Proposed Development
27 - 61 Nikko Road, Warnervale

Rail Noise and Vibration Assessment

Prepared for

The WealthMart Group

Global Acoustics

Noise and Vibration Analysis and Solutions

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Rail Noise and Vibration Assessment

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Prepared for

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Global Acoustics Pty Ltd ~ Environmental noise modelling and impact assessment ~ Sound power testing ~ Noise control advice ~ Noise and vibration monitoring ~ OHS noise monitoring and advice ~ Expert evidence in Land and Environment and Compensation Courts ~ Architectural acoustics ~ Blasting assessments and monitoring ~ Noise management plans (NMP) ~ Sound level meter and noise logger sales and hire

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1 INTRODUCTION

1.1 Background

Global Acoustics was engaged by the WealthMart Group (the client) to undertake an assessment of potential rail noise and vibration impacts for a proposed residential development at Warnervale.

The proposed development at Lot 1 DP 349727, 27 – 61 Railway Road, Warnervale is for the construction of 70 dwellings which will be a combination of townhouses and villas.

The site is located on the eastern side of the Main Northern Railway line and is bounded by the existing Nikko and Kanowna Roads, Warnervale. Access to the development will be via Nikko Road, which is a non-through local road that separates the proposed development from the rail corridor, or via Kanowna Road which comes off Nikko Road. Rail noise and vibration impacts from the rail corridor have been considered in this assessment. Additionally, the impact of traffic generated by the development has been assessed for existing residents on Nikko Road. Figure 1 shows the locality and the site's proximity to the railway corridor.

Results in this report are based on plans and other information supplied by the WealthMart Group. The site plan for the proposed development is shown in Figure 2. Additional plans showing detailed layouts of the proposed dwellings are shown in Appendix B.

Rail noise and vibration monitoring was previously carried out on 13 February 2015 for a separate and nearby development assessment, and is considered suitable for the current development assessment. Rail noise and vibration monitoring was conducted at one location as described in Table 1.1 and Figure 1.

Table 1.1: MONITORING LOCATION

Descriptor	Monitoring Location
A1	6m setback at Proposed Allotment No. 17, 31 - 41 Railway Road, Warnervale

Figure 1: Locality plan showing approximate subject area in green shading, the vibration monitoring location with a yellow star and the receptor used for the road traffic assessment with a blue star (base sourced from Google Maps)

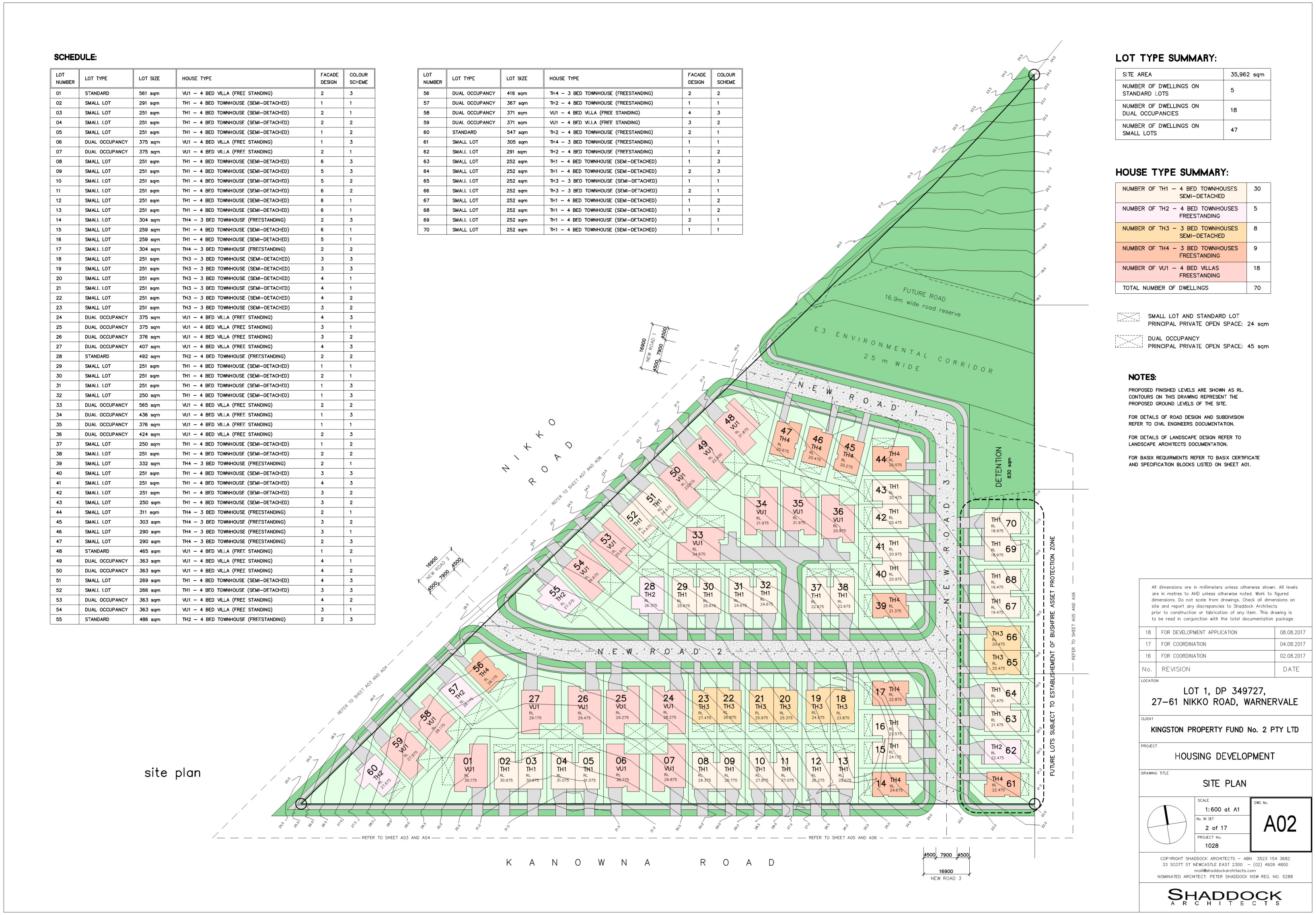


Figure 2: Proposed Layout of the Development (supplied by the client)

1.2 Terminology

Some definitions of terminology, which may be used in this report, are provided in Table 1.2.

Table 1.2: TERMINOLOGY & ABBREVIATIONS

Descriptor	Definition
L_A	The A-weighted root mean squared (RMS) noise level at any instant
L_{A10}	The noise level which is exceeded for 10 percent of the time, which is approximately the average of the maximum noise levels
L_{A90}	The level exceeded for 90 percent of the time, which is approximately the average of the minimum noise levels. The L_{A90} level is often referred to as the "background" noise level and is commonly used to determine noise criteria for assessment purposes.
L_{Aeq}	The average noise energy during a measurement period
L_{pk}	The unweighted peak noise level at any instant
dB(A)	Noise level measurement units are decibels (dB). The "A" weighting scale is used to describe human response to noise.
SPL	Sound pressure level (SPL), fluctuations in pressure measured as 10 times a logarithmic scale, the reference pressure being 20 micropascals
SEL	Sound exposure level (SEL), the A-weighted noise energy during a measurement period normalised to one second
Hertz (Hz)	Cycles per second, the frequency of fluctuations in pressure, sound is usually a combination of many frequencies together.
R_W	A single number quantity, which characterises the airborne sound insulation of a material or building element in the laboratory.
$R_{W'}$	Apparent weighted sound insulation rating, the sound insulation rating of a given building element when subjected to testing under actual site conditions.
C_{tr}	An adjustment to the RW scale that could be used for selecting a product to reduce noise from urban road traffic and other noises with large component of low frequencies.
VDV	Vibration dose level, the fourth root of the integral over the period of exposure of the fourth power of the acceleration after it has been frequency weighted

2 CRITERIA

2.1 Rail Noise Criteria

Relevant rail noise criteria for residential developments are outlined in Section 3.6 of the Department of Planning and Environment (DP&E) document "*Development Near Rail Corridors and Busy Roads – Interim Guideline*" (2008) (DNRCBR) and based on Clause 87 of the State Environment Planning Policy (Infrastructure) 2007 (the 'Infrastructure SEPP'). L_{Aeq} rail noise criteria applicable within dwellings with windows and doors closed are shown in Table 2.1.

