DEPARTMENT OF PLANNING, LANDS AND HERITAGE
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Annexure 9

Acoustic Report

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DEVELOPMENT APPLICATION: ACOUSTICS

Lot 16 (#10) Morley Drive, Tuart Hill

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True North Properties Pty Ltd

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Date:	Rev	Description	Prepared By	Verified
05-Mar-21	0	Issued to Client	Olivier Mallié	Terry George
16-Mar-21	A	*Table 4-2* and *Section 5* amended	Olivier Mallié	-

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1 INTRODUCTION

It is proposed to construct a multi-storey, mixed-use development at Lot 16 (#10) Morley Drive, Tuart Hill – refer *Figure 1-1*. The development includes:

- Basement residential car parking;
- Ground floor commercial tenancies, gym and car parking;
- Level 1 to 3 apartments; and
- Level 4-5 2-storey apartments.

Figure 1-1 Project Locality (Source: PlanWA)

With regard to acoustics, there will be several criteria that the project will need to satisfy. The apartments will need to comply with the *National Construction Code*, which provides minimum performance requirements for noise transfer between apartments, between apartments and other uses, and considers noise from their own services such as hydraulics, lifts and the like. Also applicable for the entire project will be the control of noise to neighbouring properties, predominantly from mechanical services, any outdoor area with patrons and noise breakout from the gym, which will need to comply with the *Environmental Protection (Noise) Regulations 1997*. Given this report is for Development Application (DA) purposes only, AC plant noise has been reviewed in more details, while the gym noise breakout is discussed more broadly, but will be considered further in detailed design.

The site adjoins Main Street and Morley Drive with both being 'other significant freight/traffic routes' and as such, *State Planning Policy No. 5.4 Road and Rail Noise* is applicable. The noise impacts from both roads have been considered in more detail within this report.

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

2 CRITERIA

Each of the relevant criteria are provided in the following sections. Compliance with some of these (*Section 2.1* and *Section 2.3*) will be worked through during detailed design.

2.1 Environmental Protection (Noise) Regulations 1997

Environmental noise in Western Australia is governed by the *Environmental Protection Act 1986*, through the *Environmental Protection (Noise) Regulations 1997* (EPNR). The regulations that will be applicable to this project are as follows:

- Mechanical plant and noise breakout from the gym are to comply with regulations 7 & 8 at neighbouring properties and noise sensitive parts of this development; and
- Noise during construction is to comply with regulation 13.

Each of these regulations are explained in detail in *Sections 2.1.1* and *2.1.2*.

2.1.1 Regulations 7 & 8

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

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

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

(b) Must be free of –

i. tonality;

ii. impulsiveness; and

iii. modulation,

when assessed under regulation 9"

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

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

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

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

Table 2-1 Adjustments Where Characteristics Cannot Be Removed

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

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

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

Table 2-2 Baseline Assigned Noise Levels

Premises Receiving Noise	Time Of Day	Assigned Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise sensitive premises: highly sensitive area[1]	0700 to 1900 hours Monday to Saturday (Day)	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sunday and public holidays (Sunday)	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours all days (Evening)	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	35 + influencing factor	45 + influencing factor	55 + influencing factor
Noise sensitive premises: any area other than highly sensitive area	All hours	60	75	80
Commercial	All hours	60	75	80

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

The influencing factor, applicable at the noise sensitive premises of this development and those neighbouring the site has been calculated as 6 dB, due to Main Street and Morley Drive being considered a major road, with the latest traffic counts showing:

- Main Street carries 27,563 vehicles per day in 2018/19, south of Morley Drive, and
- Morley Drive carries 20,416 vehicles per day in 2018/19, east of Main Street.

There are no significant commercial or industrial premises within 450 metres to add to the influencing factor.

Table 2-3 shows the assigned noise levels including the influencing factor and transport factor at the receiving locations.

Table 2-3 Assigned Noise Levels

Premises Receiving Noise	Time Of Day	Assigned Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise sensitive premises: highly sensitive area[1]	0700 to 1900 hours Monday to Saturday (Day)	51	61	71
	0900 to 1900 hours Sunday and public holidays (Sunday)	46	56	71
	1900 to 2200 hours all days (Evening)	46	56	61
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	41	51	61

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

2.1.2 Regulation 13

Construction noise must comply with regulation 13, which states the following:

Regulation 7 does not apply to … construction work carried out between 0700 hours and 1900 hours on any day which is not a Sunday or public holiday if the occupier of the premises … shows that –

a) The construction work was carried out in accordance with control of environmental noise practices set out in section 6 of AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites;

b) The equipment used on the premises was the quietest reasonably available; and

c) If the occupier was required to prepare a noise management plan … in respect of the construction site –

i. The noise management plan was prepared and given in accordance with the requirement, and approved by the Chief Executive Officer; and

ii. The construction work was carried out in accordance with the management plan.

Regulation 7 does not apply to … construction work carried out other than between the [above] hours if the occupier of the premises … shows that –

a) The construction work was carried out in accordance with control of environmental noise practices set out in section 6 of AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites;

b) The equipment used on the premises was the quietest reasonably available;

c) The construction work was carried out in accordance with a noise management plan in respect of the construction site –

i. Prepared and given to the Chief Executive Officer not later than 7 days before the construction work commenced; and

ii. Approved by the Chief Executive Officer;

d) At least 24 hours before the construction work commenced, the occupier of the construction site gave written notice of the proposed construction work to the occupiers of all premises at which noise emissions received were likely to fail to comply with the standard prescribed under regulation 7; and

e) It was reasonably necessary for the construction work to be carried out at that time.

2.2 State Planning Policy 5.4

State Planning Policy No. 5.4 Road and Rail Noise (hereafter referred to as SPP 5.4) produced by the Western Australian Planning Commission (WAPC) provides criteria for noise sensitive developments near roads and railways. The objectives of SPP 5.4 are to:

- Protect the community from unreasonable levels of transport noise;
- Protect strategic and other significant freight transport corridors from incompatible urban encroachment;
- Ensure transport infrastructure and land-use can mutually exist within urban corridors;
- Ensure that noise impacts are addressed as early as possible in the planning process; and
- Encourage best practice noise mitigation design and construction standards

Table 2-4 sets out noise targets that are to be achieved by proposals under which SPP 5.4 applies. Where the targets are exceeded, an assessment is required to determine the likely level of transport noise and management/mitigation required.

The application of SPP 5.4 is to consider anticipated traffic volumes for the next 20 years from when the noise assessment is undertaken.

In the application of the noise targets, the objective is to achieve:

- indoor noise levels specified in *Table 2-4* in noise-sensitive areas (e.g. bedrooms and living rooms of houses and school classrooms); and
- a reasonable degree of acoustic amenity for outdoor living areas on each residential lot. For non-residential noise-sensitive developments, for example schools and childcare centres, the design of outdoor areas should take into consideration the noise target.

Table 2-4 Noise Targets for Noise-Sensitive Land-Use

Outdoor Noise Target		Indoor Noise Target	
55 dB $L_{Aeq(Day)}$	50 dB $L_{Aeq(Night)}$	40 dB $L_{Aeq(Day)}$ (Living and Work Areas)	35 dB $L_{Aeq(Night)}$ (Bedrooms)

Notes:

- Day period is from 6am to 10pm and night period from 10pm to 6am.
- The outdoor noise target is to be measured at 1-metre from the most exposed, habitable[1] facade of the noise sensitive building.
- For all noise-sensitive land-use and/or development, indoor noise targets for other room usages may be reasonable drawn from Table 1 of Australian Standard/New Zealand Standard AS/NZS 2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors (as amended) for each relevant time period.
- Outdoor targets are to be met at all outdoor areas as far as is reasonable and practicable to do so using the various noise mitigation measures outlined in the Guidelines.

2.3 Building Code of Australia (BCA)

It is a requirement under the *National Construction Code* (NCC) for sound transmission and insulation to be considered. In this case, the relevant volume of the NCC is Volume One of the *Building Code of Australia, Class 2 to Class 9 Buildings* (BCA) and specifically Part F5.

The Objective of Part F5 as stated in *Guide to NCC Volume One* is to:

"…safeguard occupants from illness or loss of amenity as a result of undue sound being transmitted –

a) Between adjoining sole-occupancy units; and

b) From common spaces to sole-occupancy units; and

c) From parts of different classifications to sole-occupancy units."

The BCA separates the performance requirements into floors and walls for Class 2 and 3 buildings as follows:

FP5.1

Floors separating –

a) sole-occupancy units: or

b) a sole occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby, or the like, or a part of a different classification,

must provide insulation against the transmission of airborne and impact generated sound sufficient to prevent illness or loss of amenity to the occupants.

FP5.2

Walls separating sole-occupancy units or a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby, or the like, or parts of a different classification, must provide insulation against the transmission of –

[1] A habitable room is defined in State Planning Policy 3.1 as a room used for normal domestic activities that includes a bedroom, living room, lounge room, music room, sitting room, television room, kitchen, dining room, sewing room, study, playroom, sunroom, gymnasium, fully enclosed swimming pool or patio.

a) airborne sound; and
b) impact generated sound, if the wall is separating a bathroom, sanitary compartment, laundry or kitchen in one sole-occupancy unit from a habitable room (other than a kitchen) in an adjoining unit,

sufficient to prevent illness or loss of amenity to the occupants.

FP5.3

The required sound insulation of a floor or a wall must not be compromised by -

a) The incorporation or penetration of a pipe or other service element; or
b) A door assembly.

In order to satisfy FP5.1 to FP5.3, building elements are to satisfy the minimum acoustic performances nominated in *Table 2-5*, being a summary of the Deemed-to-Satisfy Provisions provided in F5.1 to F5.7.

Table 2-5 BCA Deemed-to-Satisfy Provisions

Partition	Deemed-to-Satisfy Provisions	
	Laboratory	On-Site
Floors (F5.4a)		
Separating SOU's or SOU from plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification.	$R_w + C_{tr} \geq 50$ $L_{n,w} \leq 62$	$D_{nT,w} + C_{tr} \geq 45$ $L_{nT,w} \leq 62$
Walls (F5.5a)		
Separating SOU's (Habitable to Habitable)	$R_w + C_{tr} \geq 50$	$D_{nT,w} + C_{tr} \geq 45$
Separating SOU's (Habitable to bathroom, sanitary compartment, laundry or kitchen)	$R_w + C_{tr} \geq 50$ & D.C.	$D_{nT,w} + C_{tr} \geq 45$
Separating SOU to Plant room or lift shaft	$R_w \geq 50$ & D.C.	$D_{nT,w} \geq 45$
Separating SOU to Stairway, public corridor, public lobby, or parts of a different classification	$R_w \geq 50$	$D_{nT,w} \geq 45$
Doors (F5.5b)		
Separating SOU to Stairway, public corridor, public lobby or the like.	$R_w \geq 30$	$D_{nT,w} \geq 25$
Services (F5.6)		
SOU (Habitable) to duct, soil, waste, water supply or storm water (not associated with the SOU)	$R_w + C_{tr} \geq 40$	N/A
SOU (Non-Habitable) to duct, soil, waste, water supply or storm water (not associated with the SOU)	$R_w + C_{tr} \geq 25$	N/A

Notes:
SOU – Sole Occupancy Unit
D.C. Discontinuous Construction

3 ROAD NOISE METHODOLOGY

3.1 Site Measurements

Noise monitoring was undertaken on site using two ARL type Ngara noise loggers, with one logger located approximately 11 metres from the kerb of Morley Drive's westbound lanes and the other approximately 6 metres from the kerb of Main Street's southbound lanes (refer *Figure 3-1* and *Figure 3-2*). The loggers comply with the instrumentation requirements of *Australian Standard 2702-1984 Acoustics – Methods for the Measurement of Road Traffic Noise*. The loggers were field calibrated before and after the measurement session and found to be accurate to within +/- 1 dB. Lloyd George Acoustics also holds current laboratory calibration certificate for the meter.

The microphones were approximately 1.4 metres above existing ground level with the logger along Main Street also located 1 metre from a masonry boundary wall. The measurements were recorded on 22 February, between 8.00am and 9.00am.

A relationship between hourly traffic volumes and noise levels can then be derived to determine the existing $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ noise levels at the subject site.

Figure 3-1 Noise Logger At Main Street

Figure 3-2 Noise Logger At Morley Drive

3.2 Noise Modelling

The computer programme *SoundPLAN 8.1* was utilised incorporating the *Calculation of Road Traffic Noise* (CoRTN) algorithms, modified to reflect Australian conditions. The modifications included the following:

- Vehicles were separated into heavy (Austroads Class 3 upwards) and non-heavy (Austroads Classes 1 & 2) with non-heavy vehicles having a source height of 0.5 metres above road level and heavy vehicles having two sources, at heights of 1.5 metres and 3.6 metres above road level, to represent the engine and exhaust respectively. By splitting the noise source into three, allows for less barrier attenuation for high level sources where barriers are to be considered.
- Note that a -8.0 dB correction is applied to the exhaust and -0.8 dB to the engine (based on Transportation Noise Reference Book, Paul Nelson, 1987), so as to provide consistent results with the CoRTN algorithms for the no barrier scenario;

Predictions are made at heights of 1.4 metres above floor level and at 1-metre from the window of each habitable room, resulting in a + 2.5 dB correction due to reflected noise.

Various input data are included in the modelling such as ground topography, road design, traffic volumes etc. These model inputs are discussed in the following sections.

3.2.1 Topographical Data

Topographical data was based on that publicly available from *Google* in the form of spot heights, noting the surrounding topography is relatively flat. This was then combined with the proposed plans of the development to create a 3-D noise model as shown in *Figure 3-3*.

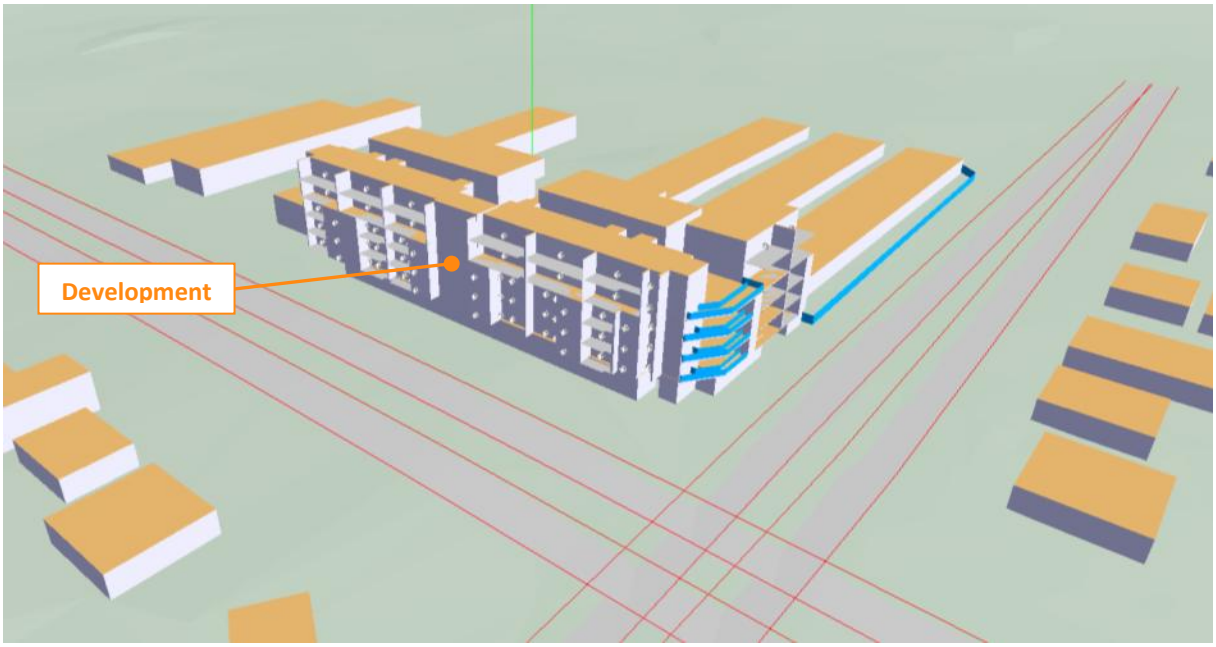

Figure 3-3 Image of Noise Model

3.2.2 Traffic Data

Traffic data includes:

- Road Surface – The noise relationship between different road surface types is shown in *Table 3-1*.

