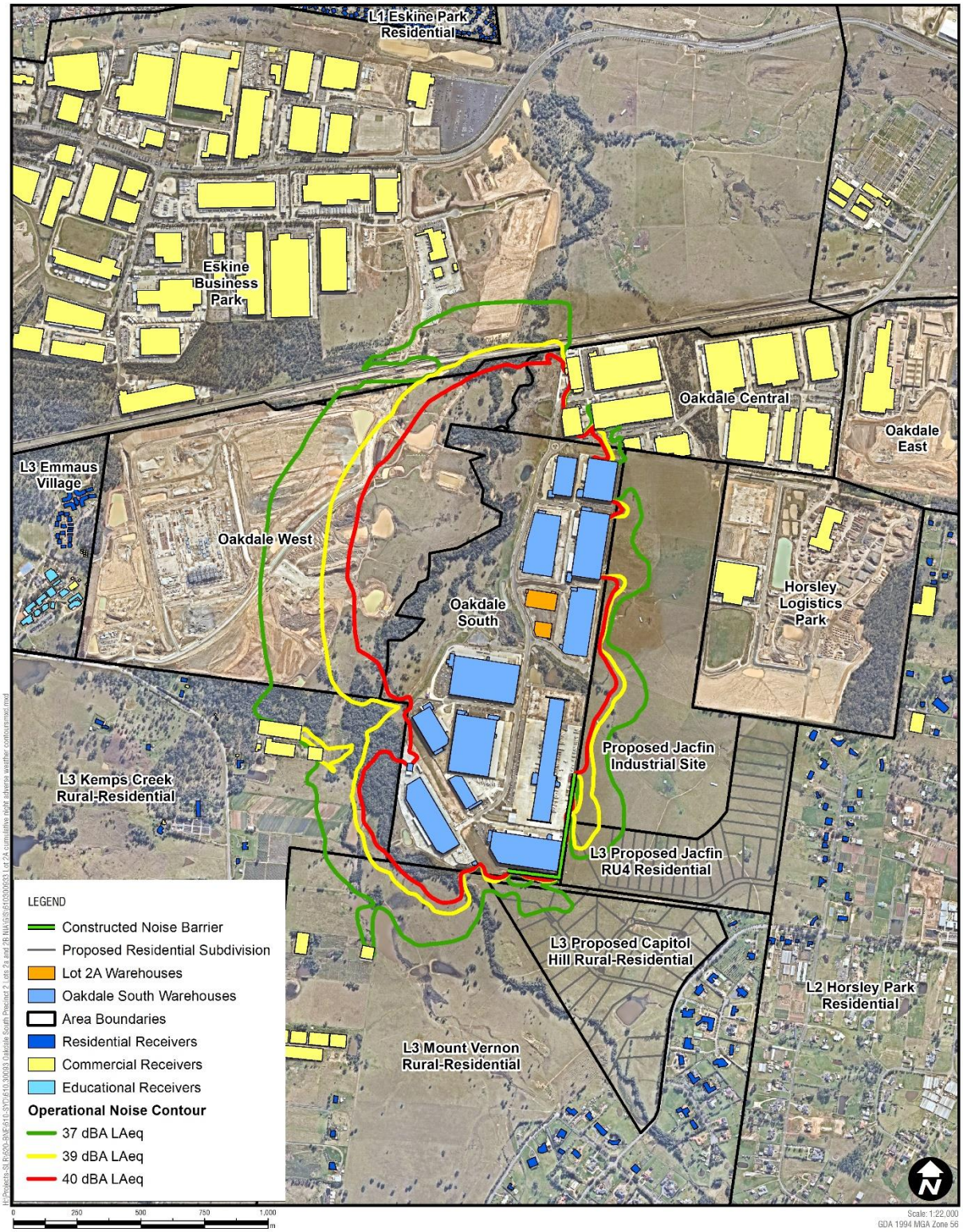
Note 2: 39 dBA LAeq noise contour (yellow) corresponds to the noise limit for residences in L2.

Note 3: 40 dBA LAeq noise contour (red) corresponds to the noise limit for residences in L3.

Figure 9 Predicted Operational Noise Contours – Lot 2A and Oakdale South Cumulative Impacts Night-time Period – Adverse Weather Conditions



Note 1: 37 dBA LAeq noise contour (green) corresponds to the noise limit for residences in L1.

Note 2: 39 dBA LAeq noise contour (yellow) corresponds to the noise limit for residences in L2.

Note 3: 40 dBA LAeq noise contour (red) corresponds to the noise limit for residences in L3.