Table 2.1: DWELLING INTERNAL L_{Aeq} NOISE LEVEL CRITERIA (WINDOWS & DOORS CLOSED)

Location	Applicable time period
In any bedroom of the building	35 dB(A) between 10.00 pm and 7.00 am
Anywhere else in the building (other than the garage, kitchen, bathroom or hallway)	40 dB(A) at any time

Section 3.6 of the DNRCBR states, if "*…internal noise levels with windows or doors open exceed the criteria by more than 10 dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia…*" and Australian Standard AS1668 – The use of ventilation and air-conditioning in buildings.

2.2 Rail Vibration Criteria

Relevant rail vibration criteria are contained within the Department of Environment and Conservation (DEC) document 'Assessing Vibration: A Technical Guideline" (2006). The DEC vibration guideline is based on British Standard BS 6472 "Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)", and presents maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. The DEC recommend that "the criteria presented are non-mandatory: they are goals that should be sought to be achieved through the application of all feasible and reasonable mitigation measures".

Rail vibration is classed as "intermittent vibration", that is, sources that operate intermittently, but which would produce continuous vibration if operated continuously. The technical guide indicates that this type of vibration should be assessed using vibration dose values (VDVs). The VDV method is a useful means of calculation of vibration dose where vibration conditions are regularly repeated throughout the day, as in the case of train movements. VDV accumulates the vibration energy received over the day and night periods. The VDV is calculated as the fourth root of the integral with respect to time of the fourth power of the acceleration after it has been frequency weighted. The use of the fourth power method makes the VDV more sensitive to peaks in the acceleration waveform.

Table 2.2 indicates preferred and maximum allowable vibration criteria. Adverse comments or complaints may be expected if vibration values approach the maximum values.

Table 2.2: ACCEPTABLE VIBRATION DOSE VALUES FOR INTERMITTENT VIBRATION ($m/s^{1.75}$)

Location	Daytime (0700 to 2200)		Night-time (2200 to 0700)	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Source: DECCW (February 2006) "Assessing Vibration: A Technical Guideline" Table 2.4

Note:

1. *Critical areas include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas.*

2.3 Road Traffic Noise Criteria

In 2011 the EPA, then known as the Department of Environment, Climate Change and Water NSW, released the Road Noise Policy (RNP). Criteria outlined in the RNP are applicable to this project and apply different noise limits dependent upon the development category and receptor type. Table 2.3 shows applicable criteria for the proposal.

Table 2.3: ROAD TRAFFIC NOISE ASSESSMENT CRITERIA FOR RESIDENTIAL LAND USES

Road Category	Type of project/land use	Assessment Criteria dB(A)	
		Day	Night
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	L_{Aeq}, (1 hour) 55 (external)	L_{Aeq}, (1 hour) 50 (external)

3 METHODOLOGY

3.1 General Assessment Methodology

Measured sound exposure levels (SEL) from a number of train pass-bys were combined with train movement information to determine $L_{Aeq,15hour}$ and $L_{Aeq,9hour}$ results (for day and night periods respectively) at the monitoring location. Acoustic modelling for rail corridor noise sources was undertaken using CadnaA, noise prediction software developed by DataKustic. The acoustic model was calibrated using noise levels from attended monitoring along the rail corridor. There are currently plans for construction of 70 dwellings in the proposed development (see Figure 2 and Appendix B for details). Acoustic modelling allowed for the prediction of external noise levels from rail noise sources at the nearest facades to the rail line. Calculations were then performed to determine internal room noise levels for a receptor in the centre of the room.

The DNRCBR outlines an acoustic assessment Zone A for buildings within 40m of an operational track where passenger and freight services travel at speeds greater than 80km/h. Within Zone A, a full noise assessment should be completed. With reference to Figure 1, the proposed dwellings with frontage to Nikko Road are approximately greater than 40m but less than 50m from the Main Northern Railway line. To be conservative, these dwellings will be considered to reside within Zone A for noise assessment purposes and the proposed facades were assessed. Additional calculations to asses the facades of residences further from Nikko Road were made to enable general recommendations.

Sound transmission loss calculations for specific facades was carried out using Marshall Day Acoustics' Insul program, version 8.0. Rw data was based on standard construction categories outlined in the DNRCBR.

The minimum acoustic performance for various building elements for each Construction Category outlined in the DNRCBR, is shown in Figure 3.

Category of Noise Control Treatment	R_w of Building Elements (minimum assumed)				
	Windows/Sliding Doors	Frontage Facade	Roof	Entry Door	Floor
Category 1	24	38	40	28	29
Category 2	27	45	43	30	29
Category 3	32	52	48	33	50
Category 4	35	55	52	33	50
Category 5	43	55	55	40	50

Figure 3: Minimum assumed Rw values of various building elements as specified in the DNRCBR

For residences in Zone B, the DNRCBR suggests that standard mitigation measures consistent with Road Noise Control Treatment Category 2 (See DNRCBR Appendix C) will normally provide adequate mitigation to reduce noise levels to those required.

3.2 Model Assumptions and Methodology

Rail noise levels were predicted to building facades for the first row of proposed dwellings with frontages to Nikko Road, as well as some proposed dwellings behind these residences. As the site plans with the precise location were not available for digital input into the model, buildings were located in the model as accurately as possible with reference to other supplied plans. Single level villas were placed in the model as predominantly square shaped buildings 3.2 metres high and townhouses were included as predominantly square shaped buildings with a height of 5.9 metres. These heights represent the solid part of the building to the eaves level. Roof elements above that level were not included, to be conservative in terms of their barrier effect on dwellings behind.

Details of the proposed building elements were supplied by the client and are shown in Appendix B.

The front row of dwellings facing Nikko Road (and the railway line) are proposed to be a mix of single level villas and two storey townhouses of four different types, with further options available within those types. To simplify the presentation of results, model predictions to the facades have been presented in terms of ground floor or first floor results. As final individual floor plans are unavailable, all building element recommendations are made based on the conservative assumption that a bedroom will be located facing the rail corridor, as this is detailed in the supplied plans and may be possible for all proposed dwellings. If the bedroom criteria is met, the living area criterion will also be achieved.

Topographic contours for the subject site were provided by the client. Regional topography covering the rail corridor and surrounding area was sourced from NSW Government sources via the Six Maps website.

All results presented in this report were calculated under neutral meteorological conditions.

Receptors were modelled at a height of 1.5 m.

Boundary fences were included as barriers in the model. The client advised that the fences would be lapped and capped timber fences to a height of 1.8 m. Side fences between dwellings were modelled as being present for approximately the rear 50% of the side boundaries of each block and across the full length of the back of blocks. These fences have been assumed to provide a continuous barrier from ground level to a height of 1.8 m.