Table 3-1 Noise Relationship Between Different Road Surfaces

Chip Seal			Asphalt			
14mm	10mm	5mm	Dense Graded	Novachip	Stone Mastic	Open Graded
+3.5 dB	+2.5 dB	+1.5 dB	0.0 dB	-0.2 dB	-1.5 dB	-2.5 dB

The existing road surface is dense graded asphalt and is expected to remain unchanged into the future.

- Vehicle Speed – The existing and future posted speeds are 70 km/hr for Morley Drive and 60 km/hr for Main Street.

- Traffic Volumes – Existing (2016) and forecast (2041) traffic volumes were provided by Main Roads WA (Thomas Ng, Traffic Modelling Analyst, Reference: #41736). A

validation plot was also provided allowing the Main Roads WA traffic volume model to be calibrated against actual counts. The validation plot shows that the Main Roads WA model for Morley Drive eastbound and westbound is over-predicting by 3,200 vpd and 3,700 vpd respectively, and for Main Street is over-predicting northbound by 900 vpd but under-predicting southbound by 500 vpd. As such, the modelled 2041 volumes have been modified by these amounts. *Table 3-2* provides the traffic volume input data in the model.

Table 3-2 Traffic Information Used in the Modelling

Existing – 2018/19	Morley Drive		Main Street	
	Eastbound	Westbound	Northbound	Southbound
24 Hour Volume	10,223	10,193	14,003	13,560
% Heavy	6	6	6	6
Future – 2041	**Morley Drive**		**Main Street**	
	Eastbound	Westbound	Northbound	Southbound
24 Hour Volume	16,100	16,700	21,400	21,200
% Heavy	5	5	6	6

3.2.3 Ground Absorption

Ground absorption varies from a value of 0 to 1, with 0 being for an acoustically reflective ground (e.g. water or bitumen) and 1 for acoustically absorbent ground (e.g. grass). In this instance, a value of 0 has been used for the roads and paved areas, and 1 elsewhere i.e. grassed areas/verges.

4 ROAD NOISE RESULTS

4.1 Noise Measurements

The results of the hourly noise level measurements were:

- Main Street, 8.00am to 9.00am – 64.6 dB $L_{Aeq,1hour}$ at 1 metre from solid wall, and
- Morley Drive, 8.00am to 9.00am – 63.3 dB $L_{Aeq,1hour}$ in free-field.

Combining the measured noise levels with the hourly traffic volumes as shown in *Figure 4-1* and *Figure 4-2*, the $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ have been determined to be:

- Main Street, 62.5 dB $L_{Aeq(Day)}$ and 56.6 dB $L_{Aeq(Night)}$, and
- Morley Drive, 62.2 dB $L_{Aeq(Day)}$ and 55.4 dB $L_{Aeq(Night)}$.

Based on these results, the $L_{Aeq(Day)}$ is more critical than the $L_{Aeq(Night)}$ since their difference is greater than 5 dB (refer *Section 2* criteria).

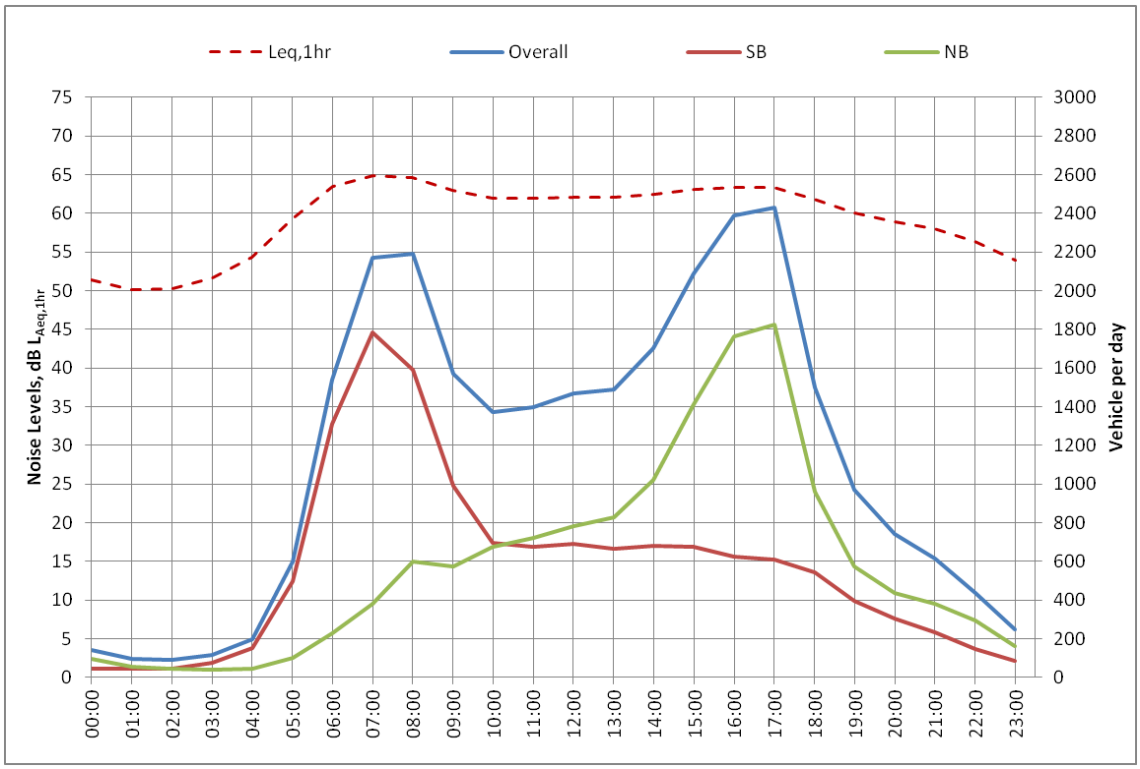

Figure 4-1 Noise Level Relationship to Main Street Hourly Traffic Volumes

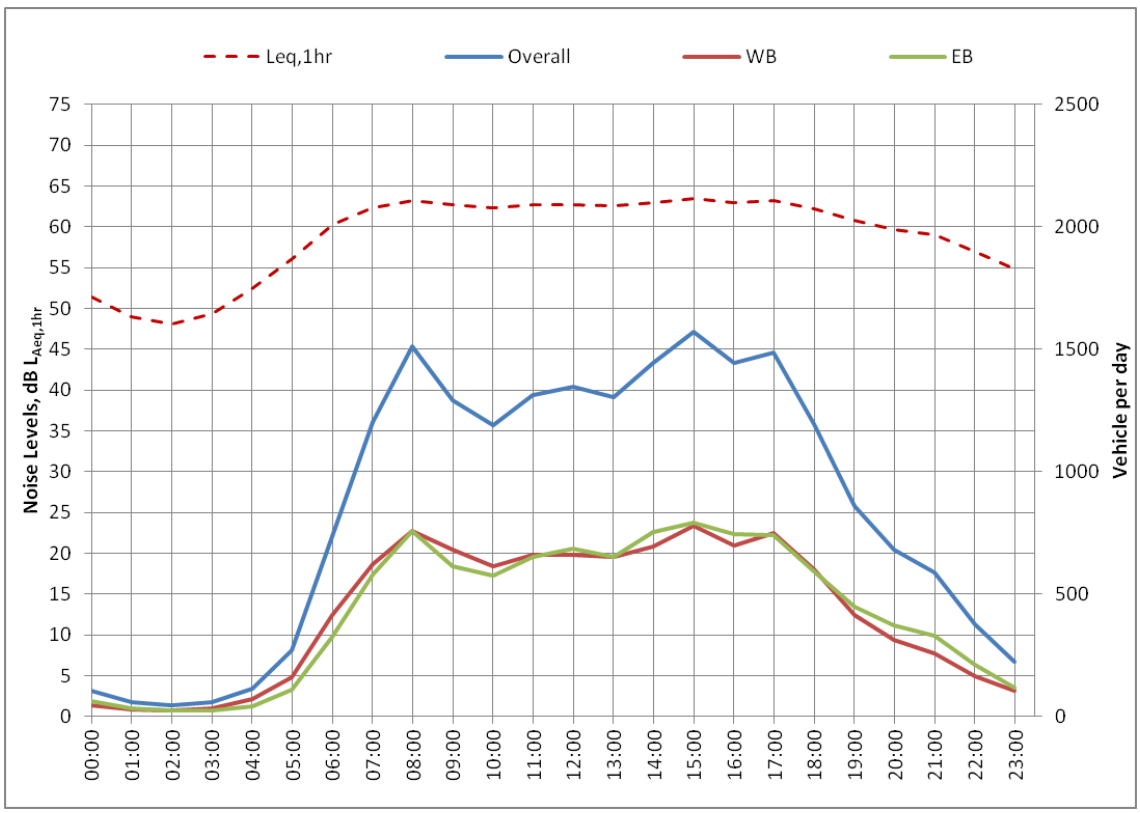

Figure 4-2 Noise Level Relationship to Morley Drive Hourly Traffic Volumes

4.2 Noise Modelling

The noise model was initially set-up for existing conditions and calibrated to the noise measurement locations. The model is then updated to include the proposed building plans and future traffic volumes, maintaining the same model calibration. *Table 4-1* provides the predicted $L_{Aeq(Day)}$ noise levels to the glazed facade of each habitable room. It is noted that where the predicted levels are below the outdoor target of 55 dB $L_{Aeq(Day)}$, these are not shown in *Table 4-1*.

Also shown in *Table 4-1* is the minimum acoustic performance of any external glazing for the nominated room. This minimum performance was based on the elevation drawings, noting that full height glazing is provided to most habitable rooms.

Table 4-2 then provides a summary of the indicative minimum noise controls along with example of glazing construction.

Table 4-1 Predicted Future (2041) $L_{Aeq(Day)}$ Noise Levels

Level	Room	Façade	$L_{Aeq(Day)}$, dB	Minimum Glazing Performance
1	U102-U106 Living	N	69	$R_w + C_{tr}$ 32
	U101 Bed1	N	69	$R_w + C_{tr}$ 34
	U102-106 Beds	N	67	$R_w + C_{tr}$ 30
	U101 Living	N	67	$R_w + C_{tr}$ 30
	U102-U106 Living	E / W	67	$R_w + C_{tr}$ 30
	U101 Bed2	N	65	$R_w + C_{tr}$ 30
	U116 Bed/Living	W	64	$R_w + C_{tr}$ 28
	U117 Bed/Living	W	63	$R_w + C_{tr}$ 28
	U117 Bed	S	60	$R_w + C_{tr}$ 28
2	U202-U206 Living	N	69	$R_w + C_{tr}$ 32
	U201 Bed1	N	69	$R_w + C_{tr}$ 34
	U202-206 Beds	N	67	$R_w + C_{tr}$ 30
	U201 Living	N	67	$R_w + C_{tr}$ 30
	U202-U203 Living	E / W	67	$R_w + C_{tr}$ 30
	U204-U206 Living	E / W	66	$R_w + C_{tr}$ 28
	U201 Bed2	N	65	$R_w + C_{tr}$ 30
	U216 Bed/Living	W	63	$R_w + C_{tr}$ 28

Level	Room	Façade	$L_{Aeq(Day)}$, dB	Minimum Glazing Performance
	U217 Bed/Living	W	62	$R_w + C_{tr}$ 28
	U217 Bed	S	61	$R_w + C_{tr}$ 28
3	U302-U304 Living	N	69	$R_w + C_{tr}$ 32
	U301 Bed1	N	69	$R_w + C_{tr}$ 34
	U305-306 Living	N	68	$R_w + C_{tr}$ 32
	U302-303 Beds	N	67	$R_w + C_{tr}$ 30
	U302 Living	E	67	$R_w + C_{tr}$ 30
	U304-U306 Beds	N	66	$R_w + C_{tr}$ 30
	U304-U306 Living	E / W	66	$R_w + C_{tr}$ 28
	U301 Living	N	65	$R_w + C_{tr}$ 28
	U301 Bed2	N	65	$R_w + C_{tr}$ 30
	U316 Bed/Living	W	62	$R_w + C_{tr}$ 28
	U317 Bed/Living	W	61	$R_w + C_{tr}$ 28
	U317 Bed	S	61	$R_w + C_{tr}$ 28
4	U401 Bed	N	67	$R_w + C_{tr}$ 30
	U401 Living	N	65	$R_w + C_{tr}$ 28
	U402, 405 & 406 Living	N	63	$R_w + C_{tr}$ 28
	U403-404 Living	N	62	$R_w + C_{tr}$ 28
	U416-417 Living	W	61	$R_w + C_{tr}$ 28
5	U501 Bed	N	67	$R_w + C_{tr}$ 30
	U501 Living	N	64	$R_w + C_{tr}$ 28
	U502-505 Living	N	61	$R_w + C_{tr}$ 28
	U516-517 Living	W	61	$R_w + C_{tr}$ 28

Table 4-2 Indicative Minimum Noise Mitigation

Element	Acoustic Performance	Minimum Requirement / Construction
Notification	-	*This lot is in the vicinity of a transport corridor and is affected by road traffic noise.*
Mechanical Ventilation	-	To be provided to allow windows to be closed. Refrigerant based systems need to be designed to achieve NCC fresh air ventilation requirements.
Walls	$R_w + C_{tr} \geq 50$	To be of mass construction, such as brick, concrete or multiple layer cement sheet and plasterboard system.
Ceiling	$R_w + C_{tr} \geq 35$	Where apartment has roof above, ceiling to habitable rooms is to be 13mm thick plasterboard with R3.5 fibrous insulation above. Roof is to be *Colorbond* or similar with *Anticon* insulation between roof sheeting and purlins.
Glazing	$R_w + C_{tr}$ 34	10.5mm thick VLam Hush laminated fixed glazing or in awning/casement window closing on compressible seals. Where a sliding door is used, double glazing incorporating 10.5mm thick VLam may be required to compensate for losses via seals.
	$R_w + C_{tr}$ 32	10.38mm thick laminated fixed glazing or in awning/casement window closing on compressible seals. Where a sliding door is used, 10.5mm thick VLam or double glazing maybe required to compensate for losses via seals.
	$R_w + C_{tr}$ 30	6.5mm thick VLam Hush fixed glazing or awning/casement window. Where a sliding door is used, 8.38mm thick laminated or double glazing maybe required to compensate for losses via seals.
	$R_w + C_{tr}$ 28	6.38mm thick laminated glazing in fixed frame, awning / casement window or sliding door closing on compressible seals.

Note that the glazing systems put forward are indicative only, noting that 6mm thick glass should be considered the minimum requirement for all glazing. The final acoustic performance will be dependent on the size of the glazing, which at this stage has been estimated. Reducing the glazing size can dramatically decrease the acoustic performance required. The final glazing system will need to be confirmed by the glazier.

5 ENVIRONMENTAL NOISE

Noise emissions from the development will include mechanical plant, car doors closing and potential operational noise from the commercial tenancies e.g. café/restaurant and the gym.

As the project is in its early stages, details of the mechanical plant are unknown, therefore a detailed assessment of noise emissions from the development will be required post-DA. It is further noted that the nature of the commercial tenancies are unknown at this stage and, therefore, separate assessment(s) will also be undertaken at fit-out stage.

5.1 AC Plant

Although the AC plant selection is not known at this stage, either, or a combination, of the following should be considered during detailed design:

- All plant is to be the quietest reasonably available. Where equivalent items of plant are being compared, noise levels shall be considered, with preference given to the quieter model;
- The commercial and Gym AC plant could be selected so that it can be set to operate on a 'quiet' mode automatically at night-time i.e. feature is programmed at the outdoor unit and not controlled by the end user, or does not operate all at night-time;
- Locate all residential AC units at balcony level to maximise screening effects from balcony slab;
- Acoustic screens or acoustic louvres could be provided to key sides of the Store rooms, while other sides maybe left open to allow for airflow;
- Any exhaust fans should be axial type fans so that in duct attenuation can be incorporated on the outside air side of the fans;
- All plant is to be suitably vibration isolated from the structure; and,
- An environmental noise assessment is to be undertaken during detailed design in regards to mechanical plant noise to ensure compliance with the *Environmental Protection (Noise) Regulations 1997*.

5.2 Car Doors Closing

Noise levels will be predicted and assessed against the night-time assigned noise level of 61 dB L_{Amax} during detailed design, with consideration given to noise walls where relevant.

5.3 Gym

Again, a detailed assessment of the noise emissions from the gym will be undertaken post-DA, including regenerated noise to adjacent properties and the apartments above.