The above results indicate that cumulative operational noise levels of Lot 2A and Oakdale South Masterplan design are predicted to be below the residential noise limits at all identified residential receivers under both neutral and adverse weather conditions during the applicable periods.

The $L_{A1(1minute)}$ noise emissions are also predicted to be below the nominated noise criteria at all identified receivers under both neutral and adverse weather conditions during the applicable periods.

As such, with consideration of the above, operational noise emissions from Lot 2A are considered to be acceptable.

4.4 Off-site Operational Traffic Movements

While light and heavy vehicle movements within Oakdale South are classified as part of the operational site noise, once they move out of Oakdale South and onto public roads they are assessed under the *NSW Road Noise Policy* (RNP).

The RNP requires noise mitigation to be considered where new land use developments increase road traffic noise by more than 2.0 dB. For reference, an increase of greater than 2.0 dB requires an increase in traffic volumes of around 60% or higher.

The main access route to the development site is via Ottelia Road, Milner Avenue, Old Wallgrove Road and Lenore Drive. No residential receivers are located adjacent to Ottelia Road or Milner Avenue.

Potential noise increases on the arterial roads of Old Wallgrove Road and Lenore Drive are anticipated to be negligible given the high existing volumes of traffic on these routes in comparison to traffic associated with Lot 2A. Therefore, negligible increases in traffic noise are expected on these routes and no mitigation is required to be considered.

Forecast traffic volumes for Oakdale South as a whole are generally consistent with those in the approved Masterplan design.

5 Construction Noise and Vibration Impact Assessment

5.1 Construction Noise Modelling

Noise modelling of the project was undertaken by modifying the SoundPLAN V7.1 noise models prepared for the Masterplan construction noise impact assessment for Oakdale South.

The three-dimensional models were updated to reflect the current design of Lot 2A, based on the provided design plans.

The noise model includes the noise barrier as constructed along the south eastern boundary of Oakdale South (refer to **Figure 3**).

Sound power levels (SWLs) for the typical construction equipment items and construction activities that have been used in the noise modelling are listed in **Table 9**. It is noted that works associated with bulk earthworks, construction of the boundary retaining wall, earth mounds and noise barrier have previously been completed as part of the Masterplan development.

Table 9 Sound Power Levels for Construction Equipment

Construction Activity	Equipment	Operating minutes in 15-min period	No of items in same location	Sound Power Level SWL (dBA)	
				Item	Activity
Paving Works including Concrete Pours	Concrete Pump	7.5	1	106	113
	Concrete Truck / Agitator	7.5	1	106	
	Concrete Vibrator	15	1	102	
	Paving Machine	15	1	104	
	Plate Compactor	5	1	108	
	Vibratory Roller (10-12 t)[1]	15	1	109	
Construction of Warehouse and Office Structures	Elevated Working Platform	15	2	97	107
	Flatbed Truck	15	1	100	
	Hand Tools (electric)	15	4	96	
	Mobile Crane (100 tonne)	15	1	101	
	Welding Equipment	15	1	97	
Landscaping and Finishing Works	Hydromulching Equipment	15	1	97	102
	Skidsteer Loader (approx. ½ t)	15	1	97	
	Ute	15	1	98	

Note 1: In accordance with the ICNG, for activities identified as particularly annoying (such as jackhammering, rock breaking and power saw operations), a 5 dB 'penalty' is added to the source sound power level when predicting noise using the quantitative method.

The ICNG recommends that the realistic worst-case or conservative noise levels from the source should be predicted for assessment locations representing the most noise-exposed residences or other sensitive land uses. For each receiver area the noise levels are predicted at the most noise-exposed location, which would usually be the closest receiver.

For most construction activities, it is expected that the construction noise levels would frequently be lower than predicted at the most-exposed receiver as the noise levels presented in this report are based on a realistic worst-case assessment.

Furthermore, other receivers within each receiver area would generally experience lower noise levels compared to the most noise-exposed location as construction work is undertaken at greater separation distance from receivers. To provide an indication of the likely reduction in construction noise levels, the following can be assumed:

- A doubling of the distance between the source and receiver would provide an approximate 6 dB reduction in noise level. For example the sound pressure levels from most items of plant would decrease by around 6 dB as the distance increases from 10 m to 20 m.
- Buildings and other solid structures located between the construction noise source and sensitive receivers would act as barriers and would typically reduce noise levels by up to 15 dB. For example, in a residential area adjoining a construction site the first row of houses would provide an effective shield to the second and subsequent rows with resulting noise levels up to 10 dB lower than would otherwise be experienced in the absence of the first row.