3.3 Attended Noise and Vibration Monitoring

Because rail noise is an intermittent source at the site and is not part of the background noise, attended monitoring was preferred to determine rail noise impact. Attended noise monitoring was conducted at the representative location on 13 February 2015 to determine noise and vibration levels from rail pass-bys. Measurements were made at one monitoring location (A1)and it's approximate location is shown in Figure 1. As location A1 is closer to the rail corridor than any of the dwelling in the proposed development, vibration levels measured at this location can be assumed to be a worst case result, with actual results expected to be lower given the added distance from the source. The section of railway line adjacent to both developments is a straight section of track with less than 2% grade.

Windows are generally the weakest paths in a building façade so noise level measurements were made at at a height of 1.5m above ground level to represent ground floor windows. SEL (Sound Exposure Level) and VDV (Vibration Dose Value) data was obtained from measurements of train passbys. These noise and vibration measurements were combined with track volume information to determine the impacts from the rail corridor during each period.

3.4 Monitoring Equipment

The equipment used to measure noise is detailed in Table 3.1. Calibration certificates current at the time of monitoring are provided in Appendix A.

Table 3.1: ATTENDED MONITORING EQUIPMENT

Model	Serial Number	Calibration Due Date
SVAN 958 noise and vibration analyser	20880	25/03/2015
Rion NC-74 acoustic calibrator	50941314	18/11/2017

3.5 Rail Volume Information

Rail volume information was sourced from Sydney trains timetables and the Central Coast Regional Transport Plan (CCRTP), December 2013 which indicates there are approximately 82 passenger train movements past the site per day. Section a, iii of Appendix D of the DNRCBR outlines the 'consideration of future railway proposals'. The CCRTP outlines an upgrade to the Northern Sydney Freight Corridor, a project which is currently under way, that when completed will increase the freight carrying capacity for the corridor between Newcastle and Sydney from 29 to 44 freight trains per day. The project comprises four key components: Gosford Passing Loops, North Strathfield Rail Underpass, Epping to Thornleigh Third Track and the Hexham Passing Loop. Of these four components, only the Epping to Thornleigh Third Track is yet to be finished, with completion expected mid 2016. Given the likely time frame within which the proposed Nikko Road residential development could be completed, the upgraded freight carrying capacity has been used (44 freight trains per day) in conjunction with current passenger train numbers to determine worst case rail noise and vibration impacts.

3.6 Road Traffic Scenario

In order to assess the impact of increased traffic volumes on the existing residents on Nikko Road a model was created to predict noise levels at the closest facade of varying numbers of vehicle passbys. The vehicle numbers represent assumed peak hourly flows of traffic from the proposed development along Nikko Road past existing residences. A peak flow of 70 was chosen to represent a vehicle from every dwelling travelling on Nikko Road during a morning peak hour. A peak flow of 100 vehicles was also modelled, but is considered to be an unlikely occurrence.

One receptor, the nearest to Nikko Road, was selected for modelling purposes. All other receptors are further from the road and would be expected to receive lower noise levels. Vehicles were assumed to be travelling at the speed limit of 50 km/hr.

4 RESULTS

4.1 Attended Rail Noise Levels

Table 4.1 provides a summary of attended rail noise measurements at A1. Train pass-by noise measurements were made to determine a worst-case impact on the site. The monitoring location is shown in Figure 1.

Table 4.1: MEASURED NOISE LEVELS AT A1, dB

Date	Period	Rail Passby Noise Levels (dB)	
		SEL	L_{Amax}
13/02/2015 10:19	Passenger	78	71
13/02/2015 10:30	Freight	89	78
13/02/2015 10:38	Passenger	68	61
13/02/2015 10:50	Passenger	72	66
13/02/2015 11:05	Passenger	79	74
13/02/2015 11:17	Passenger	81	76
13/02/2015 11:17	Passenger	79	71
13/02/2015 11:29	Freight	87	77
13/02/2015 11:37	Passenger	72	63
13/02/2015 11:39	Freight	94	85
13/02/2015 11:57	Passenger	73	66

The logarithmic average of SEL measurements was compared with current rail corridor capacity information to determine $L_{Aeq,period}$ noise impact. Rail noise impacts based on the CCRTP upgraded rail corridor capacity at the monitoring location (A1) are outlined in Table 4.2.

Table 4.2: CALCULATED $L_{Aeq,period}$ NOISE IMPACT AT A1, dB

Freight Movements	Passenger Movements	Day $L_{Aeq,15hour}$ [1]	Night $L_{Aeq,8hour}$ [1]
44	82	59	58

Notes:

1. *Freight and passenger train movements have been used in calculations, however results are driven primarily by freight train movements.*

4.2 Attended Rail Vibration Levels

Table 4.3 shows measured VDV levels adjusted for period.

Table 4.3: MEASURED VDV AGAINST CRITERION AT A1 ($m/s^{1.75}$)

Freight Movements	Passenger Movements	VDV Criterion[1]	VDV Day	VDV Night
44	82	0.2	0.09	0.07

Notes:

1. *British Standard BS 6472 "Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)".*

There were no exceedances of the rail vibration criterion at A1, hence no exceedance of the criterion is expected at any of the proposed dwellings in the development.

5 NOISE ASSESSMENT

5.1 Predicted Noise Levels

Rail noise levels were predicted to the facades of the proposed dwellings with frontage to Nikko Road. Table 5.1 shows modelled results at the facades of those proposed dwellings.

Table 5.1: RAIL NOISE PREDICTIONS AT THE FACADE OF NIKKO ROAD DWELLINGS, $L_{Aeq,period}$ RESULTS

Dwelling type	Predicted Level $L_{Aeq,9h}$ (Night)	Estimated Internal level with windows open $L_{Aeq,9h}$ (Night)[1]	DNRCBR Criteria $L_{Aeq,9h}$ (Night)	Exceedance[2]
Villa, ground floor	56	46	35	**11**
Townhouse, ground floor	56	46	35	**11**
Townhouse, first floor	57	47	35	**12**

Notes:

1. *Assumes a standard facade loss of 10 dB with windows open; and*
2. *Bold red font indicates exceedance of relevant criterion.*

Results in Table 5.1 confirm that for dwellings on Nikko Road, internal noise levels cannot be achieved with windows open, assuming a standard facade loss, therefore mechanical ventilation will be required. These residences include dwellings 48 through to 60.

Additional calculations on dwellings further back from Nikko Road indicated that this was also the case for most windows facing the rail corridor so mechanical ventilation is recommended for all proposed dwellings. As the location of proposed dwellings in the model was approximated, specific results for dwellings further back have not been provided, as shielding effects may vary slightly from those predicted by the model.

Table 5.2 shows internal noise predictions using Insul software based on materials specified in drawings from the client for dwellings on Nikko Road. The modelling assumed Category 2 construction as specified in the DNRCBR for the front and side facades of dwellings on Nikko Road and additionally, laminated glass for a large window option for townhouse 4.

Table 5.2: INTERNAL NOISE PREDICTIONS OF NIKKO ROAD DWELLINGS, $L_{Aeq,period}$ RESULTS

Dwelling type	Predicted Internal $L_{Aeq,9h}$ (Night)[1]	DNRCBR Criteria $L_{Aeq,9h}$ (Night)	Exceedance[3]
Villa, ground floor	<35	35	Nil
Townhouse, ground floor	<35	35	Nil
Townhouse, first floor, small window	<35	35	Nil
Townhouse, first floor, large window (TH4 bed 3)[2]	<35	35	Nil

Notes:

1. *Model results assume Category 2 construction for the front and side facades of these dwelling types;*
2. *This result assumes Category 2 construction and 6mm laminated glass for Window 6.1; and*
3. *Bold red font indicates exceedance of relevant criterion.*

Proposed dwellings in Zone B (further back than Nikko Road frontages but within 80 m of the railway line) have not been assessed individually, however the facades of townhouse 47 were assessed as a worst case result for this group of dwellings. These dwellings include dwellings 1 to 5, 25 to 30, 33 to 35 and 45 – 47. Table 5.3 shows the predicted internal levels for townhouse 47 assuming Category 2 building materials are used for the front and railway side of the dwelling. Results assume the provision for adequate ventilation to all sleeping areas to allow doors and windows to remain closed.