At this stage, the following mitigation measures are to be considered during detailed design:

- Gym to be provided with a sound barrier ceiling consisting of 1 x 13mm thick sound-rated plasterboard, suspended on resilient hangers with fibrous insulation above.
- East glazing to be as small as practicable and achieving $R_w + C_{tr}$ of 34 minimum (e.g. 10.5mm thick VLam Hush).
- Equipment selections to be given consideration including minimising weight and no connection to walls or ceilings.
- Impact isolation to be provided to the floor. This can be in the form of a thick mat in low impact areas. If areas exist where high impact will occur, these will require a higher degree of isolation such as spring mounted floor.
- Only low level background music to be played in the gym, with no subwoofers.
- Time restrictions may need to be applied to the gym e.g. not 24/7 operations.

Appendix A

Development Plans

PROPOSED MIXED USE DEVELOPMENT

10 MORLEY DRIVE, TUART HILL, WA 6060

DEVELOPMENT APPLICATION

SHEET LIST

SHEET NO.	SHEET NAME	REV.	REV. DATE
DA0000	COVER SHEET WITH DRAWING LIST & SUMMARY		
DA0001	SURVEY PLAN		
DA0010	SITE PLAN		
DA0020	SITE ANALYSIS		
DA0500	DEMOLITION PLAN		
DA1000	BASEMENT PLAN		
DA1001	GROUND FLOOR PLAN		
DA1002	LEVEL 01 PLAN		
DA1003	LEVEL 02 PLAN		
DA1004	LEVEL 03 PLAN		
DA1005	LEVEL 04 PLAN		
DA1006	LEVEL 05 PLAN		
DA1007	ROOF PLAN		
DA2000	ELEVATION 01		
DA2001	ELEVATION 02		
DA2002	ELEVATION 03		
DA2003	ELEVATION 04		
DA2500	SECTION 01		
DA2501	SECTION 02		
DA2502	SECTION 03		
DA4000	SHADOW DIAGRAM 01 - JUNE 21		
DA4001	SHADOW DIAGRAM 02 - AUG 22		
DA4002	SHADOW DIAGRAM 03 - SEPT 22		
DA4003	SHADOW DIAGRAM 04 - OCT 22		
DA4010	PLOT RATIO AREA 01		
DA4011	PLOT RATIO AREA 02		

APARTMENT SCH.

APARTMENT TYPE	NO.

APARTMENT MIX

NO. OF BEDROOMS	NO.

AREAS

APARTMENT TYPE	AREA

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T (61 8) 9412 8355

perth@architectus.com.au
ABN 90 131 245 684

checked	AS
drawn	FMK
scale	@A3

project	10 MORLEY DRIVE, TUART HILL
drawing	COVER SHEET WITH DRAWING LIST & SUMMARY
project no	200611
	issue
drawing no.	**DA0000**

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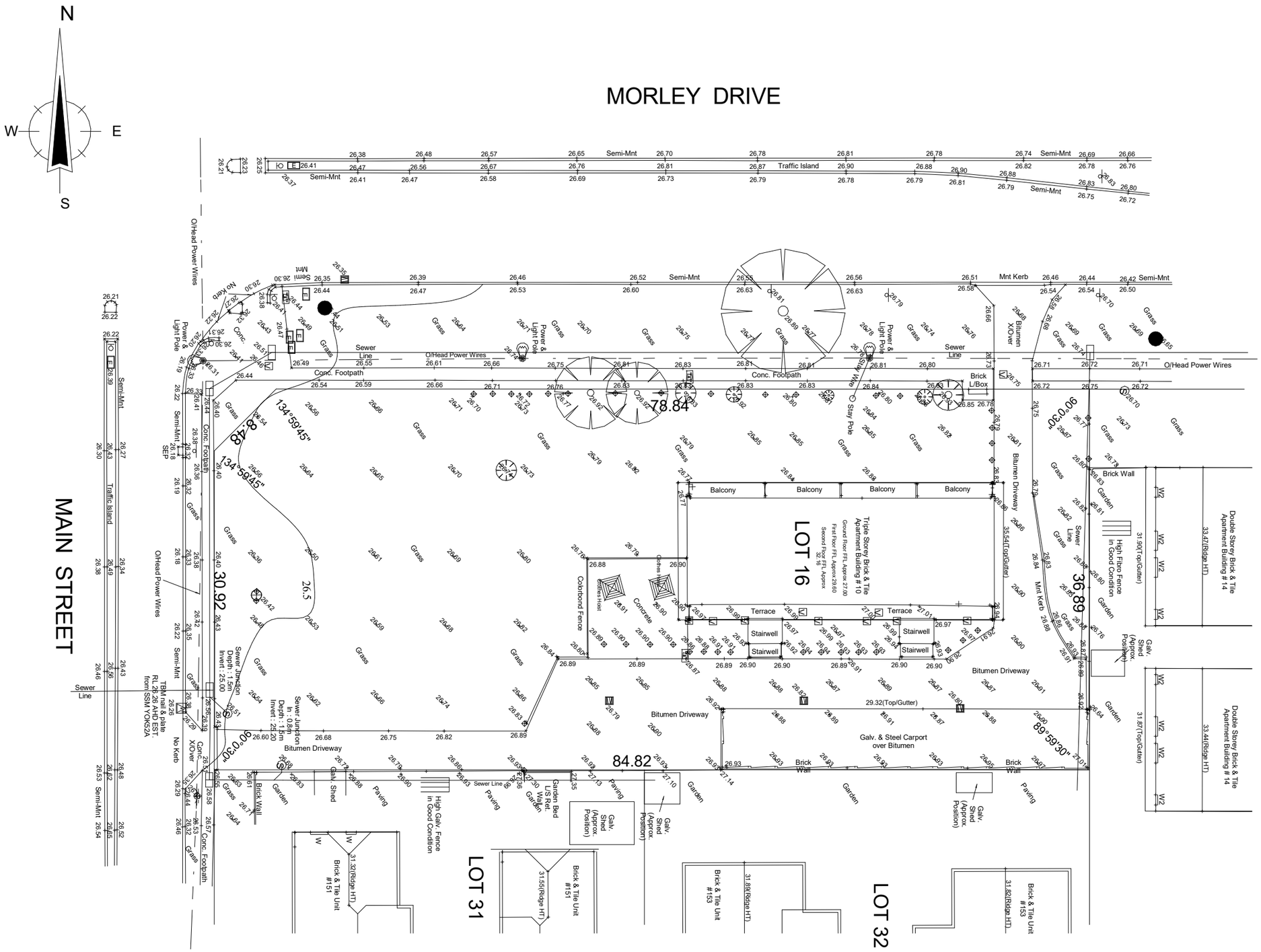

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checked	Checker
drawn	Author
scale	1 : 400@A3

project	10 MORLEY DRIVE, TUART HILL
drawing	SURVEY PLAN
project no	200611
issue	
drawing no.	**DA0001**

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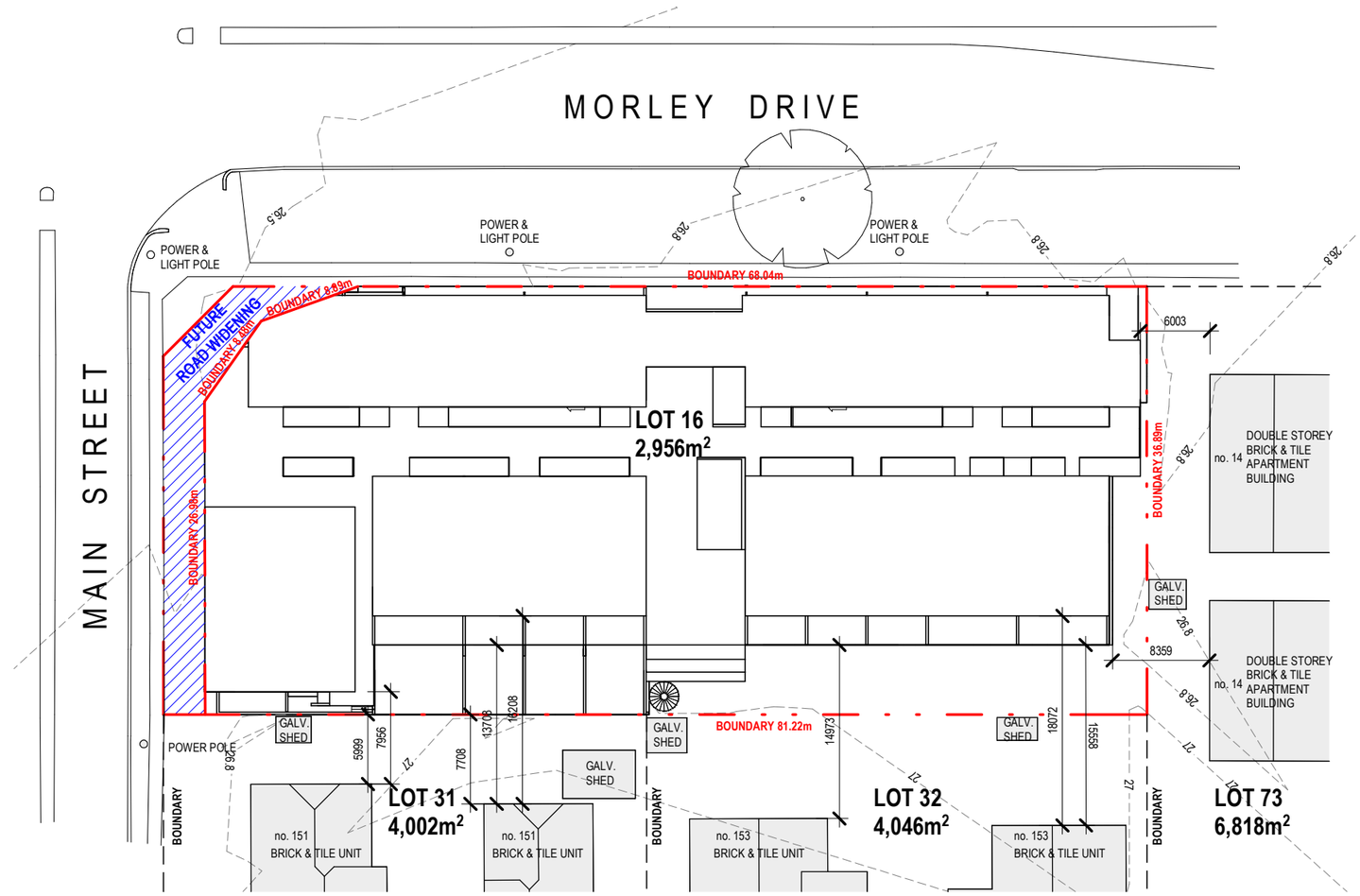

1 SITE PLAN
SCALE: 1 : 500

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checked	AS
drawn	FMK
scale	1 : 500@A3

project	10 MORLEY DRIVE, TUART HILL
drawing	SITE PLAN
project no	200611
issue	
drawing no.	**DA0010**

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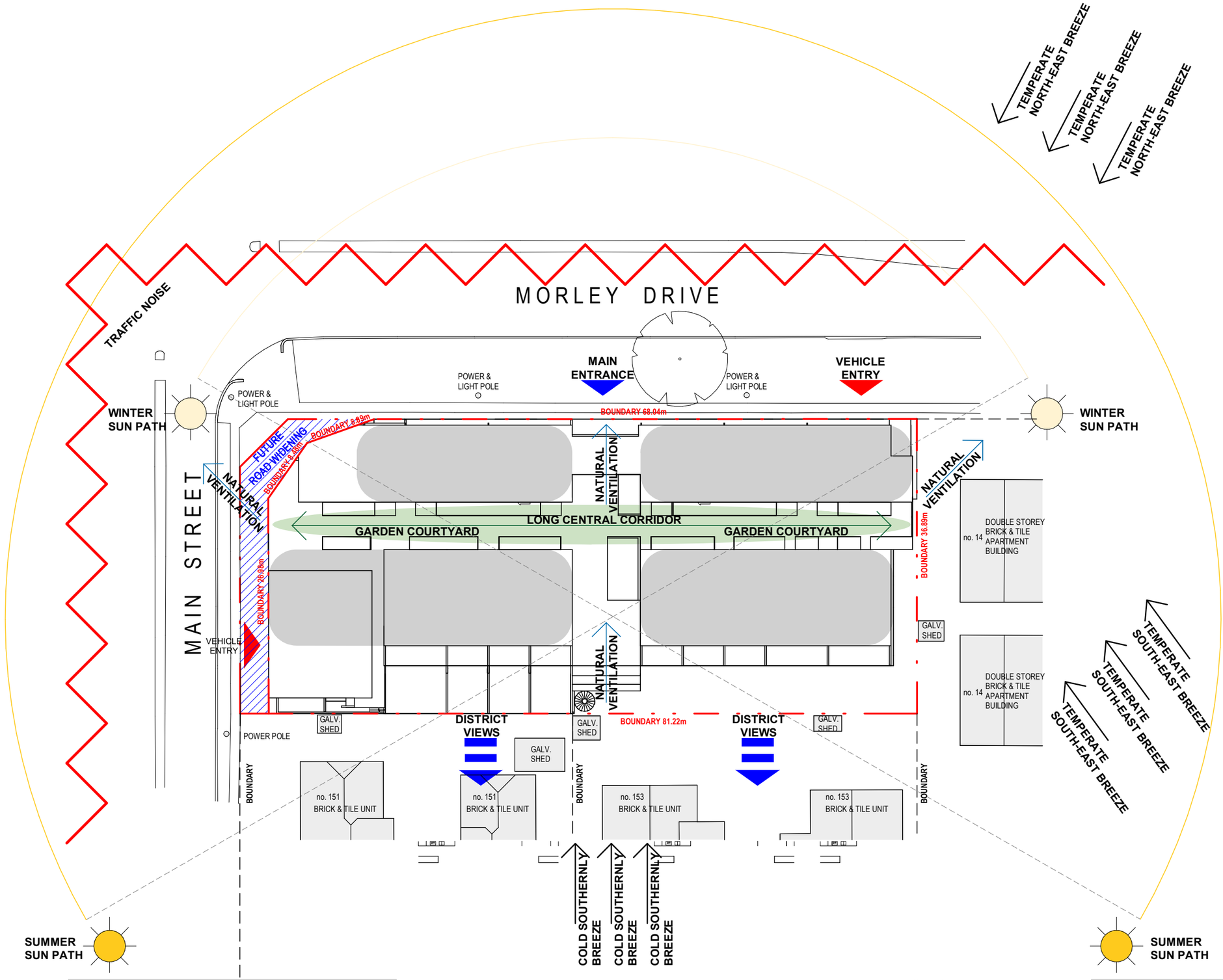

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checked	AS
drawn	FMK
scale	1 : 500@A3

project 10 MORLEY DRIVE, TUART HILL

drawing

SITE ANALYSIS

project no 200611

issue

drawing no. **DA0020**

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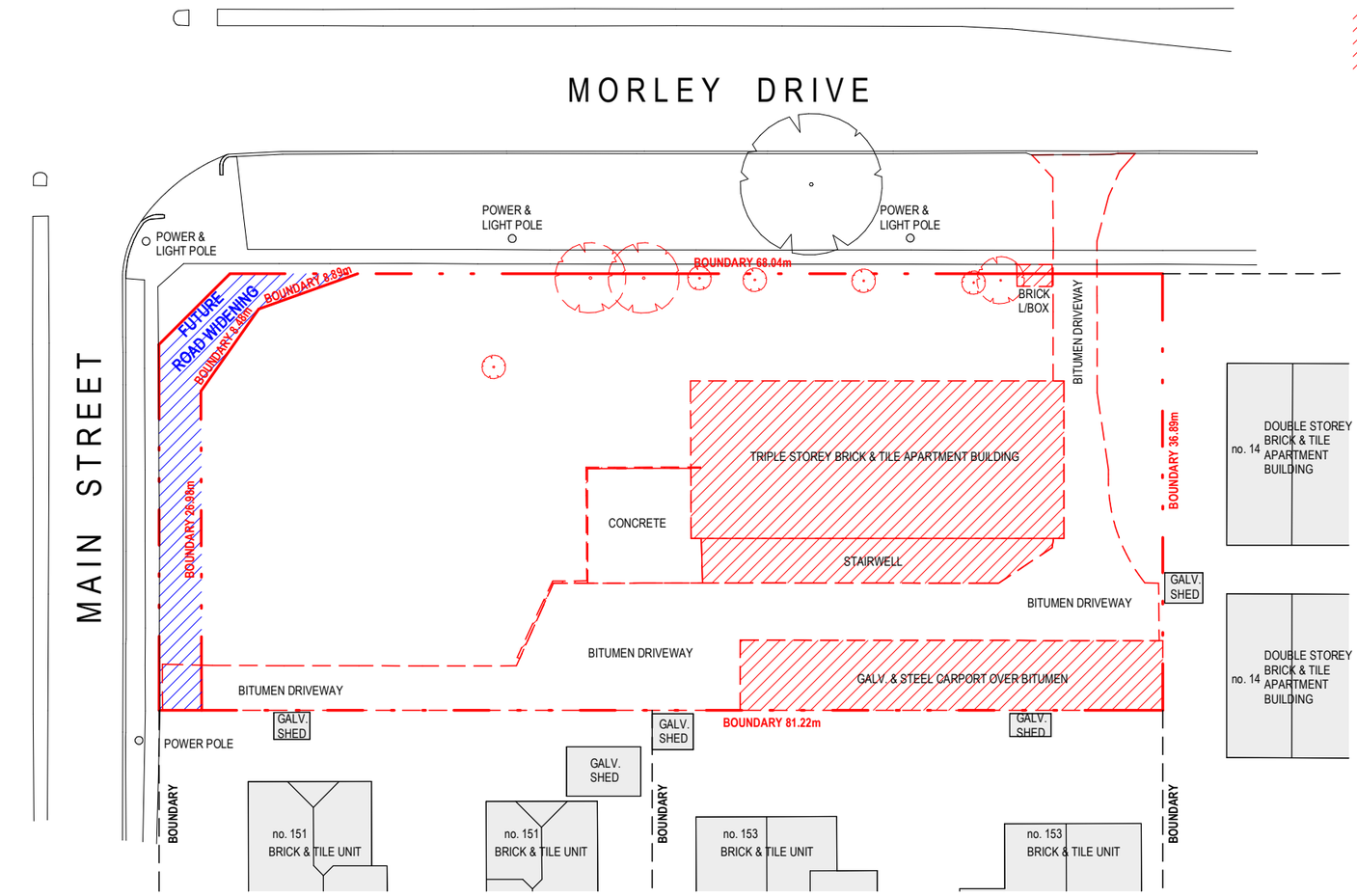
DEMOLITION LEGEND