5.2 Predicted Construction Noise Impacts

Construction noise impacts from the project at the surrounding sensitive receivers have been quantitatively assessed for the activities described in **Table 9**. The predicted typical $L_{Aeq(15minute)}$ noise levels at the surrounding noise sensitive receivers are provided in **Table 10** for each of the construction activities and are representative of the 'noisiest' construction periods with the simultaneous operation of noise intensive construction plant in close proximity. These predictions relate to the plant operating at the closest proposed construction location to the receiver.

Construction noise levels have been predicted during the daytime period only, as per the Development Consent for Oakdale South, which limits construction to standard construction hours, ie:

- Monday to Friday 7:00 am to 6:00 pm.
- Saturday 8:00 am to 1:00 pm

Table 10 Predicted Construction Noise Levels – Lot 2A

Sensitive Receiver Area	Construction $L_{Aeq(15minute)}$ NML (dBA) (Standard Hours)	Noise Level – $L_{Aeq(15minute)}$ (dBA)	
		Worst-case Predicted	NML Exceedance
Paving Works including Concrete Pours			
L1 Erskine Park Residential	42	<30	-
L2 Horsley Park Residential	42	32	-
L3 Proposed Jacfin Residential	42	35	-
L3 Proposed Capitol Hill Residential	42	32	-
L3 Mount Vernon Residential	42	30	-
L3 Kemps Creek Residential	42	30	-
L3 Emmaus Village Residential	42	<30	-
Construction of Warehouse and Office Structures			
L1 Erskine Park Residential	42	<30	-
L2 Horsley Park Residential	42	<30	-
L3 Proposed Jacfin Residential	42	<30	-
L3 Proposed Capitol Hill Residential	42	<30	-
L3 Mount Vernon Residential	42	<30	-
L3 Kemps Creek Residential	42	<30	-
L3 Emmaus Village Residential	42	<30	-
Landscaping and Finishing Works			
L1 Erskine Park Residential	42	<30	-
L2 Horsley Park Residential	42	<30	-
L3 Proposed Jacfin Residential	42	<30	-
L3 Proposed Capitol Hill Residential	42	<30	-
L3 Mount Vernon Residential	42	<30	-
L3 Kemps Creek Residential	42	<30	-
L3 Emmaus Village Residential	42	<30	-

The results presented in **Table 10** indicate the noise levels are predicted to be compliant with the NMLs at the surrounding residential receivers. Worst-case construction noise emissions of up to 35 dBA are predicted at the most-affected receivers.

It is noted that construction in this precinct may occur before construction of residential buildings within the proposed Jacfin and Capitol Hill areas. The construction NMLs apply only to dwellings occupied during construction of Oakdale South.

The ICNG describes strategies for construction noise mitigation and control that are applicable to this project. The strategies are designed to minimise noise during construction, to the fullest extent practicable. While no exceedances of the NMLs are predicted, best practice measures should be undertaken to minimise construction noise emissions where possible. Typical construction noise mitigation measures include the following:

- Avoiding the coincidence of noisy plant working simultaneously close together would result in reduced noise emissions.
- Equipment which is used intermittently is to be shut down when not in use.
- Where possible, equipment with directional noise emissions should be oriented away from sensitive receivers.
- Regular compliance checks on the noise emissions of all plant and machinery used for the project would indicate whether noise emissions from plant items were higher than predicted. This also identifies defective silencing equipment on the items of plant.
- Non-tonal reversing alarms should be used on all items of plants and heavy vehicles used for construction.

5.3 Construction Vibration Impacts

The effects of vibration in buildings can be divided into three main categories – those in which the occupants or users of the building are inconvenienced or possibly disturbed, those where the building contents may be affected and those in which the integrity of the building or the structure itself may be prejudiced.

The propagation of vibration from a source would be site specific with the level of vibration potentially experienced at a receiver dependent upon the vibration energy generated by the source, the predominant frequencies of vibration, the localised geotechnical conditions and the interaction of structures and features which can dampen vibration.

The recommended minimum working distances for construction plant in **Table 11** are referenced from the TfNSW *Construction Noise Strategy*.

Consistent with British Standard BS 7385 Part 2-1993 and the *Assessing Vibration: A Technical Guideline*, the recommendations are for the practical management of potential vibration to minimise the likelihood of cosmetic damage to buildings and disturbance or annoyance in humans. The human comfort minimum working distances are conservative, developed with reference to the more stringent objectives for continuous vibration for typical residential building constructions.

The minimum working distances referenced from BS 7385 have been used to determine minimum working distances for the German Standard DIN 4150 criteria for dwellings specified in the Development Consent for the Masterplan. It is noted that the criteria for commercial buildings is higher than that for dwellings, therefore, the minimum working distances for commercial buildings would be smaller than those outlined below. However, the below distances can still be used as a screening criteria before considering detailed assessment of vibration levels at commercial buildings.