Table 5.3: INTERNAL NOISE PREDICTIONS OF TOWNHOUSE 47, $L_{Aeq,period}$ RESULTS

Dwelling type	Predicted Internal $L_{Aeq,9h}$ (Night)[1]	DNRCBR Criteria $L_{Aeq,9h}$ (Night)	Exceedance[3]
Townhouse 47, ground floor	<35	35	Nil
Townhouse 47, first floor, small window	<35	35	Nil
Townhouse 47, first floor, large window (TH4 bed 3)[2]	<35	35	Nil

Notes:

1. *Model results assume Category 2 construction for the front and side facades of these dwelling types; and*
2. *Bold red font indicates exceedance of relevant criterion.*

The remaining proposed dwellings beyond Zone B have not been assessed individually, however, additional calculations indicate that the use of Category 1 standard building materials and the provision for adequate ventilation to all sleeping areas to allow doors and windows to remain closed would be more than adequate to meet internal noise level requirements outlined in the DNRCBR.

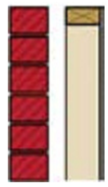
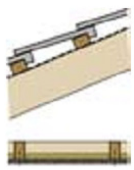
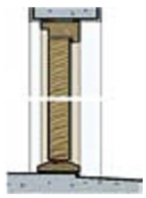
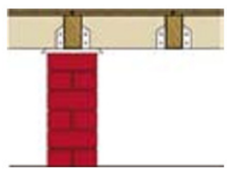
Category No.	Building Element	Standard Constructions	sample
1	**Windows/Sliding Doors**	Openable with minimum 4mm monolithic glass and standard weather seals	
	Frontage Facade	**Timber Frame or Cladding:** 6mm fibre cement sheeting or weatherboards or plank cladding externally, 90mm deep timber stud or 92mm metal stud, 13mm standard plasterboard internally	
		Brick Veneer: 110mm brick, 90mm timber stud or 92mm metal stud, minimum 50mm clearance between masonry and stud frame, 10mm standard plasterboard internally	
		Double Brick Cavity: 2 leaves of 110mm brickwork separated by 50mm gap	
	Roof	Pitched concrete or terracotta tile or metal sheet roof with sarking, 10mm plasterboard ceiling fixed to ceiling joists, R1.5 insulation batts in roof cavity.	
	Entry Door	35mm solid core timber door fitted with full perimeter acoustic seals	
	Floor	1 layer of 19mm structural floor boards, timber joist on piers	
		Concrete slab floor on ground	

Figure 4: Category 1 Construction Standards as specified in the DNRCBR

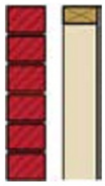
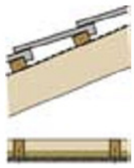
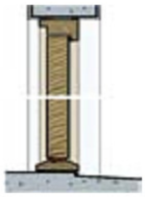
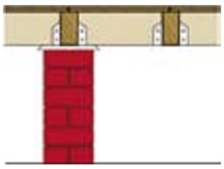
Category No.	Building Element	Standard Constructions	sample
2	**Windows/Sliding Doors**	Openable with minimum 6mm monolithic glass and full perimeter acoustic seals	
	Frontage Facade	**Timber Frame or Cladding Construction:** 6mm fibre cement sheeting or weatherboards or plank cladding externally, 90mm deep timber stud or 92mm metal stud, 13mm standard plasterboard internally with R2 insulation in wall cavity.	
		Brick Veneer Construction: 110mm brick, 90mm timber stud frame or 92mm metal stud, minimum 50mm clearance between masonry and stud frame, 10mm standard plasterboard internally.	
		Double Brick Cavity Construction: 2 leaves of 110mm brickwork separated by 50mm gap	
	Roof	Pitched concrete or terracotta tile or metal sheet roof with sarking, 10mm plasterboard ceiling fixed to ceiling joists, R2 insulation batts in roof cavity.	
	Entry Door	40mm solid core timber door fitted with full perimeter acoustic seals	
	Floor	1 layer of 19mm structural floor boards, timber joist on piers	
		Concrete slab floor on ground	

Figure 5: Category 2 Construction Standards as specified in the DNRCBR

5.2 Road Traffic Noise Assessment

One receptor, the nearest to Nikko Road as shown in Figure 1, was selected for modelling purposes. All other receptors are further from the road and would be expected to receive lower noise levels. Predicted road traffic noise levels are shown in Table 5.4.

Table 5.4: ROAD TRAFFIC ASSESSMENT RESULTS

Location	Vehicles per hour	Result at Facade L_{Aeq} (dB)	Day criteria L_{Aeq} (dB)	Exceedance Day L_{Aeq} (dB)
No 17 Nikko Rd	70	53	55	Nil
No 17 Nikko Rd	100	55	55	Nil

Notes: All vehicles modelled were light vehicles travelling at 50 km/hr.

No exceedances of the road traffic criteria are predicted.

6 CONCLUSION AND RECOMMENDATIONS

Rail noise and vibration impacts have been determined for a proposed development at 27 - 61 Nikko Road, Warnervale. Additionally, the impact of traffic generated by the development has been assessed for existing residents on Nikko Road. The results show that:

- Vibration levels from the rail corridor are predicted to be below the recommended maximum levels outlined in BS6472 at the closest dwellings, compliance is thus expected at all other dwellings;

- Modelling results indicate that internal noise levels will meet the DNRCBR night time criteria at Nikko Road dwellings if Category 2 construction standards, as specified in the DNRCBR, are adopted for front and side facades with the exception of a large window (window schedule 6.1) proposed for bedroom 3 upstairs in townhouse type 4 (of facade type 2 and 3). Window 6.1 will be required to be 6mm laminated glass or similar to meet the criteria. Results assume the provision for adequate ventilation to all sleeping areas to allow doors and windows to remain closed. These residences include dwellings 48 through to 60;

- Proposed dwellings in Zone B (further back than Nikko Road frontages but within 80 m of the railway line) have not been assessed individually, however the facades of townhouse 47 were assessed as a worst case result for this group of dwellings. Table 5.3 shows the predicted internal levels for townhouse 47 assuming Category 2 building materials are used for the front and railway sides of these dwellings. Results assume the provision for adequate ventilation to all sleeping areas to allow doors and windows to remain closed. These dwellings include dwellings 1 to 5, 25 to 30, 33 to 35, 45 – 47;

- All remaining dwellings outside Zone B, will likely benefit from substantial shielding from town houses closer to the rail corridor, and have not been individually assessed, but calculations indicate Category 1 construction standards will enable compliance with DNRCBR criteria. Results assume the provision for adequate ventilation to all sleeping areas to allow doors and windows to remain closed; and

- No exceedances of the road traffic noise criteria were predicted.

We trust this report meets your requirements, however, if you have any questions please contact our office.