DEMOLISH
DASHED RED LINES DENOTES DEMOLITION

DEMOLISH
ZONE TO BE DEMOLISHED



1 DEMOLTION PLAN
SCALE: 1 : 500

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checked	AS
drawn	FMK
scale	As indicated@A3

project	10 MORLEY DRIVE, TUART HILL
drawing	DEMOLITION PLAN
project no	200611
issue	
drawing no.	**DA0500**

16/02/2021 5:28:49 PM

MORLEY DRIVE

BOUNDARY 68.04m

FUTURE ROAD WIDENING

BOUNDARY 6.89m

BOUNDARY 5.48m

BOUNDARY 26.80m

BOUNDARY 36.89m

BOUNDARY 81.22m

SERVICES

PLANT ROOM

LOBBY

SERVICES

STAIR

STAIR

SMALL CAR

SMALL CAR

SMALL CAR

SMALL CAR

BASEMENT CARPARK
76 CAR PARKING BAYS

RL 23.75

RL 23.75

DEEP SOIL FOR PLANTING 31.6m²

DEEP SOIL FOR PLANTING 318m²

RAMP TO GROUND FLOOR 1:4

UP 1:8

SETBACK 6000

43155 SETBACK

MAIN STREET

1 DA2000

1 DA2500

1 DA2001

2 DA2501

1 DA2003

3 DA2502

1 DA2002

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checked	AS
drawn	FMK
scale	1 : 250@A3

project	10 MORLEY DRIVE, TUART HILL
drawing	BASEMENT PLAN
project no	200611
issue	
drawing no.	**DA1000**

16/02/2021 5:28:51 PM

MORLEY DRIVE

MAIN STREET

BOUNDARY 68.04m

BOUNDARY 6.89m

BOUNDARY 5.48m

FUTURE ROAD WIDENING

BOUNDARY 26.98m

BOUNDARY 36.89m

BOUNDARY 81.22m

BOUNDARY

LEVEL ABOVE

PLANTER

COMMERCIAL 01
178.7 m²

COMMERCIAL 02
66.7 m²

COMMERCIAL 03
65.6 m²

COMMERCIAL 04
104.3 m²

LOBBY

LETTERBOXES

STAIR

MALE WC

FEMALE WC

UAT

RESIDENTIAL DRIVEWAY ENTRY

RL 26.90

1:8 DW

1:4 RAMP TO BASEMENT

GYM
88.8 m²

DEEP SOIL FOR PLANTING
31.6m²

DEEP SOIL FOR PLANTING
318m²

COMMERCIAL DRIVEWAY ENTRY

SERVICES

MOTORBIKE PARKING

BIKE PARKING

RESI. BINS

COM. BINS

RES. BIKE STORE
35 BIKES

3000 SETBACK

no. 14

no. 151

no. 153

1 DA2000

1 DA2001

2 DA2501

1 DA2003

3 DA2502

1 DA2002

1 DA2500

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checked	AS
drawn	FMK
scale	1 : 250@A3

project 10 MORLEY DRIVE, TUART HILL

drawing GROUND FLOOR PLAN

project no 200611

issue

drawing no. **DA1001**

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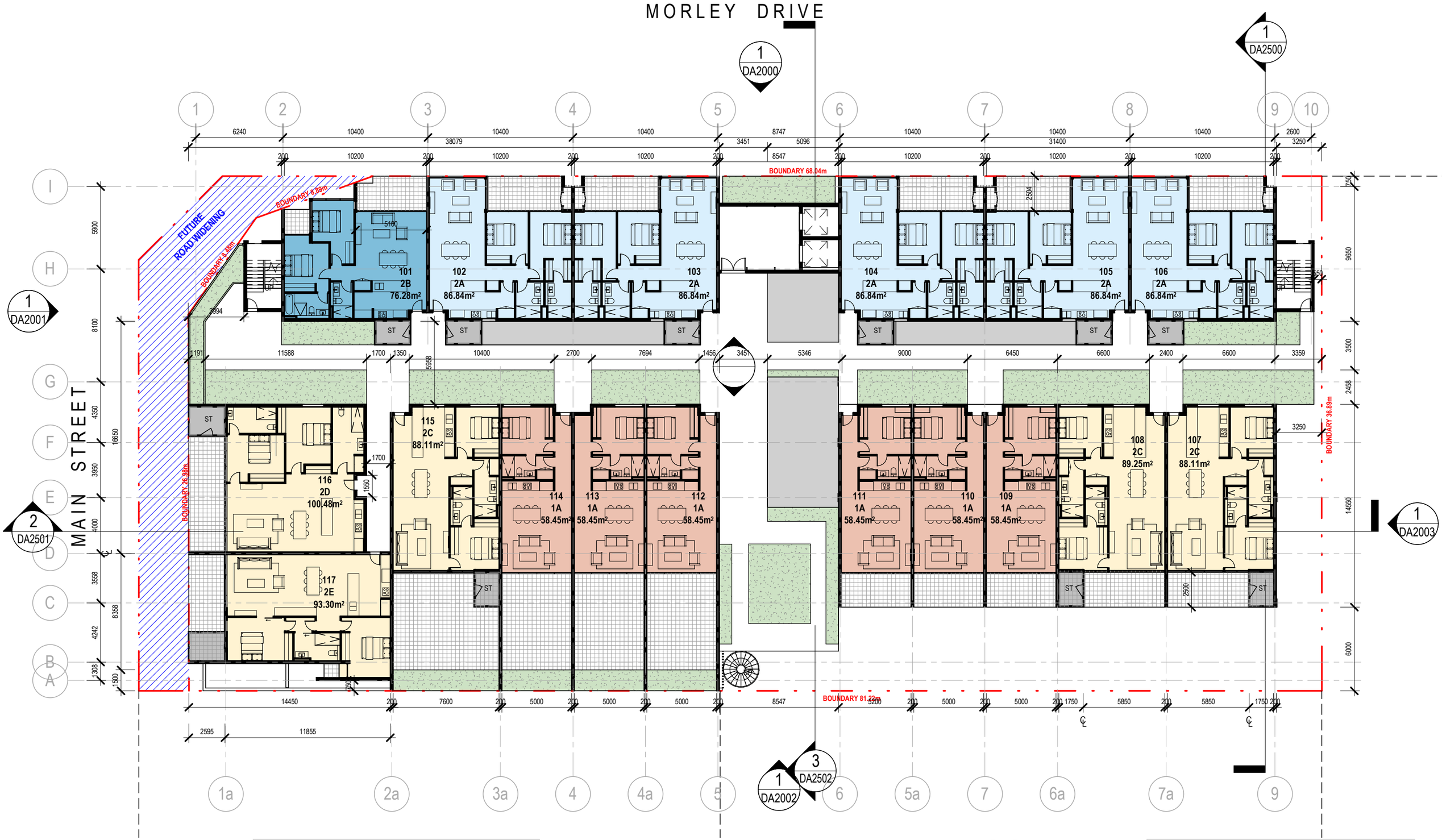

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checked	AS
drawn	FMK
scale	1 : 250@A3

project	10 MORLEY DRIVE, TUART HILL
drawing	LEVEL 01 PLAN
project no	200611
issue	
drawing no.	**DA1002**

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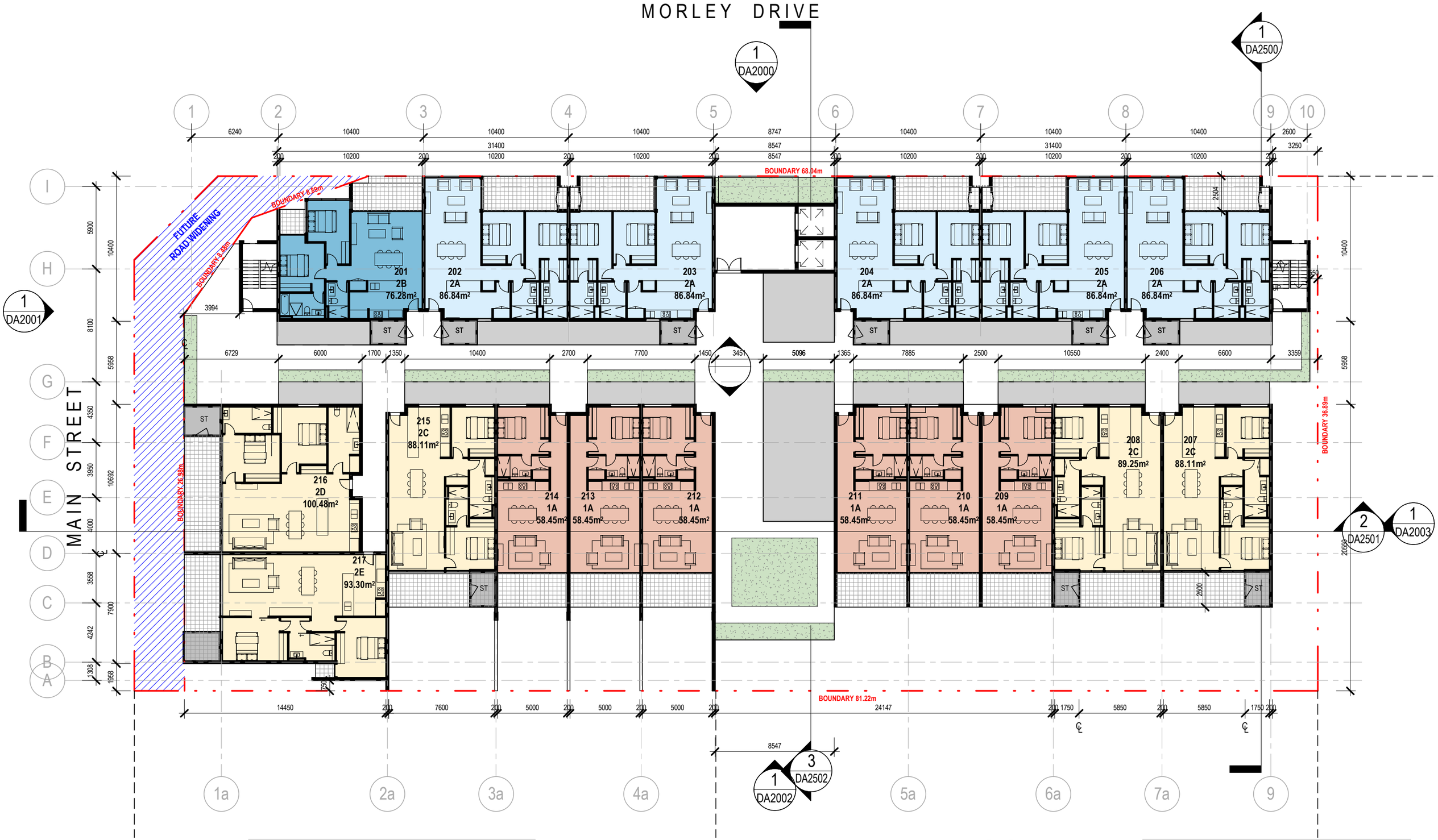

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checked	AS
drawn	FMK
scale	1 : 250@A3

project	10 MORLEY DRIVE, TUART HILL
drawing	LEVEL 02 PLAN
project no	200611
issue	
drawing no.	**DA1003**

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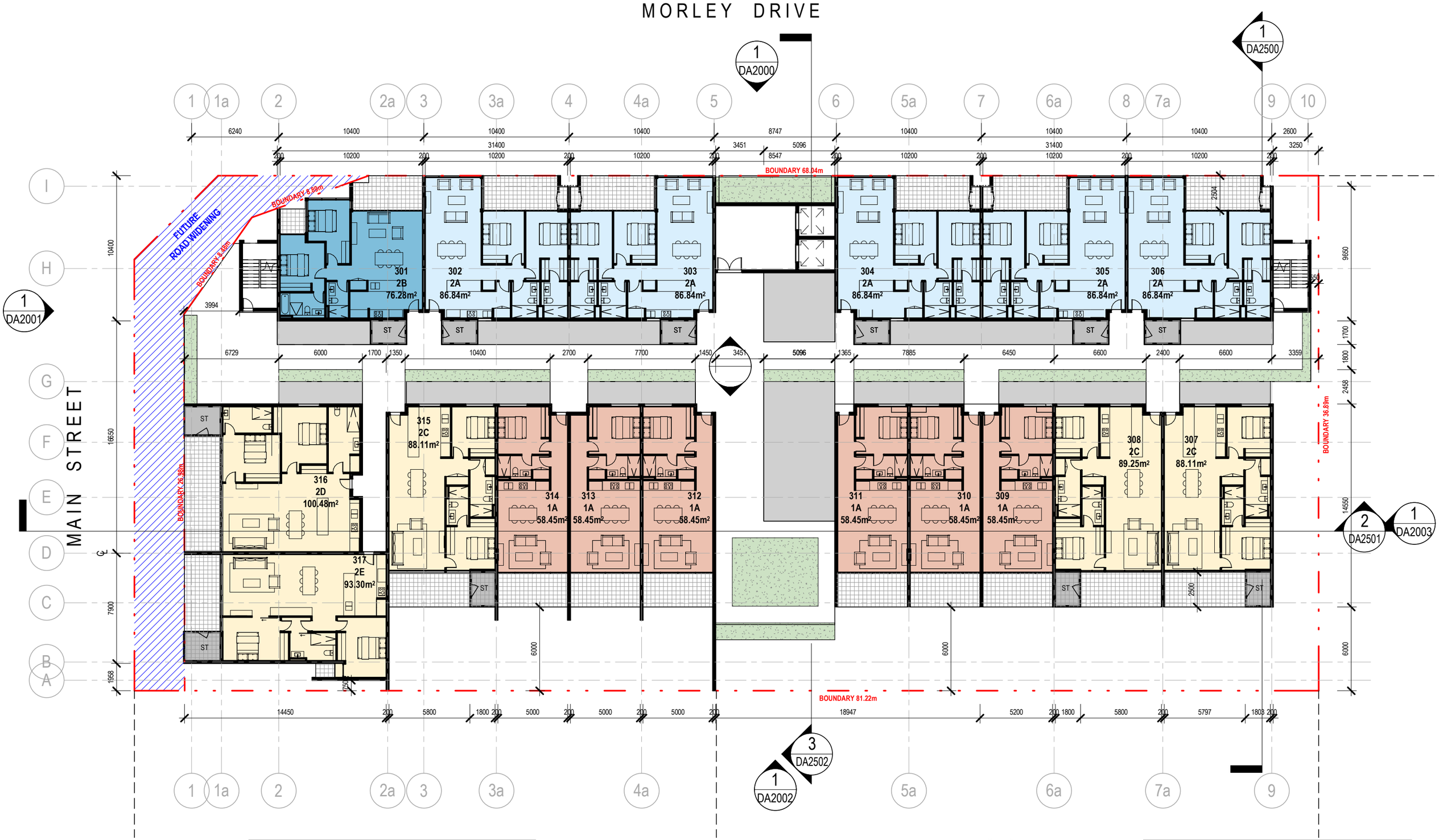