Table 11 Recommended Minimum Working Distances for Vibration Intensive Plant

Plant Item	Rating / Description	Minimum Working Distance		
		Cosmetic Damage		Human Response[3]
		BS 7385[1] – Residential and light commercial	DIN 4150[2] – Group 2 - dwellings and similar	
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 m	7 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	8 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	16 m	40 m
	< 300 kN (Typically 7-13 tonnes)	15 m	20 m	100 m
	> 300 kN (Typically 13-18 tonnes)	20 m	26 m	100 m
	> 300 kN (Typically > 18 tonnes)	25 m	33 m	100 m
Small Hydraulic Hammer	300 kg – 5 to 12t excavator	2 m	3 m	7 m
Medium Hydraulic Hammer	900 kg – 12 to 18t excavator	7 m	10 m	23 m
Large Hydraulic Hammer	1600 kg – 18 to 34t excavator	22 m	29 m	73 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	3 m	20 m to 100 m
Pile Boring	≤ 800 mm	2 m (nominal)	3 m	N/A
Jackhammer	Hand held	1 m (nominal)	2 m	Avoid contact with structure

Note 1: Referenced from British Standard BS 7385 Part 2-1993.

Note 2: Referenced from German Standard DIN 4150-3.

Note 3: Referenced from *Assessing Vibration: A Technical Guideline*.

Vibration intensive items of plant proposed for use during the construction of the development would include plate compactors and vibratory rollers. These items of equipment are proposed to be used during paving works including concrete pours.

The nearest existing residential receivers to the development construction works are located over 800 m from the nearest point of Lot 2A. The separation distance between the works location and the nearest existing vibration sensitive receivers is considered sufficient to mitigate potential vibration generated from the site and specific vibration mitigation measures are not required.

Where vibration intensive works are being undertaken within the minimum working distances of other buildings within Oakdale South, such as Lot 1D, vibration impacts should be considered further in the construction noise and vibration management plans. This may include the requirement for vibration monitoring at the start of the works to ensure vibration levels remain at an appropriate level where works are required within the minimum working distances of these buildings.

6 Conclusion

The recommendations made in this report are based on 24-hour operation of warehouse and distribution facilities in Oakdale South. As such, this is considered a worst-case assessment of potential impacts. Typical impacts are likely to be lower than the worst-case predicted impacts.

6.1 Operational Noise Impacts

An operational noise impact assessment has been conducted for Lot 2A of Oakdale South. Operational Noise Limits consistent with those in the Development Consent SSD 6917 for the Oakdale South Masterplan have been adopted.

An analysis of the prevailing weather conditions for Oakdale South indicated that adverse weather is only a feature of the area during the night-time period.

The operational noise modelling for Lot 2A found no exceedances of the Noise Limits at any sensitive receivers under both neutral (day, evening and night periods) and adverse (night period) weather conditions.

Cumulative operational noise levels of Lot 2A and the Oakdale South Masterplan design are also predicted to be compliant with the Noise Limits at all identified residential receivers under both neutral and adverse weather conditions during the applicable periods.

The $L_{A1(1minute)}$ noise emissions are predicted to comply with the nominated noise criteria at all identified receivers under both neutral and adverse weather conditions during the applicable periods.

As such, with consideration of the above, operational noise emissions from Lot 2A are considered to be acceptable.

Noise emitted by the fixed mechanical plant items will need to be confirmed during detailed design and, if required, mitigated to achieve the required noise emission levels. This can be achieved through standard acoustic measures such as judicious selection of mechanical plant and localised shielding around fixed plant.

Off-site traffic movements associated within Lot 2A are predicted to have a negligible impact on road traffic noise levels in the vicinity of the main access routes of Lenore Drive and Old Wallgrove Road, given the existing high volume of traffic on these arterial roads. Traffic volumes for Oakdale South are generally consistent with the approved Masterplan.

6.2 Construction Noise and Vibration Impacts

A construction noise and vibration impact assessment has been conducted for Lot 2A of Oakdale South. Construction Noise Management Levels (NMLs) consistent with those in the Development Consent SSD 6917 for the Oakdale South Masterplan have been used.

Works would be completed during standard construction hours and noise levels are predicted to be compliant with the NMLs at the surrounding residential receivers.

It is noted that construction in these precincts may occur before construction of the residential buildings within the proposed Jacfin and Capitol Hill areas. The construction NMLs apply only to dwellings occupied during construction of Oakdale South.

Best practice construction noise mitigation measures should be implemented where feasible and reasonable.