Global Acoustics Pty Ltd

APPENDIX

A CALIBRATION CERTIFICATES

Acoustic Research Labs Pty Ltd
Level 7 Building 2 423 Pennant Hills Rd
Pennant Hills NSW AUSTRALIA 2120
Ph: +61 2 9484 0800 A.B.N. 65 160 399 119
www.acousticresearch.com.au

Sound Level Meter

IEC 61672-3.2006

Calibration Certificate

Calibration Number C15135

Client Details Global Acoustics Pty Ltd
12/16 Huntingdale Drive
THORNTON NSW 2322

Equipment Tested/ Model Number : Svantek SVAN 958
Instrument Serial Number : 20880
Microphone Serial Number : 2294434
Pre-amplifier Serial Number : 17079

Pre-Test Atmospheric Conditions		Post-Test Atmospheric Conditions	
Ambient Temperature :	21.2°C	**Ambient Temperature :**	23°C
Relative Humidity :	59.8%	**Relative Humidity :**	54.7%
Barometric Pressure :	996.4kPa	**Barometric Pressure :**	99.64kPa

Calibration Technician : Adrian Walker
Calibration Date : 25/03/2015
Secondary Check: Sandra Minto
Report Issue Date : 26/03/2015

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10: Self-generated noise	*Pass*	14: Level linearity on the reference level range	*Pass*
11: Acoustical tests of a frequency weighting	*Pass*	15: Level linearity incl. the level range control	*Pass*
12: Electrical tests of frequency weightings	*Pass*	16: Toneburst response	*Pass*
13: Frequency and time weightings at 1 kHz	*Pass*	17: Peak C sound level	*Pass*
		18: Overload Indication	*Pass*

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed.

However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2002 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002 and because the periodic tests of IEC 61672-3:2006 cover only a limited subset of the specifications in IEC 61672-1:2002.

Least Uncertainties of Measurement -

Acoustic Tests		Environmental Conditions	
31.5 Hz to 8kHz	*±0.120dB*	*Temperature*	*±0.3°C*
12.5kHz	*±0.165dB*	*Relative Humidity*	*±4.1%*
16kHz	*±0.245dB*	*Barometric Pressure*	*±0.1kPa*
Electrical Tests			
31.5 Hz to 20 kHz	*±0.121dB*		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

NATA
WORLD RECOGNISED ACCREDITATION

This calibration certificate is to be read in conjunction with the calibration test report.

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number 14172.
Accredited for compliance with ISO/IEC 17025.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/National standards.

PAGE 1 OF 1

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Pennant Hills NSW AUSTRALIA 2120
Ph: +61 2 9484 0800 A.B.N. 65 160 399 119
www.acousticresearch.com.au

Sound Calibrator

IEC 60942-2004

Calibration Certificate

Calibration Number C15598

Client Details Global Acoustics Pty Ltd
12/16 Huntingdale Drive
THORNTON NSW 2322

Equipment Tested/ Model Number : Rion NC-74
Instrument Serial Number : 50941314

Atmospheric Conditions
Ambient Temperature : 20.9°C
Relative Humidity : 55.4%
Barometric Pressure : 99.32kPa

Calibration Technician : Dennis Kim **Secondary Check:** Sandra Minto
Calibration Date : 18/11/2015 **Report Issue Date :** 18/11/2015

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
5.2.2: Generated Sound Pressure Level	*Pass*	5.3.2: Frequency Generated	*Pass*
5.2.3: Short Term Fluctuation	*Pass*	5.5: Total Distortion	*Pass*

Nominal Level	Nominal Frequency	Measured Level	Measured Frequency
94.0	1000.0	93.9	1002.91

The sound calibrator has been shown to conform to the class 1 requirements for periodic testing, described in Annex B of IEC 60942:2004 for the sound pressure level(s) and frequency(ies) stated, for the environmental conditions under which the tests were performed.

Least Uncertainties of Measurement -

Specific Tests		Environmental Conditions	
Generated SPL	*±0.09dB*	*Temperature*	*±0.3°C*
Short Term Fluct.	*±0.02dB*	*Relative Humidity*	*±4.1%*
Frequency	*±0.01%*	*Barometric Pressure*	*±0.1kPa*
Distortion	*±0.51%*		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

NATA WORLD RECOGNISED ACCREDITATION

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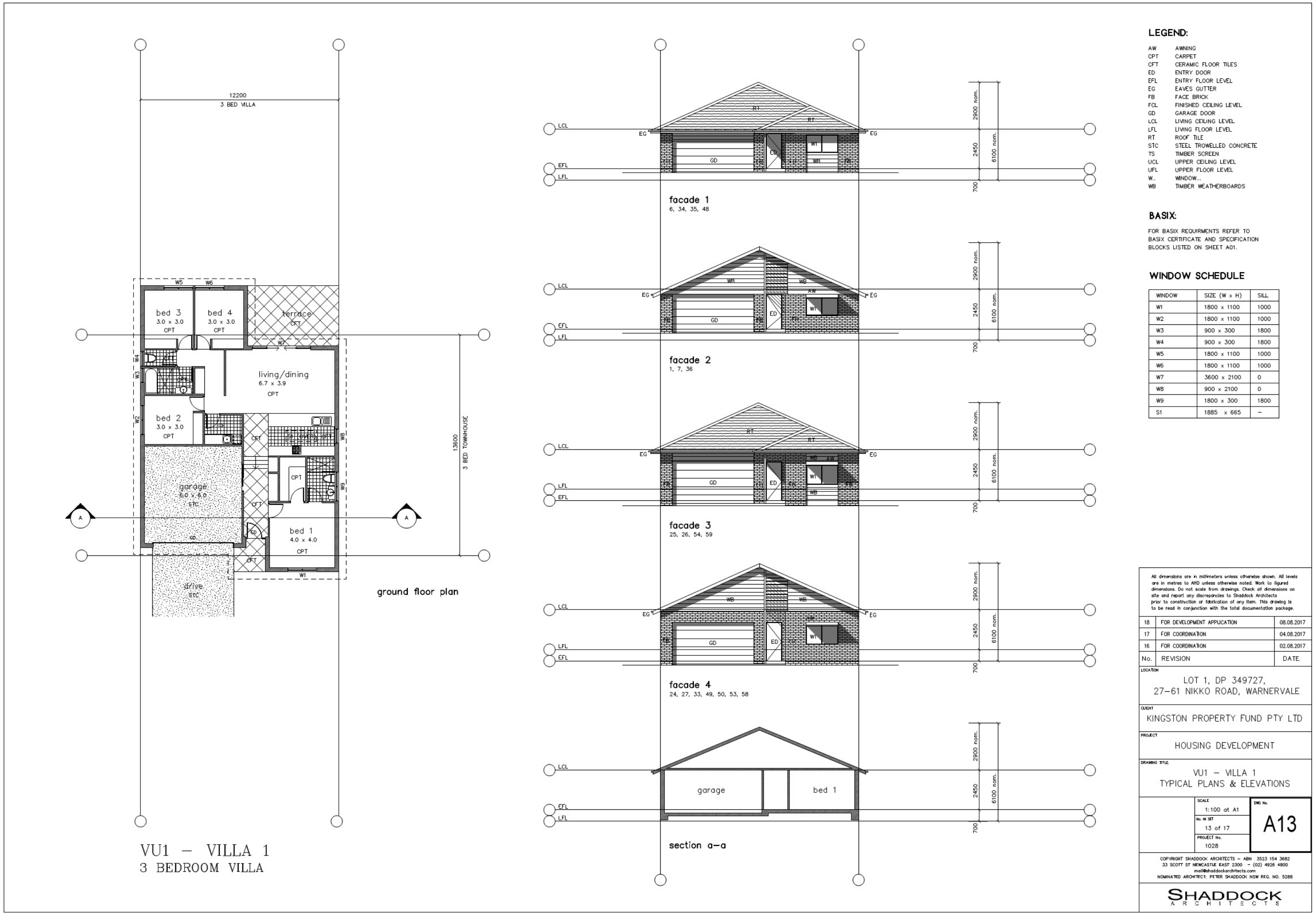
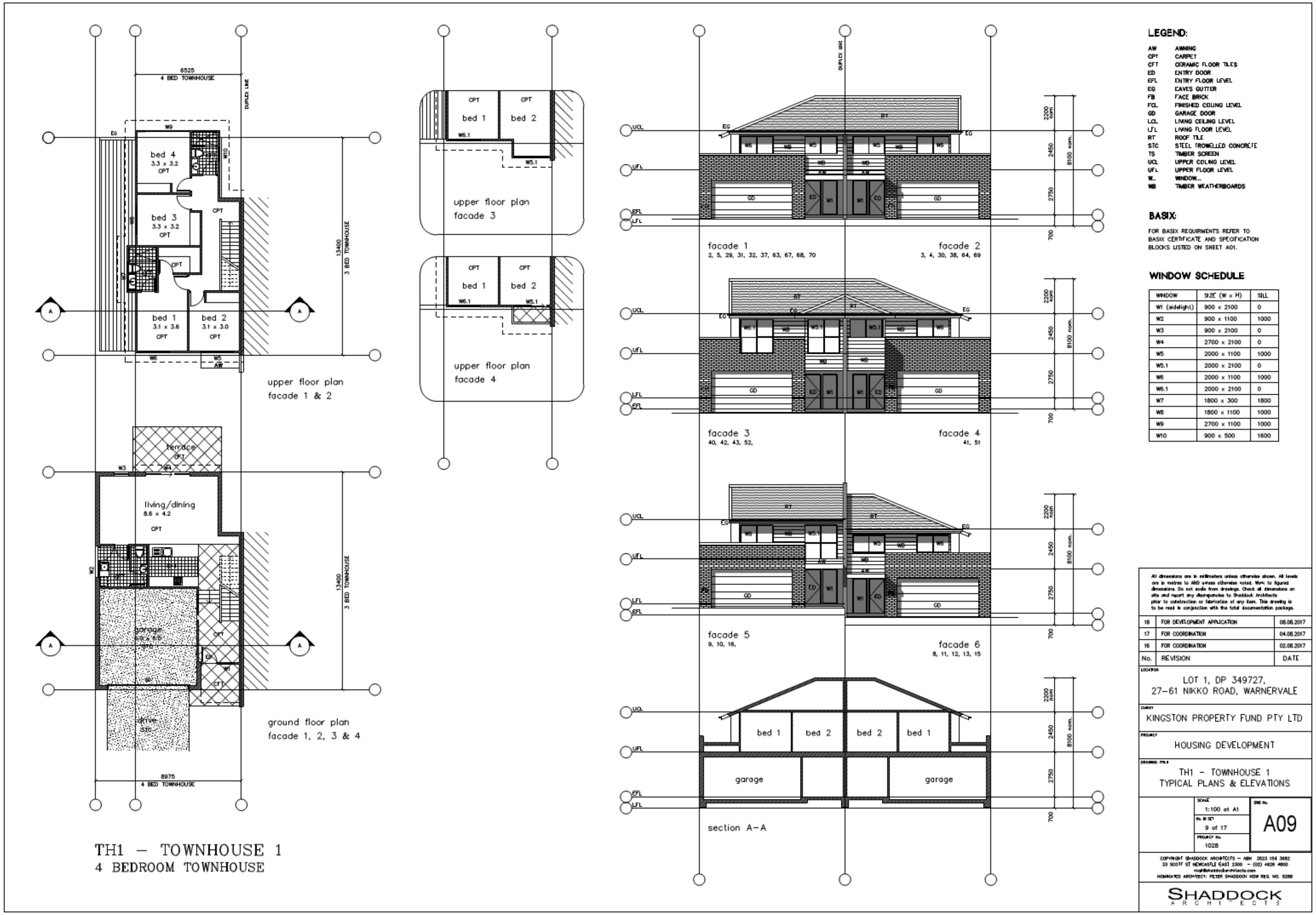
PAGE 1 OF 1