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checked	AS
drawn	FMK
scale	1 : 250@A3

project 10 MORLEY DRIVE, TUART HILL

drawing LEVEL 03 PLAN

project no 200611

drawing no. **DA1004** issue

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checked	AS
drawn	FMK
scale	1 : 250@A3

project	10 MORLEY DRIVE, TUART HILL
drawing	LEVEL 04 PLAN
project no	200611
issue	
drawing no.	**DA1005**

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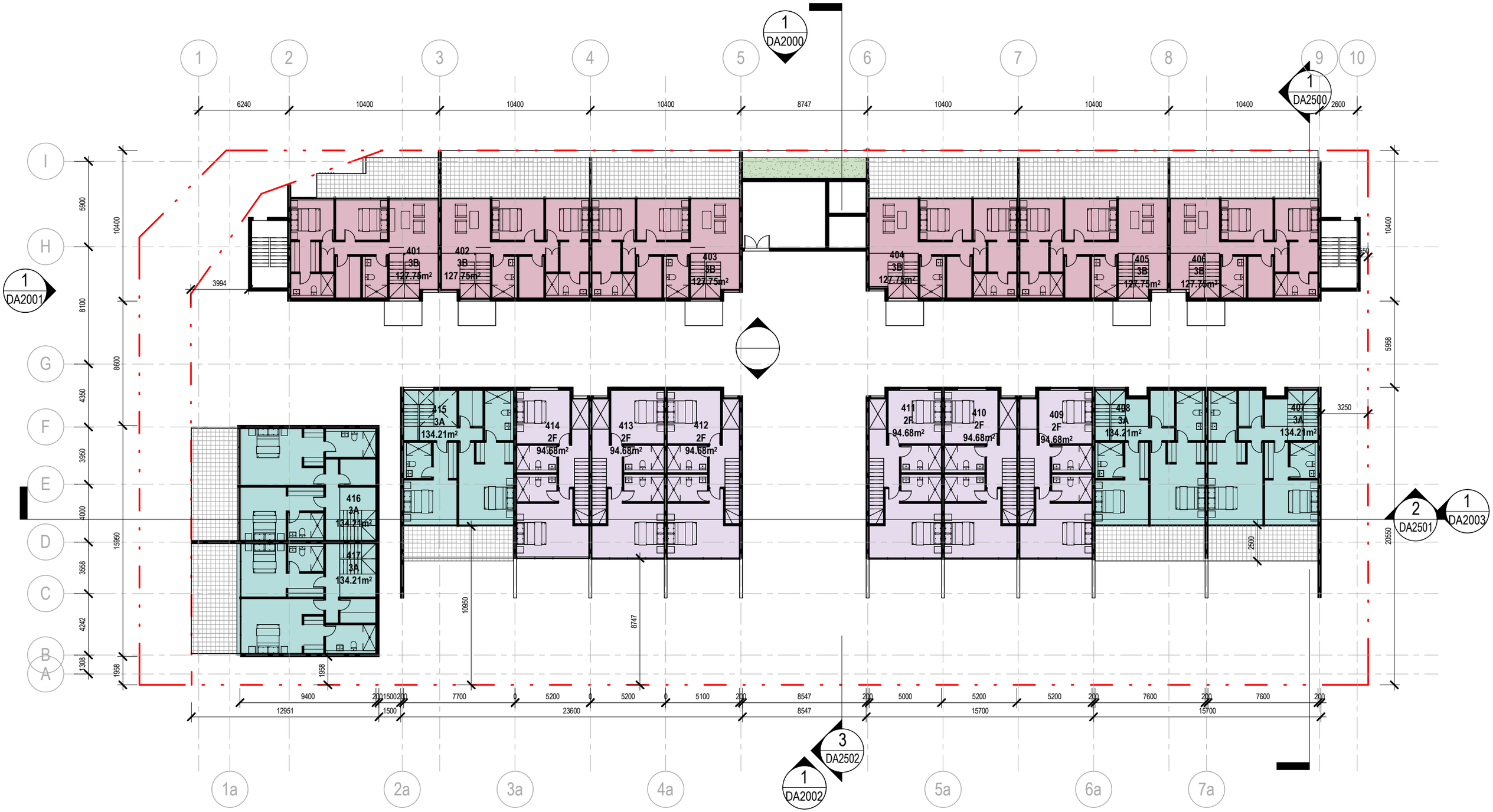

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checked	AS
drawn	FMK
scale	1 : 250@A3

project	10 MORLEY DRIVE, TUART HILL
drawing	LEVEL 05 PLAN
project no	200611
issue	
drawing no.	**DA1006**

16/02/2021 5:29:33 PM

MORLEY DRIVE

MAIN STREET

BOUNDARY 68.04m

FUTURE ROAD WIDENING

BOUNDARY 6.89m

BOUNDARY 5.48m

BOUNDARY 16.36m

BOUNDARY 36.89m

BOUNDARY 81.22m

BOUNDARY

SETBACK 3000

RL 46.45

RL 40.15

1500

8547

6003

8359

8358

no. 14

no. 151

no. 153

1 DA2000

1 DA2001

1 DA2002

3 DA2502

1 DA2500

2 DA2501

1 DA2003

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checked	AS
drawn	FMK
scale	1 : 250@A3

project 10 MORLEY DRIVE, TUART HILL

drawing ROOF PLAN

project no 200611

issue

drawing no. **DA1007**

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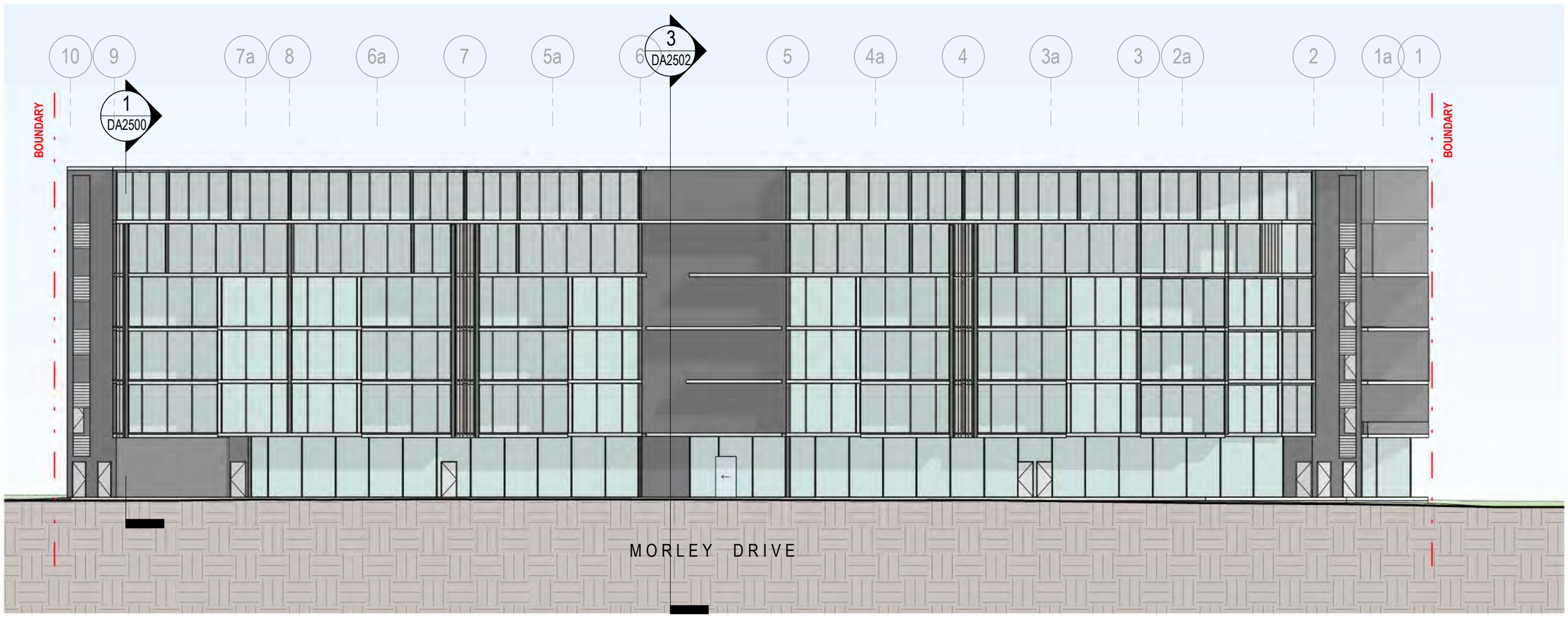

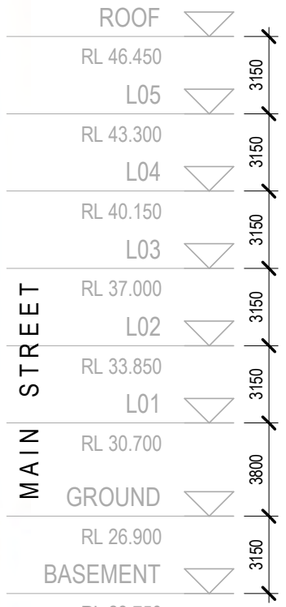

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checked	AS
drawn	FMK
scale	1 : 250@A3

project	10 MORLEY DRIVE, TUART HILL
drawing	ELEVATION 01
project no	200611
issue	
drawing no.	**DA2000**

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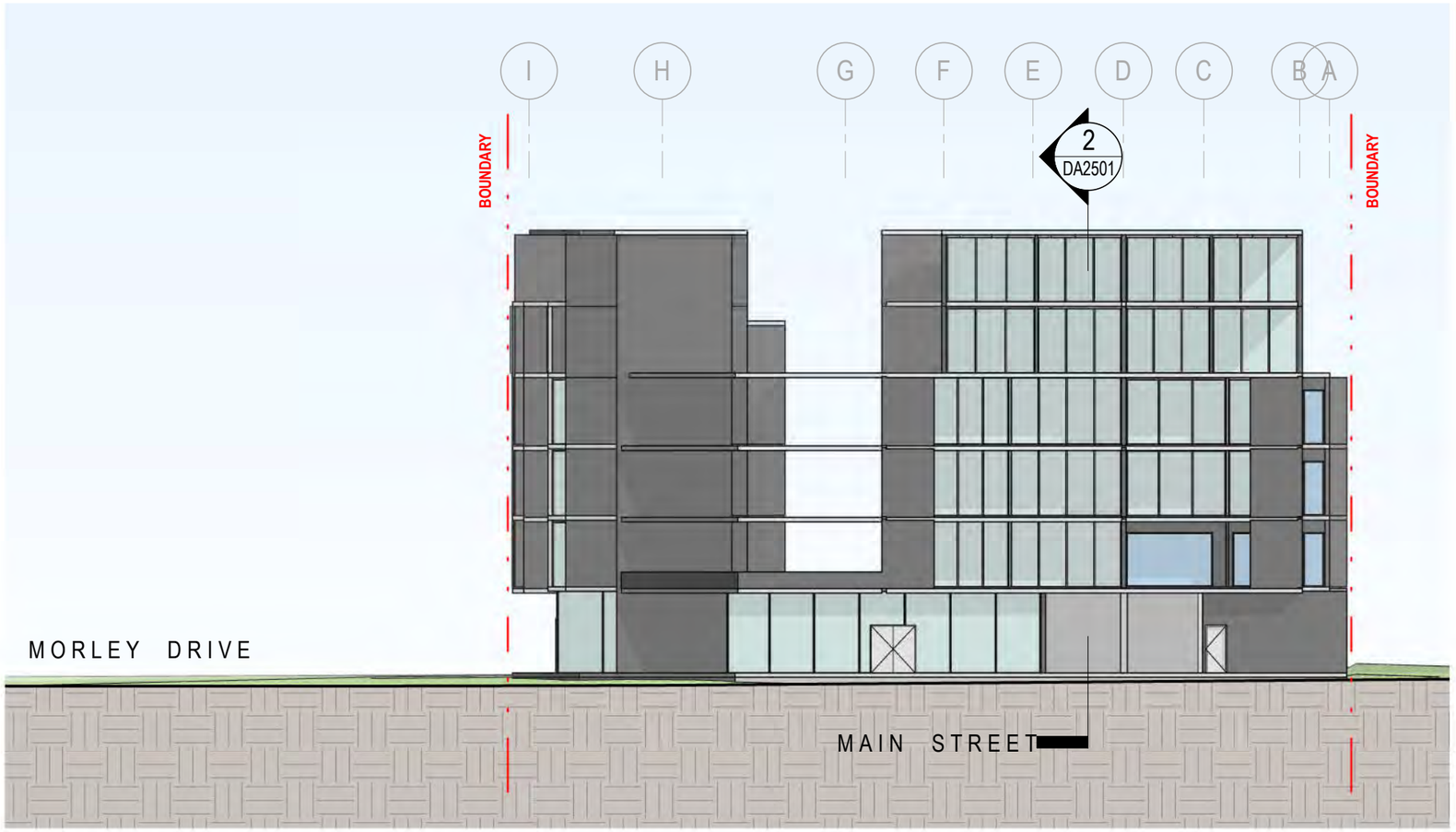

MATERIAL LEGEND

ITEM	DESCRIPTION
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	(2)
	(3)
	(4)
	(5)
	(6)

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checked	AS
drawn	FMK
scale	As indicated@A3

project	10 MORLEY DRIVE, TUART HILL
drawing	ELEVATION 02
project no	200611
issue	
drawing no.	**DA2001**

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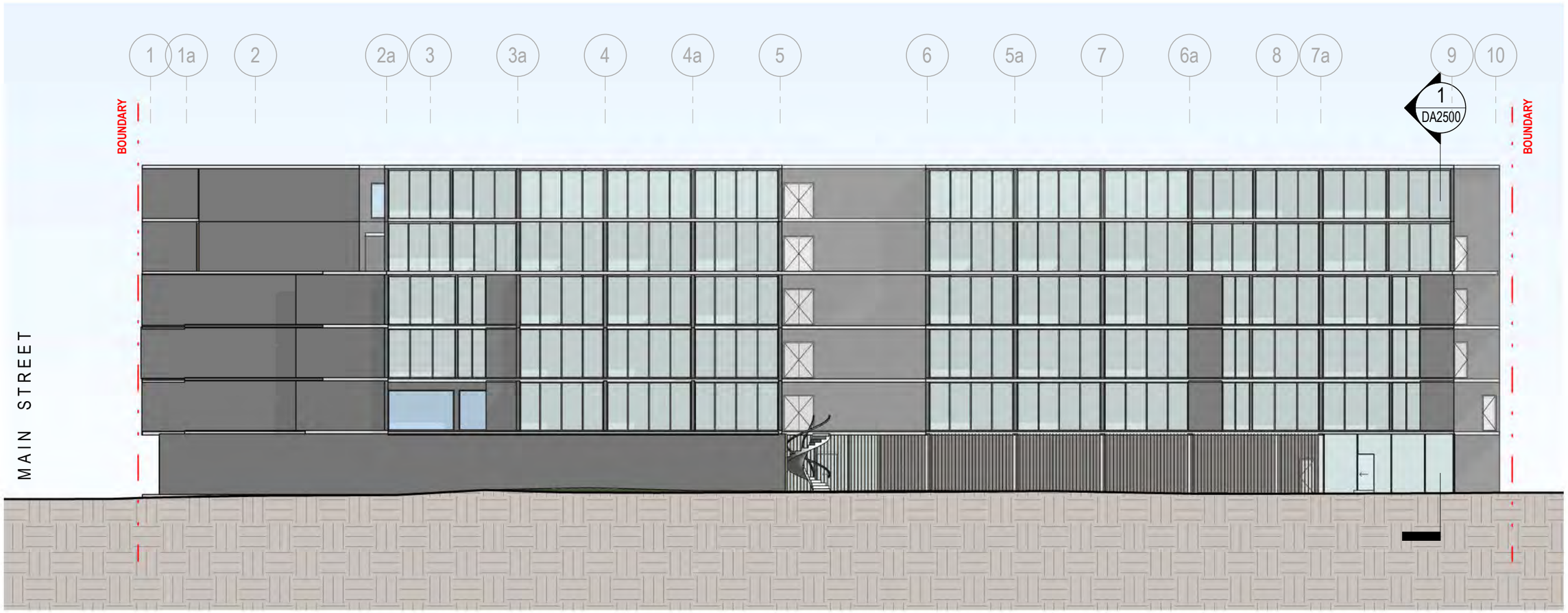