The separation distance between Lot 2A and the nearest existing residential receivers is considered to be sufficient to mitigate potential impacts. Where vibration intensive works are being undertaken within the minimum working distances of other buildings within Oakdale South, such as Lot 1D, vibration impacts should be considered further in the construction noise and vibration management plans.

APPENDIX A

Acoustic Terminology

1. Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that 'noise' often refers to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure. The human ear responds to changes in sound pressure over a very wide range with the loudest sound pressure to which the human ear can respond being ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2 x 10^{-5} Pa.

2. 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4,000 Hz), and less sensitive at lower and higher frequencies. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels.

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear', and the units are expressed as dB(lin) or dB.

3. Sound Power Level

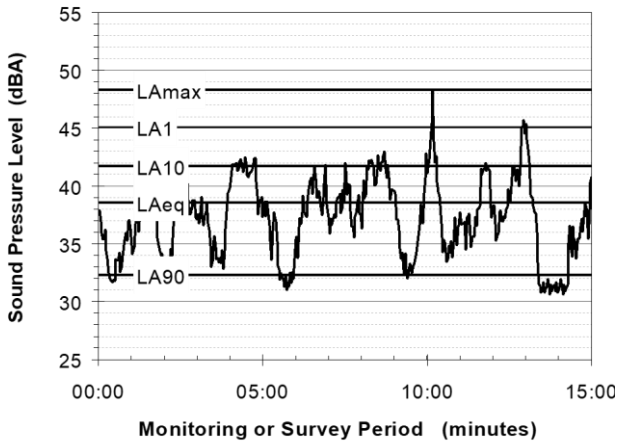
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure is similar to the effect of an electric radiator, which is characterised by a power rating but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4. Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels LAN, where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the LA1 is the noise level exceeded for 1% of the time, LA10 the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

LA1 The noise level exceeded for 1% of the 15 minute interval.

LA10 The noise level exceeded for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

LA90 The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

LAeq The A-weighted equivalent noise level (basically, the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

5. Frequency Analysis

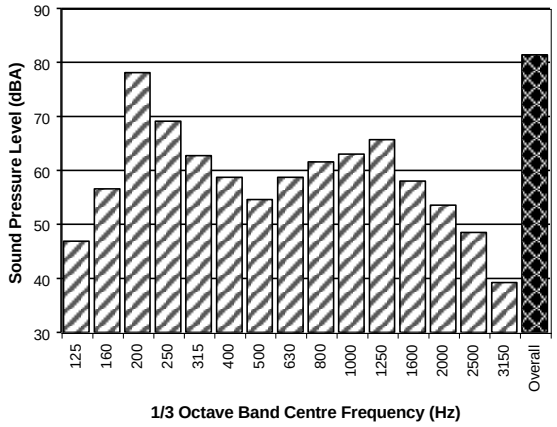
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (three bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



6. Annoying Noise (Special Audible Characteristics)

A louder noise will generally be more annoying to nearby receivers than a quieter one. However, noise is often also found to be more annoying and result in larger impacts where the following characteristics are apparent:

- **Tonality** - tonal noise contains one or more prominent tones (ie differences in distinct frequency components between adjoining octave or 1/3 octave bands), and is normally regarded as more annoying than 'broad band' noise.
- **Impulsiveness** - an impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.
- **Intermittency** - intermittent noise varies in level with the change in level being clearly audible. An example would include mechanical plant cycling on and off.
- **Low Frequency Noise** - low frequency noise contains significant energy in the lower frequency bands, which are typically taken to be in the 10 to 160 Hz region.

7. Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements (ie vertical, longitudinal and transverse).

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/Vo), where Vo is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used.

8. Human Perception of Vibration

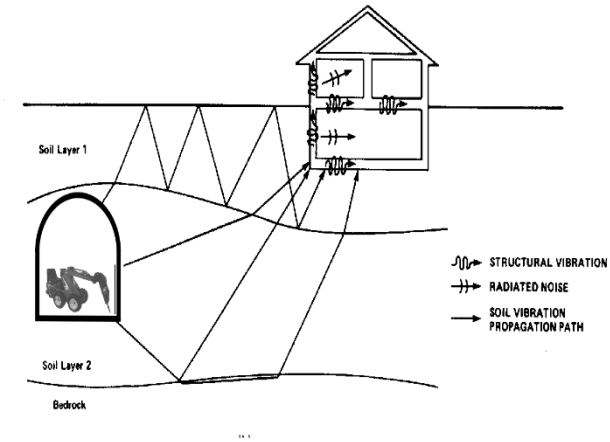
People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as 'normal' in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

9. Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents an example of the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise.

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