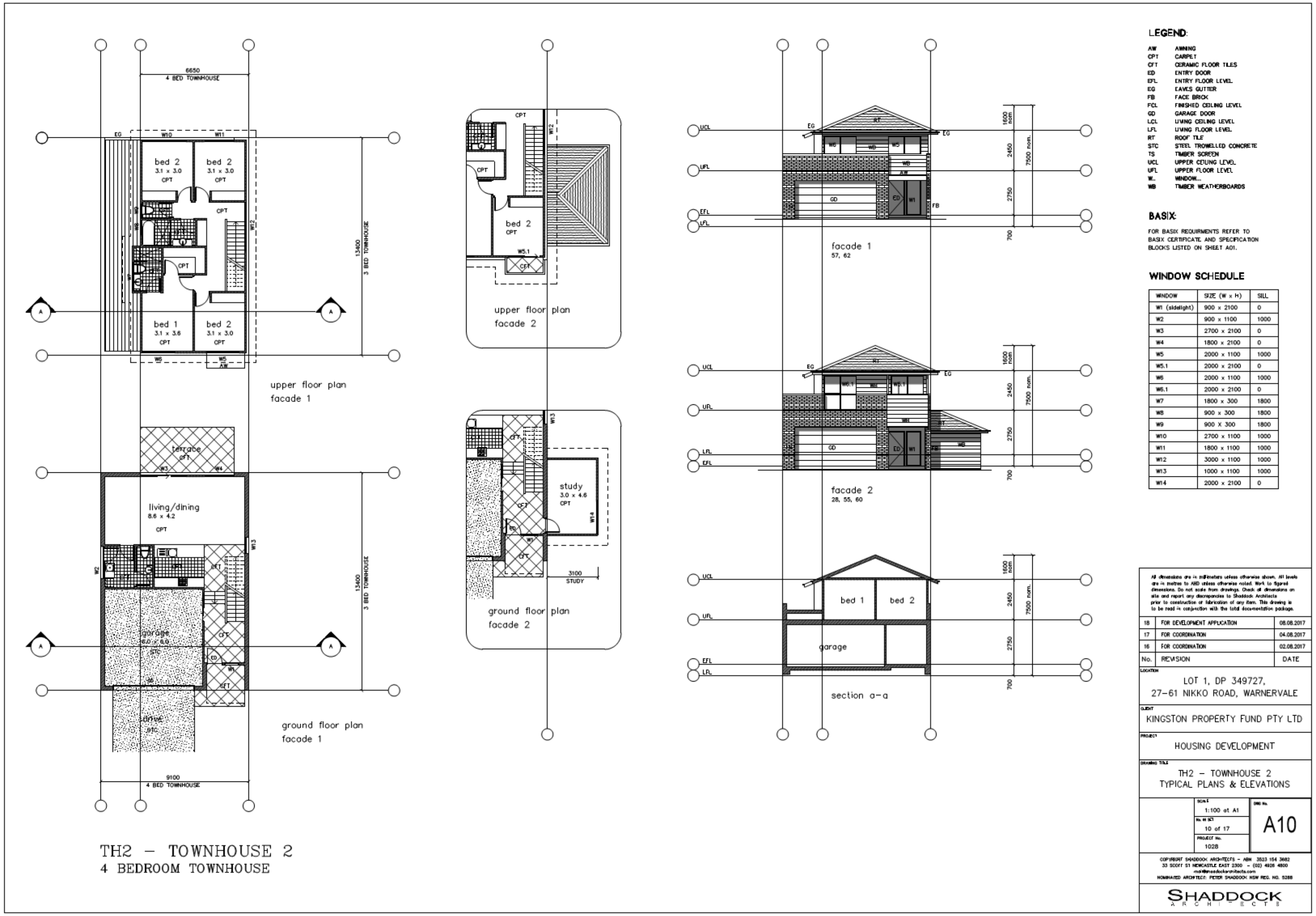
APPENDIX

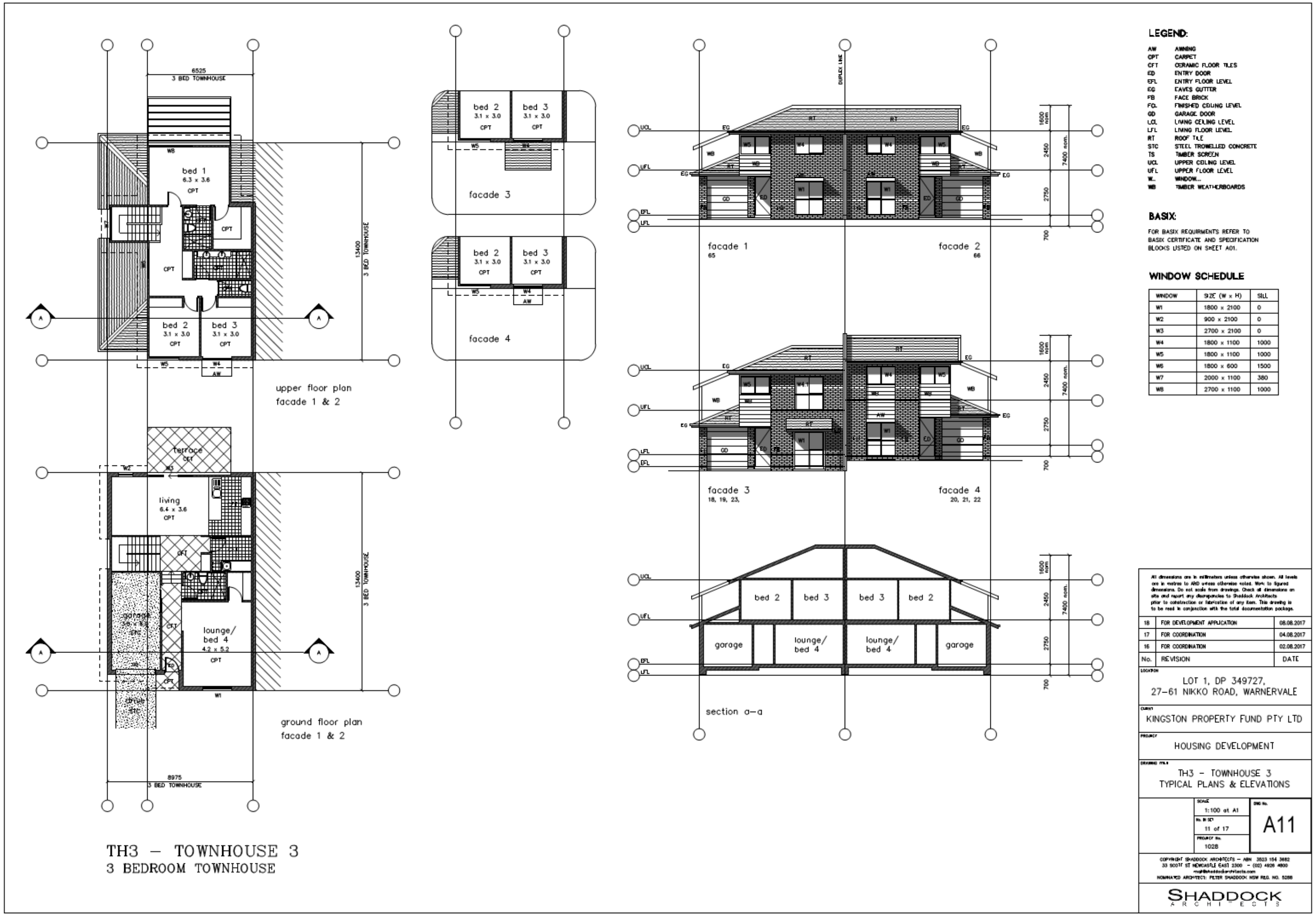
B SUPPLIED PLANS OF THE PROPOSED DEVELOPMENT

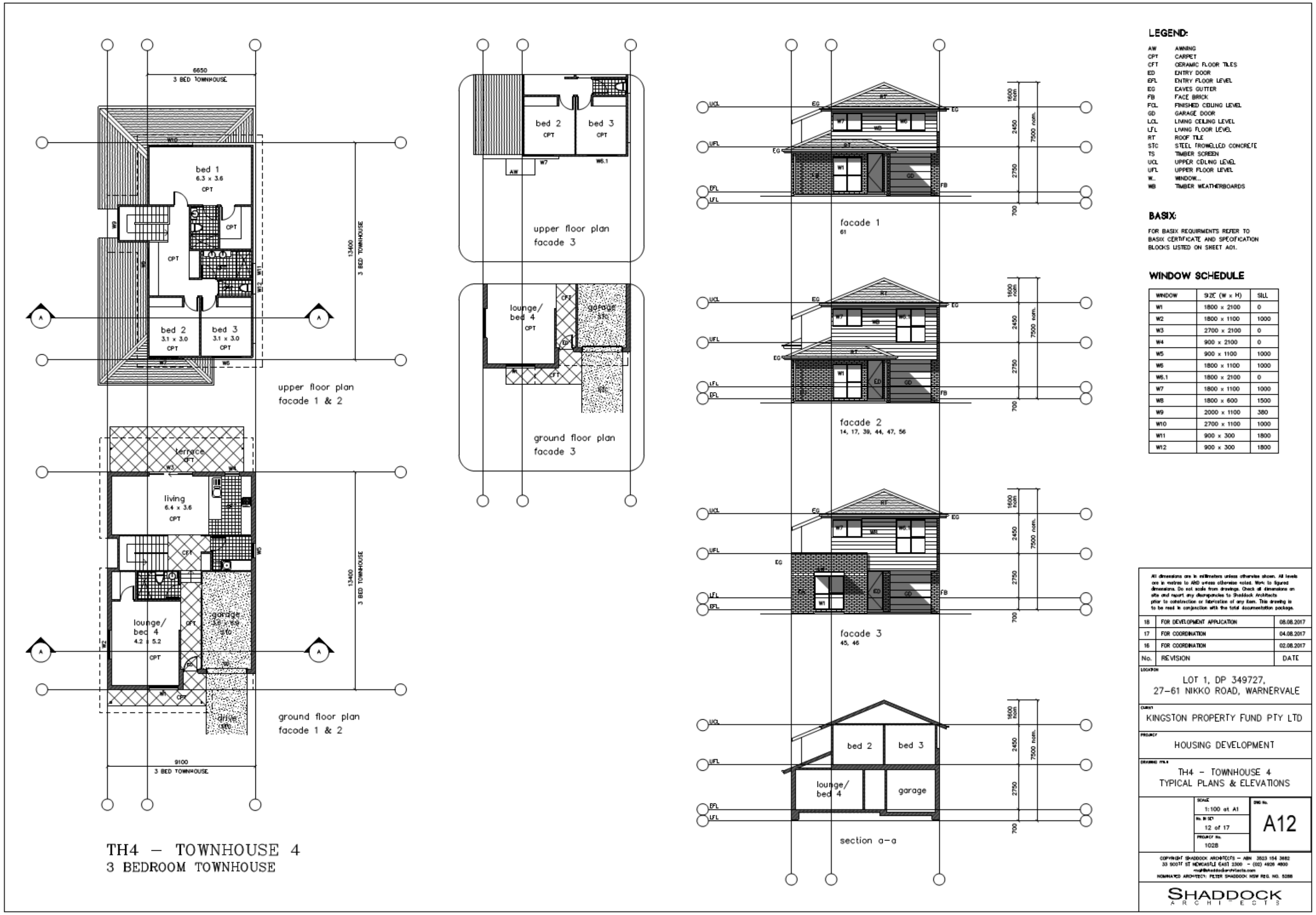


WINDOW	SIZE (W x H)	SILL
W1	1800 x 1100	1000
W2	1800 x 1100	1000
W3	900 x 300	1800
W4	900 x 300	1800
W5	1800 x 1100	1000
W6	1800 x 1100	1000
W7	3600 x 2100	0
W8	900 x 2100	0
W9	1800 x 300	1800
S1	1885 x 665	–