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checked	AS
drawn	FMK
scale	1 : 250@A3

project	10 MORLEY DRIVE, TUART HILL
drawing	ELEVATION 03
project no	200611
issue	
drawing no.	**DA2002**

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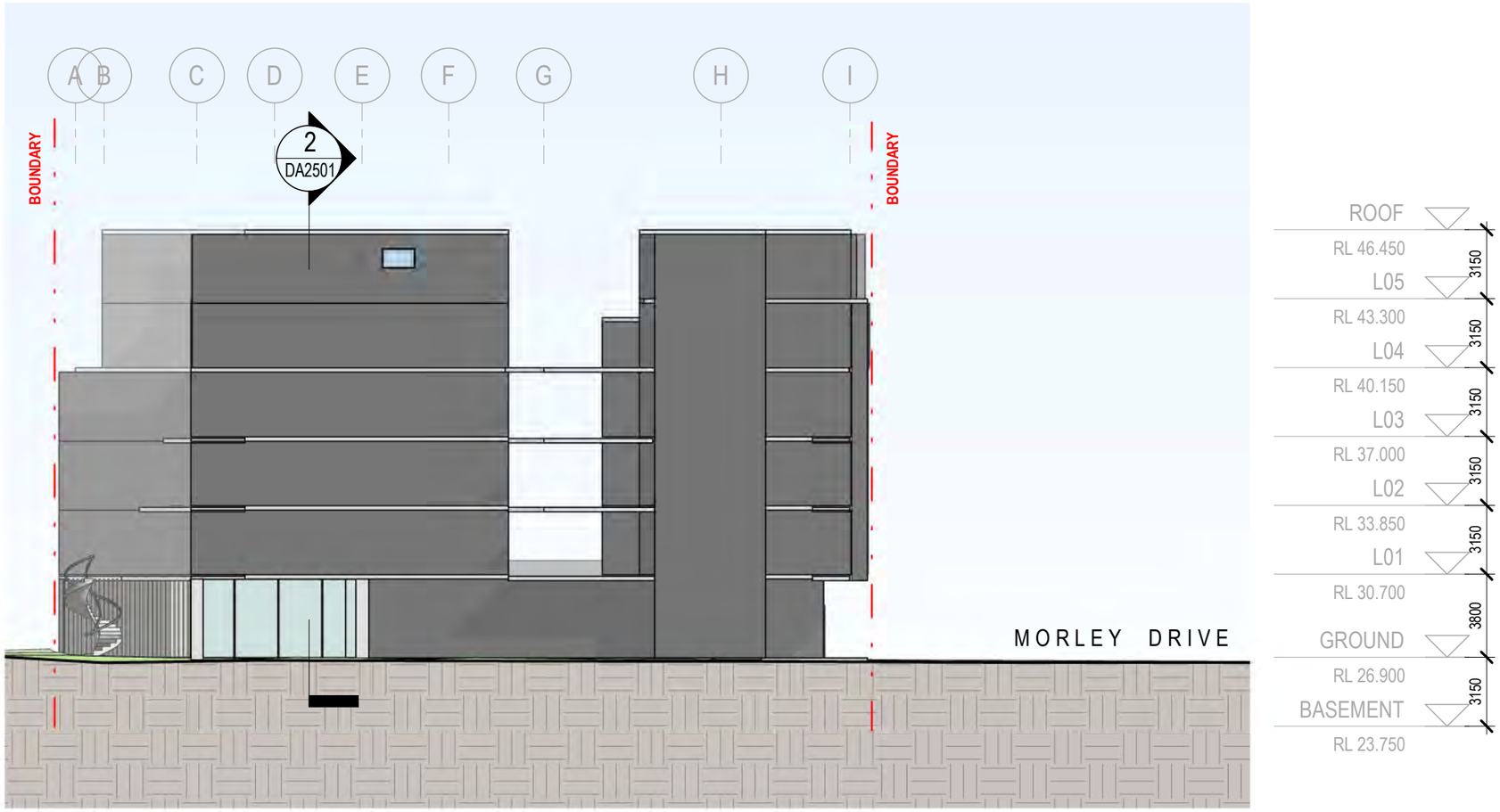

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drawn	FMK
scale	1 : 250@A3

project	10 MORLEY DRIVE, TUART HILL
drawing	ELEVATION 04
project no	200611
issue	
drawing no.	**DA2003**

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project	10 MORLEY DRIVE, TUART HILL
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issue	
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drawing	SECTION 02
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issue	
drawing no.	**DA2501**

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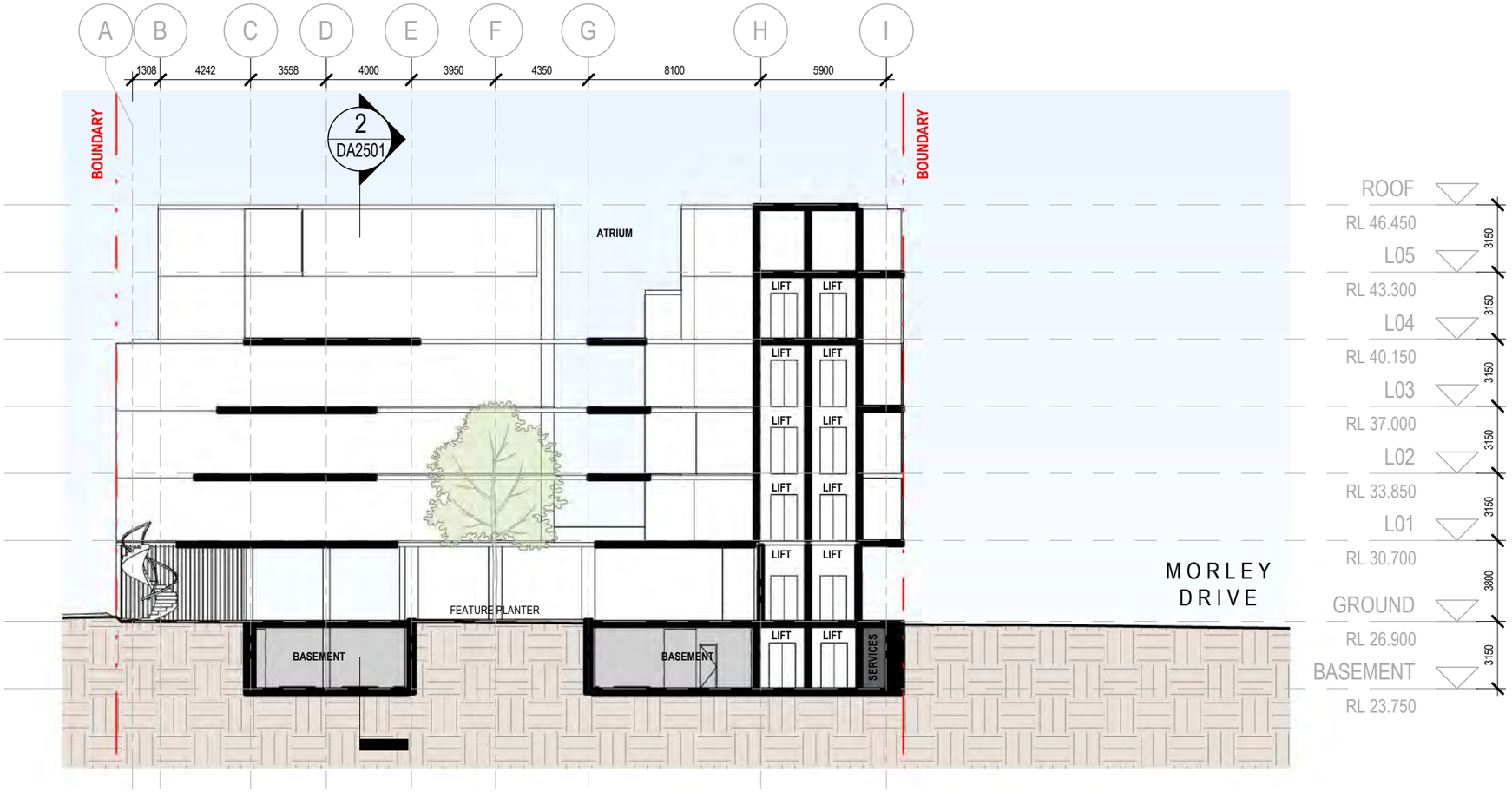

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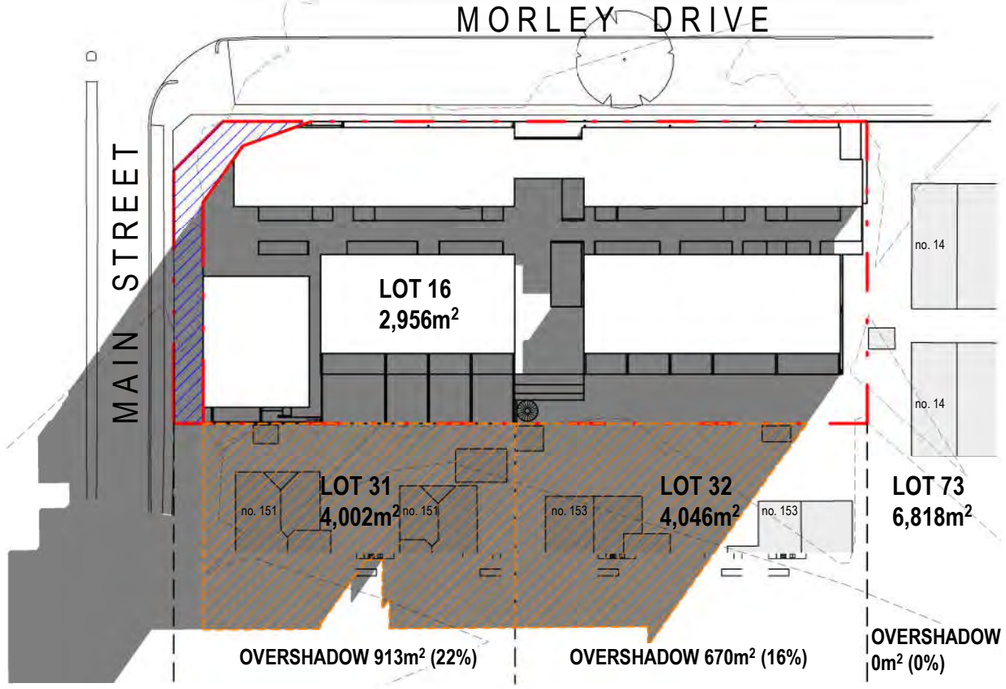

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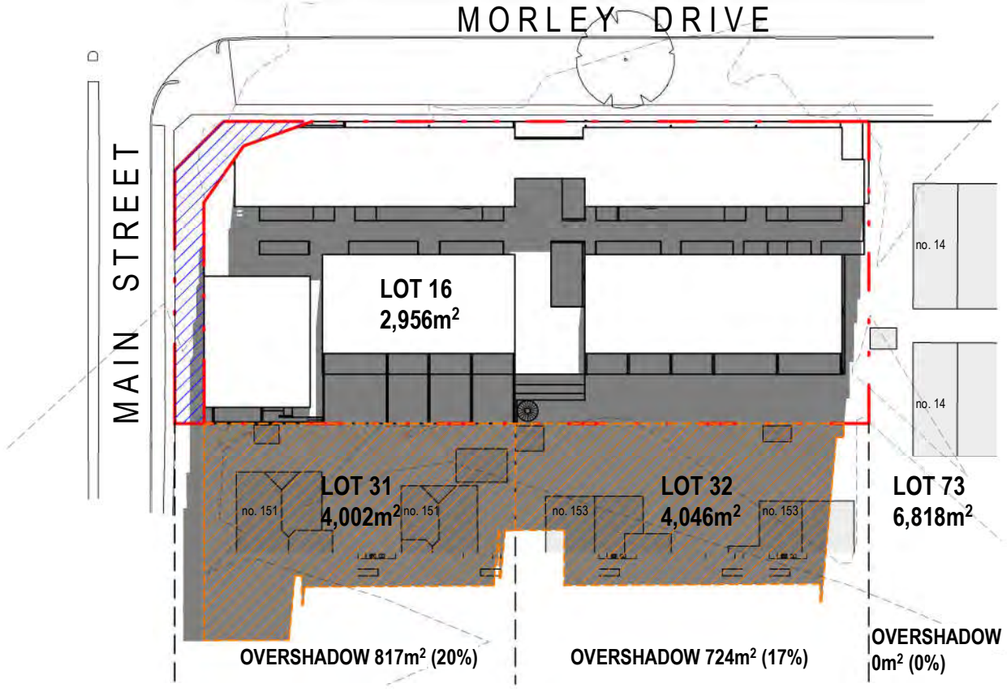

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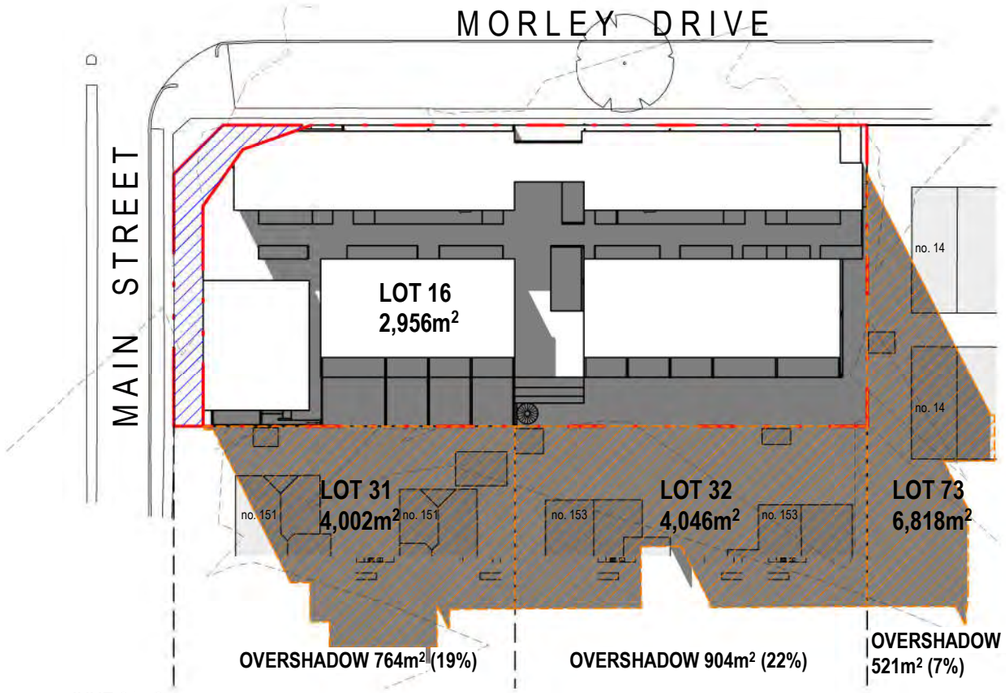

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drawing	SHADOW DIAGRAM 01 - JUNE 21
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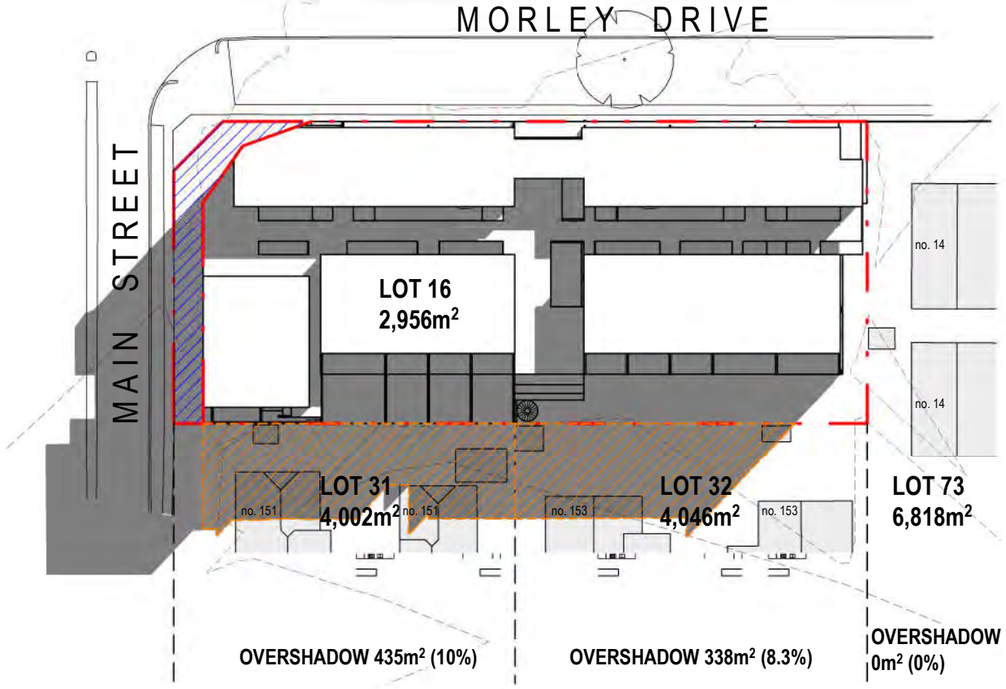

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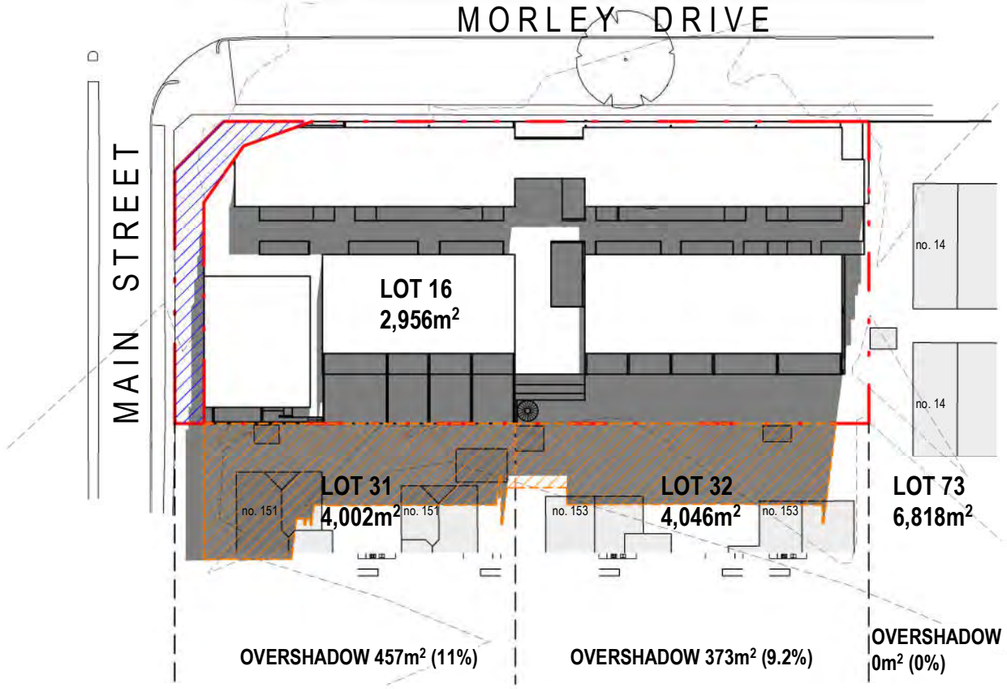

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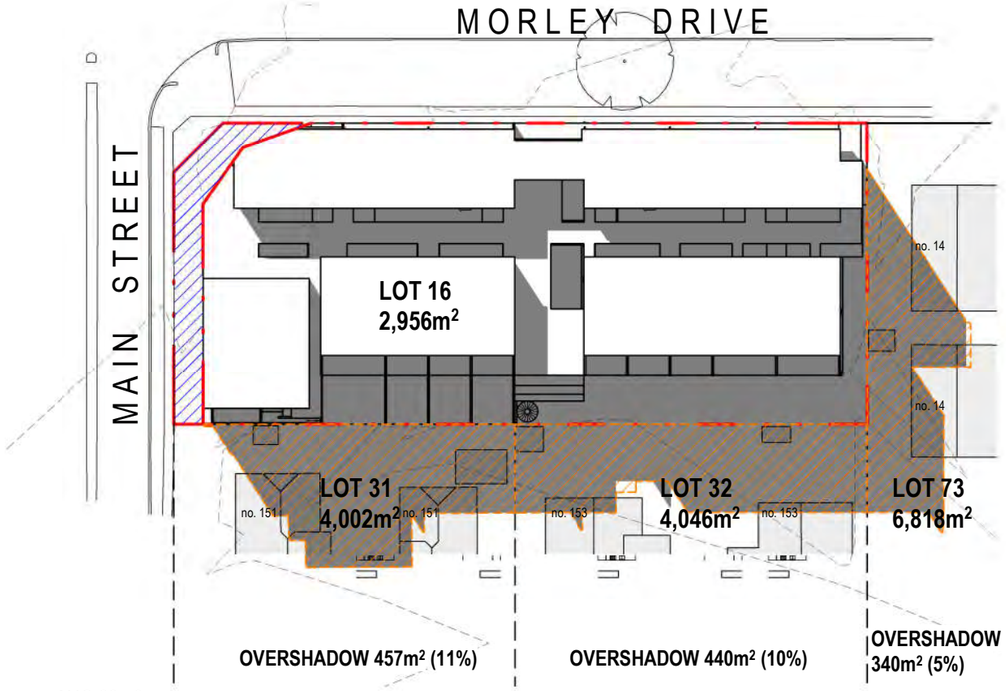

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scale	1 : 750@A3

project	10 MORLEY DRIVE, TUART HILL
drawing	SHADOW DIAGRAM 02 - AUG 22
project no	200611
issue	
drawing no.	**DA4001**

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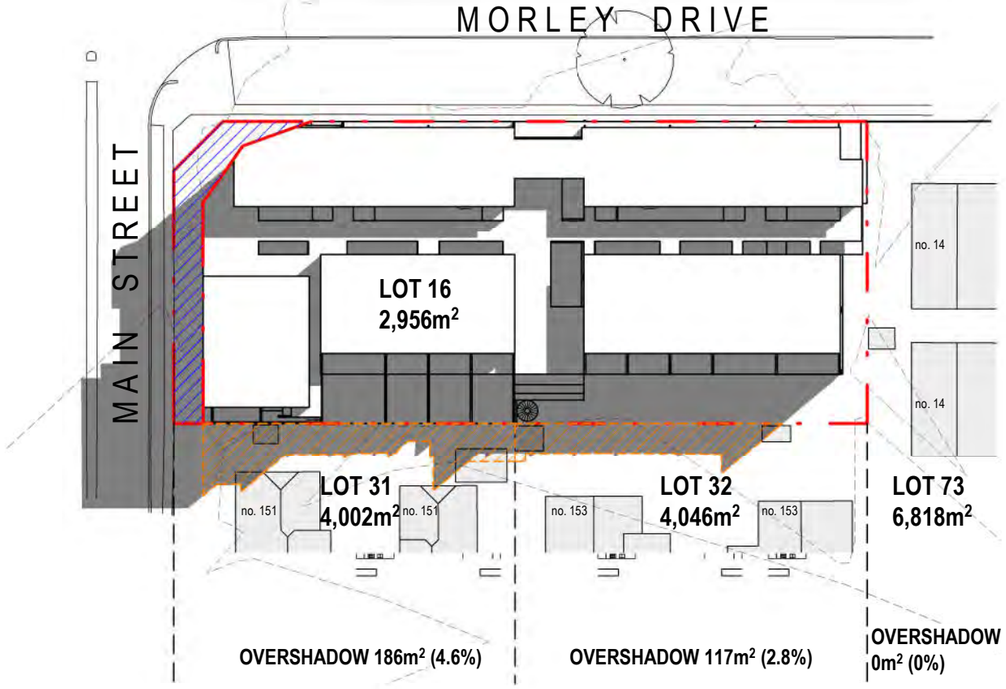

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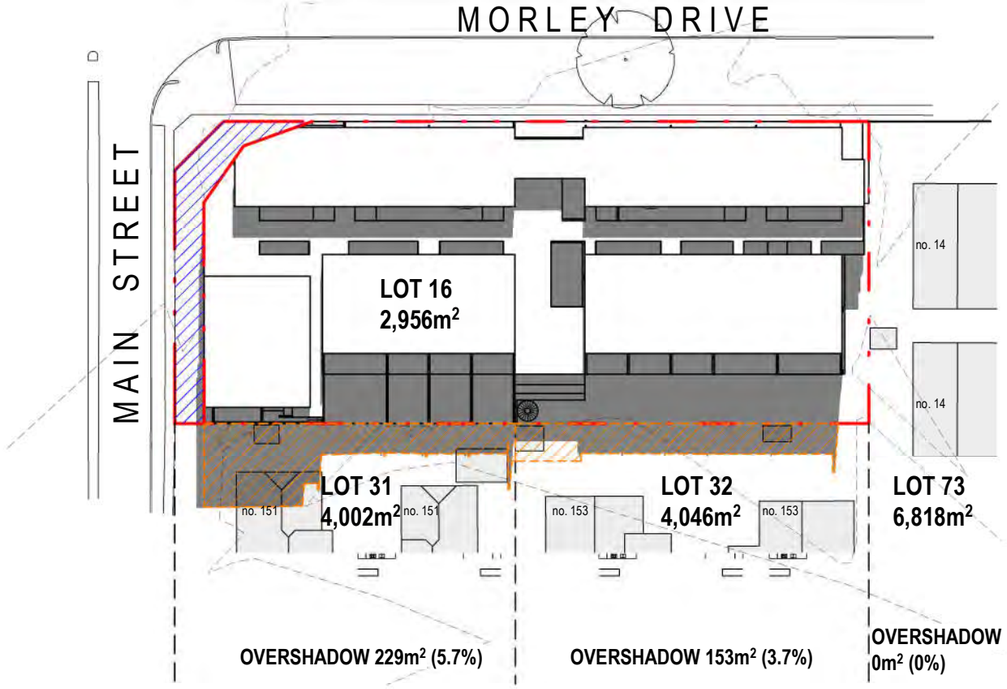

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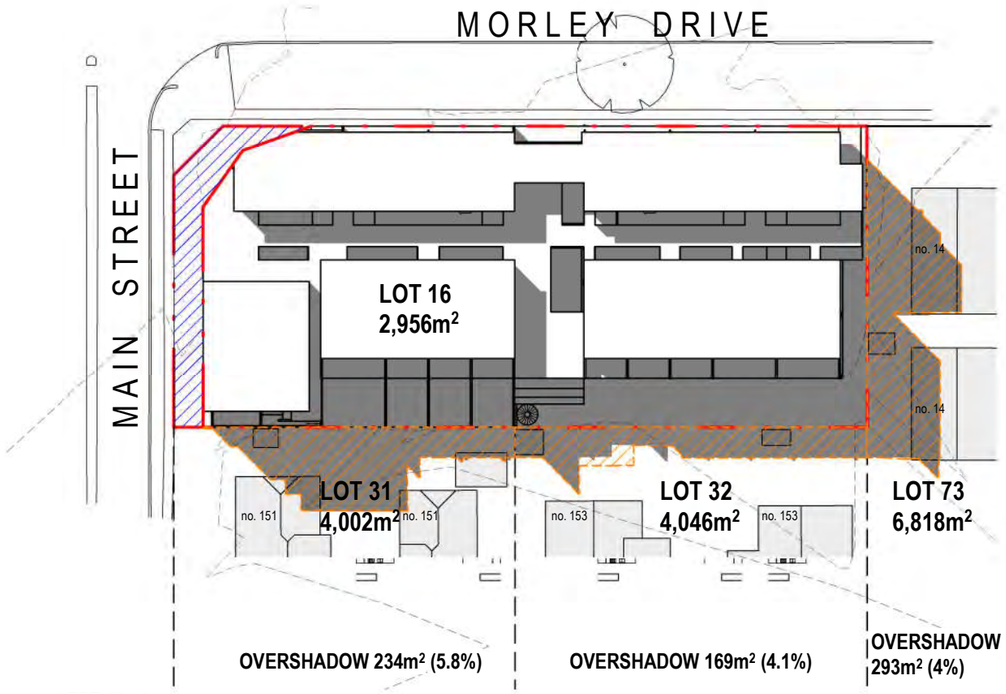

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drawing	SHADOW DIAGRAM 03 - SEPT 22
project no	200611
issue	
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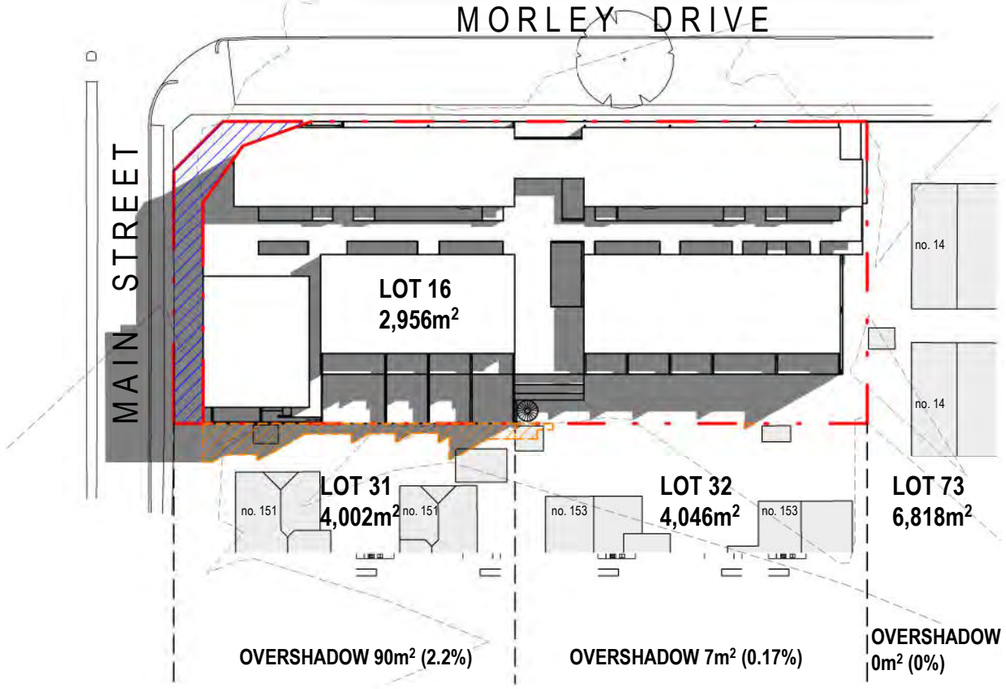

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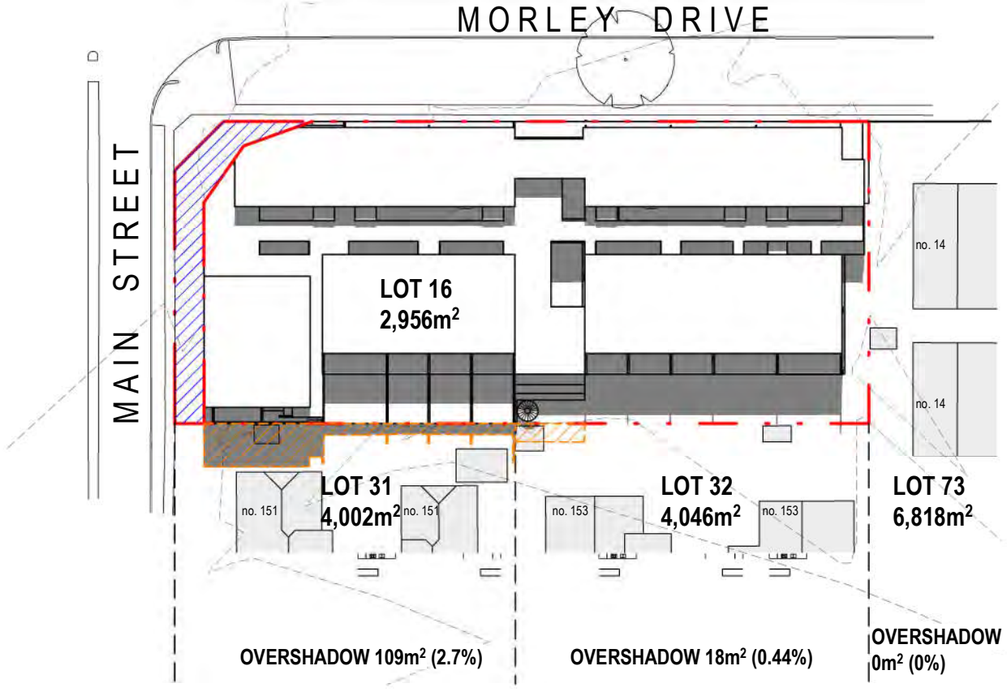

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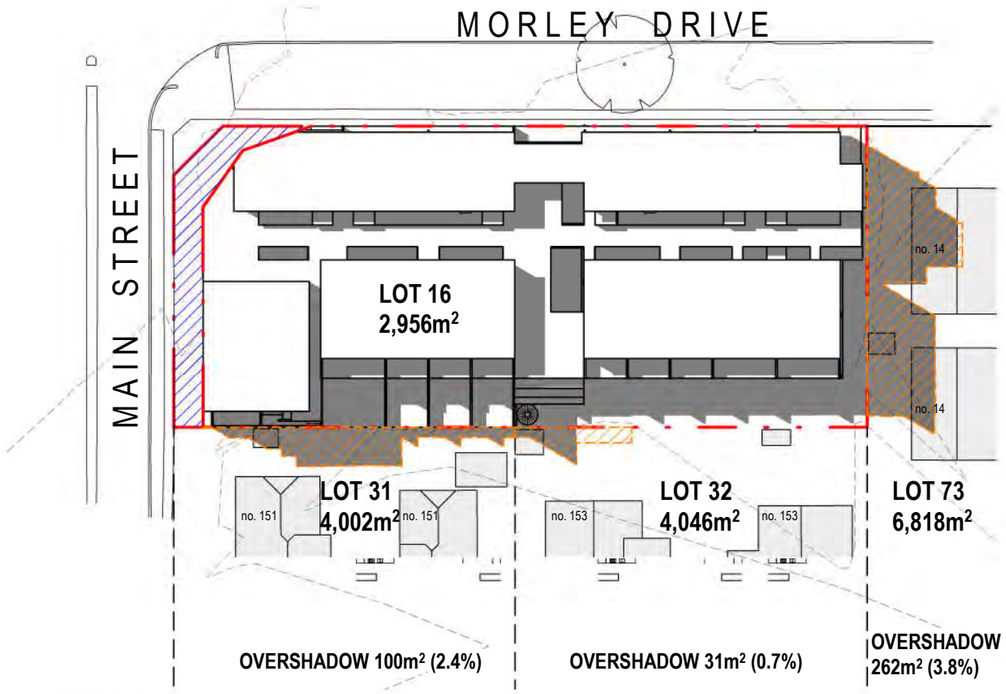

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project	10 MORLEY DRIVE, TUART HILL
drawing	SHADOW DIAGRAM 04 - OCT 22
project no	200611
issue	
drawing no.	**DA4003**

16/02/2021 5:32:30 PM

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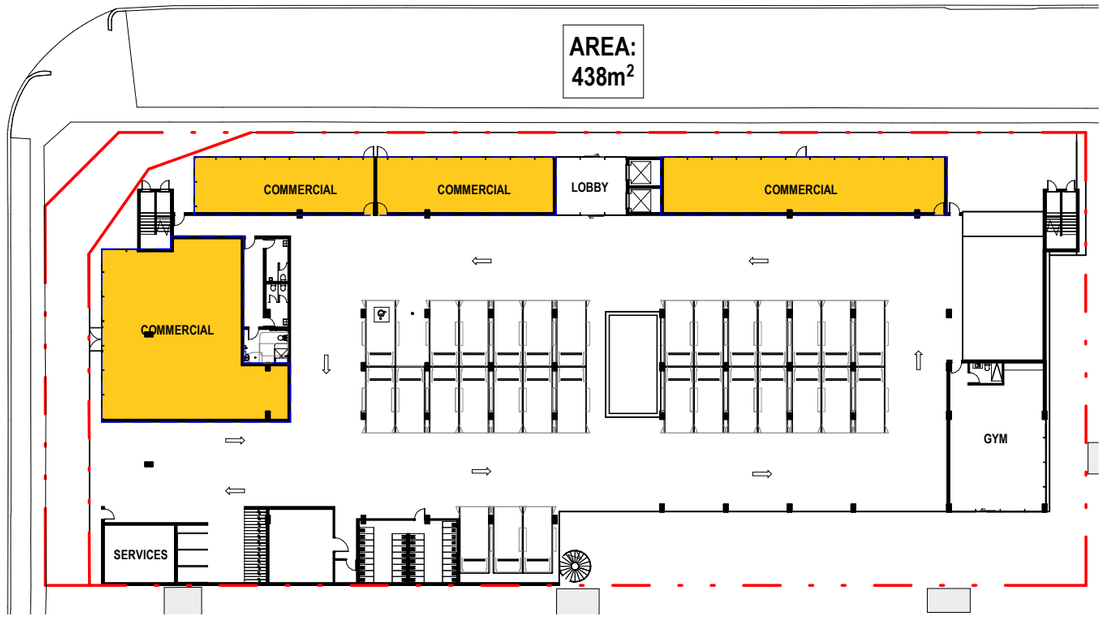
0m²

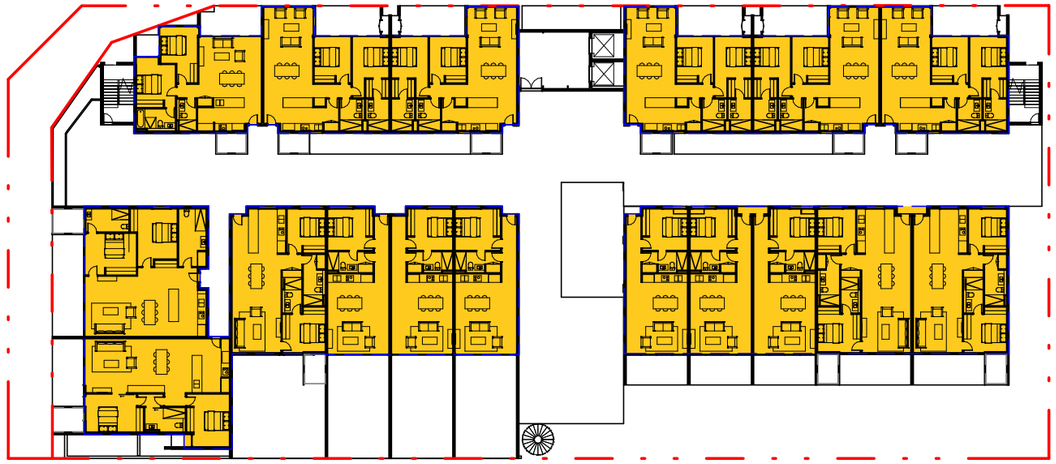
1 PLOT RATIO AREA - BASEMENT PLAN
SCALE: 1 : 500

AREA:
438m²



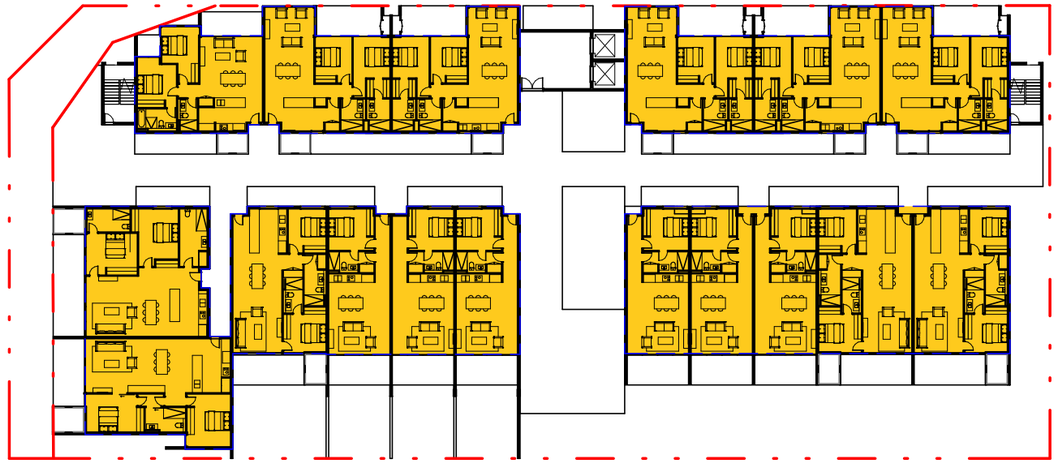
2 PLOT RATIO AREA - GROUND FLOOR
SCALE: 1 : 500

AREA:
1,408m²



3 PLOT RATIO AREA - L01
SCALE: 1 : 500

AREA:
1,408m²



4 PLOT RATIO AREA - L02
SCALE: 1 : 500

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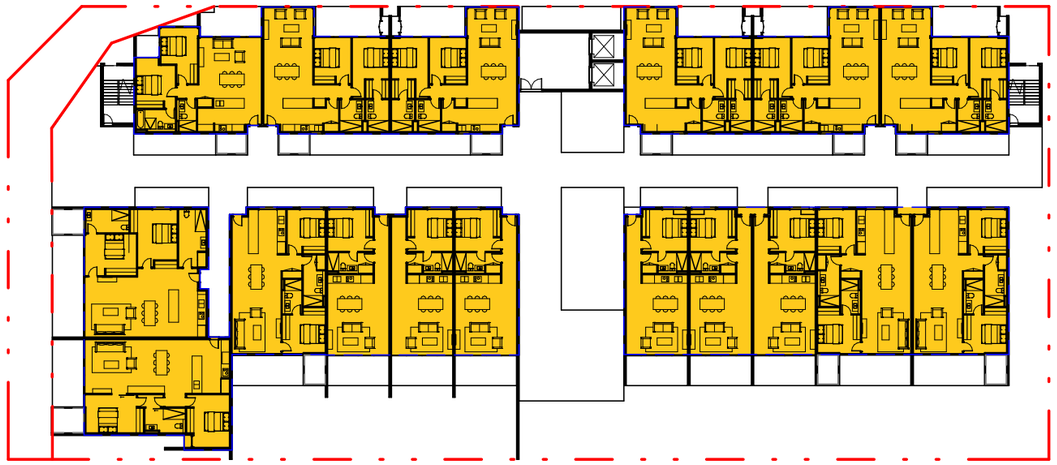
scale	1 : 500@A3

project	10 MORLEY DRIVE, TUART HILL
drawing	PLOT RATIO AREA 01
project no	200611
issue	
drawing no.	**DA4010**

16/02/2021 5:32:42 PM

AREA:
1,408m²



1 PLOT RATIO AREA - L03
SCALE: 1 : 500

AREA:
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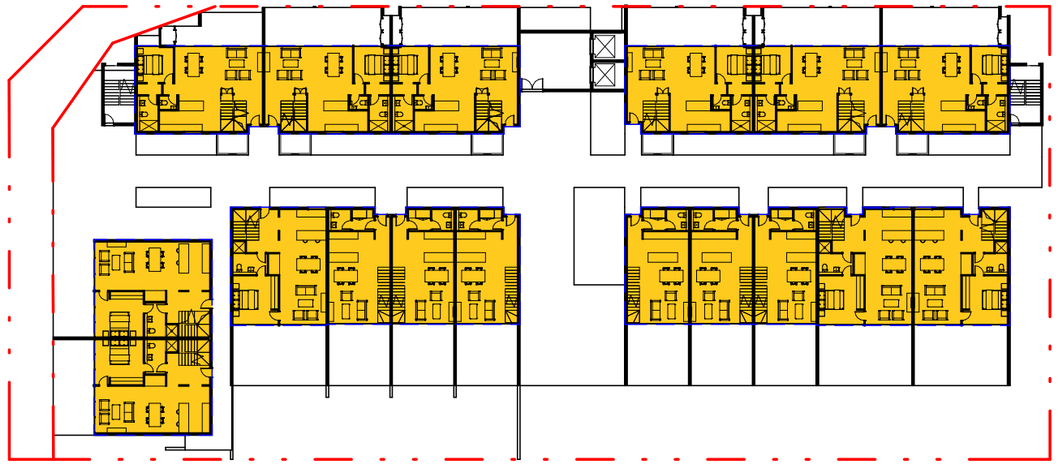
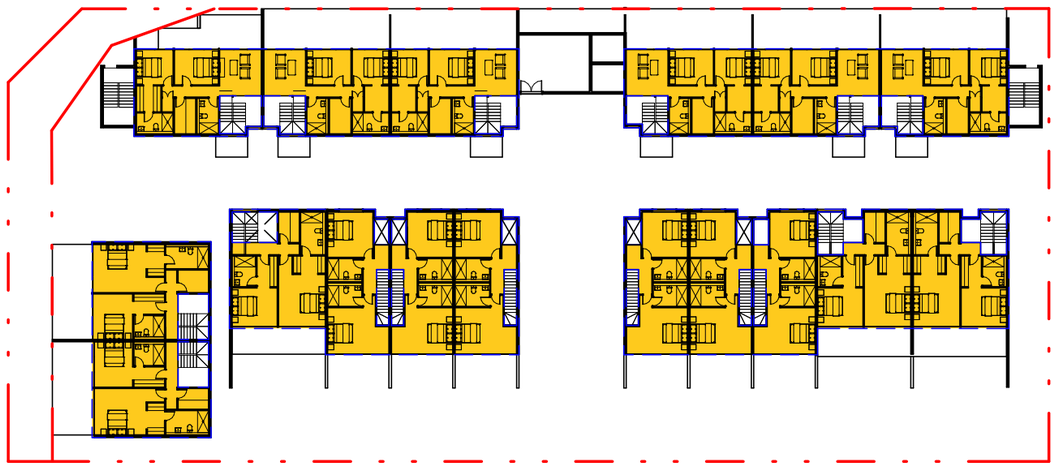


2 PLOT RATIO AREA - L04
SCALE: 1 : 500

AREA:
1,044m²



3 PLOT RATIO AREA - L05
SCALE: 1 : 500

PLOT RATIO

SITE AREA	**2,956m²**

FLOOR:	**AREA:**
BASEMENT	0m²
GROUND	438m²
L01	1,408m²
L02	1,408m²
L03	1,408m²
L04	1,122m²
L05	1,044m²
TOTAL:	**6,828m²**

6,828m² (TOTAL m²) ÷
2,956m² (SITE m²) =

2.30:1 (PLOT RATIO)

Plot Ratio Area: the gross total area of all floors of buildings on a development site, including the area of any internal and external walls but not including:

* The areas of any lift shafts.

* Stairs or stair landings common to two or more dwellings.

* Machinery, air conditioning and equipment rooms.

* Space that is wholly below natural ground level.

* Areas used exclusively for the parking of wheeled vehicles at or below natural ground level;

* Storerooms.

* Lobbies, bin storage areas, passageways to bin storage areas or amenities areas common to more than one dwelling.

* Balconies, eaves, verandahs, courtyards and roof terraces.

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checked	AS
drawn	FMK
scale	As indicated@A3

project	10 MORLEY DRIVE, TUART HILL
drawing	PLOT RATIO AREA 02
project no	200611
issue	
drawing no.	**DA4011**

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Appendix B

Terminology

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

This is relatively common in most noise sources.

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

a variation in the emission of noise that —

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

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

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

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

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

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

Influencing Factor (IF)

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

where:

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

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

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

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

+ Traffic Factor (maximum of 6 dB)

= 2 for each secondary road within 100m

= 2 for each major road within 450m

= 6 for each major road within 100m

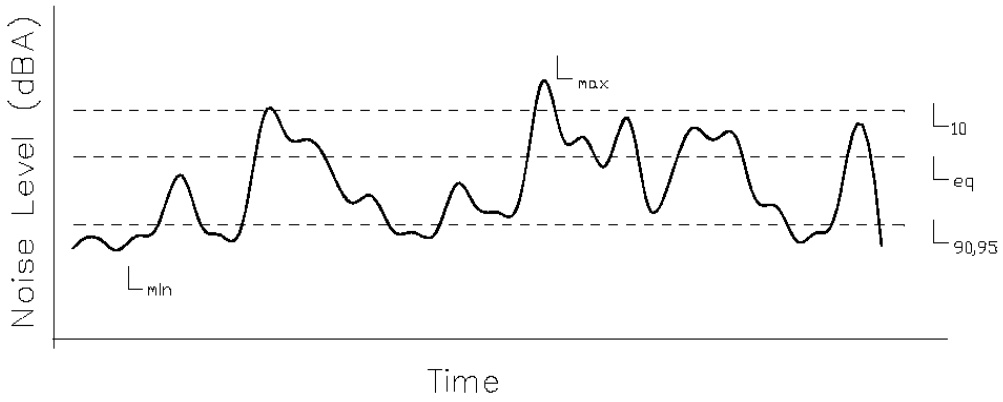
Representative Assessment Period
Means a period of time not less than 15 minutes, and not exceeding four hours, determined by an inspector or authorised person to be appropriate for the assessment of a noise emission, having regard to the type and nature of the noise emission.

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

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

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

Chart of Noise Level Descriptors



Typical Noise Levels