upper floor plan
facade 1 & 2
upper floor plan
facade 3
upper floor plan
facade 4
ground floor plan
facade 1, 2, 3 & 4
bed 1
bed 2
bed 3
bed 4
living/dining
garage
drive
terrace
facade 1
2, 5, 29, 31, 32, 37, 63, 67, 68, 70
facade 2
3, 4, 30, 38, 64, 69
facade 3
40, 42, 43, 52,
facade 4
41, 51
facade 5
9, 10, 16,
facade 6
8, 11, 12, 13, 15
section A-A
TH1 – TOWNHOUSE 1
4 BEDROOM TOWNHOUSE
LEGEND:
AW AWNING
CPT CARPET
CFT CERAMIC FLOOR TILES
ED ENTRY DOOR
EFL ENTRY FLOOR LEVEL
EG EAVES GUTTER
FB FACE BRICK
FCL FINISHED CEILING LEVEL
GD GARAGE DOOR
LCL LIVING CEILING LEVEL
LFL LIVING FLOOR LEVEL
RT ROOF TILE
STC STEEL TROWELLED CONCRETE
TS TIMBER SCREEN
UCL UPPER CEILING LEVEL
UFL UPPER FLOOR LEVEL
W.. WINDOW...
WB TIMBER WEATHERBOARDS
BASIX:
FOR BASIX REQUIRMENTS REFER TO BASIX CERTIFICATE AND SPECIFICATION BLOCKS LISTED ON SHEET A01.
WINDOW SCHEDULE
WINDOW | SIZE (W x H) | SILL
W1 (sidelight) | 900 x 2100 | 0
W2 | 900 x 1100 | 1000
W3 | 900 x 2100 | 0
W4 | 2700 x 2100 | 0
W5 | 2000 x 1100 | 1000
W5.1 | 2000 x 2100 | 0
W6 | 2000 x 1100 | 1000
W6.1 | 2000 x 2100 | 0
W7 | 1800 x 300 | 1800
W8 | 1800 x 1100 | 1000
W9 | 2700 x 1100 | 1000
W10 | 900 x 500 | 1600
All dimensions are in millimeters unless otherwise shown. All levels are in metres to AHD unless otherwise noted. Work to figured dimensions. Do not scale from drawings. Check all dimensions on site and report any discrepancies to Shaddock Architects prior to construction or fabrication of any item. This drawing is to be read in conjunction with the total documentation package.
18 FOR DEVELOPMENT APPLICATION 08.08.2017
17 FOR COORDINATION 04.08.2017
16 FOR COORDINATION 02.08.2017
No. REVISION DATE
LOT 1, DP 349727,
27–61 NIKKO ROAD, WARNERVALE
KINGSTON PROPERTY FUND PTY LTD
HOUSING DEVELOPMENT
TH1 – TOWNHOUSE 1
TYPICAL PLANS & ELEVATIONS
1:100 at A1
9 of 17
1028
A09
SHADDOCK
ARCHITECTS


6650
4 BED TOWNHOUSE
bed 2
3.1 x 3.0
CPT
bed 1
3.1 x 3.6
upper floor plan
facade 1
13400
3 BED TOWNHOUSE
terrace
CFT
living/dining
8.6 x 4.2
garage
6.0 x 6.0
STC
drive
STC
ground floor plan
facade 1
9100
4 BED TOWNHOUSE
upper floor plan
facade 2
study
3.0 x 4.6
CPT
3100
STUDY
ground floor plan
facade 2
facade 1
57, 62
facade 2
28, 55, 60
section a-a
UCL
UFL
EFL
LFL
1600 nom
2450
2750
700
7500 nom.
TH2 – TOWNHOUSE 2
4 BEDROOM TOWNHOUSE
LEGEND:
AW AWNING
CPT CARPET
CFT CERAMIC FLOOR TILES
ED ENTRY DOOR
EFL ENTRY FLOOR LEVEL
EG EAVES GUTTER
FB FACE BRICK
FCL FINISHED CEILING LEVEL
GD GARAGE DOOR
LCL LIVING CEILING LEVEL
LFL LIVING FLOOR LEVEL
RT ROOF TILE
STC STEEL TROWELLED CONCRETE
TS TIMBER SCREEN
UCL UPPER CEILING LEVEL
UFL UPPER FLOOR LEVEL
W.. WINDOW...
WB TIMBER WEATHERBOARDS
BASIX:
FOR BASIX REQUIRMENTS REFER TO BASIX CERTIFICATE AND SPECIFICATION BLOCKS LISTED ON SHEET A01.
WINDOW SCHEDULE
WINDOW | SIZE (W x H) | SILL
W1 (sidelight) | 900 x 2100 | 0
W2 | 900 x 1100 | 1000
W3 | 2700 x 2100 | 0
W4 | 1800 x 2100 | 0
W5 | 2000 x 1100 | 1000
W5.1 | 2000 x 2100 | 0
W6 | 2000 x 1100 | 1000
W6.1 | 2000 x 2100 | 0
W7 | 1800 x 300 | 1800
W8 | 900 x 300 | 1800
W9 | 900 X 300 | 1800
W10 | 2700 x 1100 | 1000
W11 | 1800 x 1100 | 1000
W12 | 3000 x 1100 | 1000
W13 | 1000 x 1100 | 1000
W14 | 2000 x 2100 | 0
All dimensions are in millimeters unless otherwise shown. All levels are in metres to AHD unless otherwise noted. Work to figured dimensions. Do not scale from drawings. Check all dimensions on site and report any discrepancies to Shaddock Architects prior to construction or fabrication of any item. This drawing is to be read in conjunction with the total documentation package.
18 FOR DEVELOPMENT APPLICATION 08.08.2017
17 FOR COORDINATION 04.08.2017
16 FOR COORDINATION 02.08.2017
No. REVISION DATE
LOCATION
LOT 1, DP 349727,
27-61 NIKKO ROAD, WARNERVALE
CLIENT
KINGSTON PROPERTY FUND PTY LTD
PROJECT
HOUSING DEVELOPMENT
DRAWING TITLE
TH2 – TOWNHOUSE 2
TYPICAL PLANS & ELEVATIONS
SCALE
1:100 at A1
10 of 17
PROJECT No.
1028
DWG No.
A10
SHADDOCK
ARCHITECTS


upper floor plan
facade 1 & 2
ground floor plan
facade 1 & 2
facade 3
facade 4
facade 1
facade 2
facade 3
facade 4
section a–a
bed 1
bed 2
bed 3
living
terrace
garage
lounge/ bed 4
TH3 – TOWNHOUSE 3
3 BEDROOM TOWNHOUSE
LEGEND:
AW AWNING
CPT CARPET
CFT CERAMIC FLOOR TILES
ED ENTRY DOOR
EFL ENTRY FLOOR LEVEL
EG EAVES GUTTER
FB FACE BRICK
FCL FINISHED CEILING LEVEL
GD GARAGE DOOR
LCL LIVING CEILING LEVEL
LFL LIVING FLOOR LEVEL
RT ROOF TILE
STC STEEL TROWELLED CONCRETE
TS TIMBER SCREEN
UCL UPPER CEILING LEVEL
UFL UPPER FLOOR LEVEL
W.. WINDOW...
WB TIMBER WEATHERBOARDS
BASIX:
FOR BASIX REQUIRMENTS REFER TO BASIX CERTIFICATE AND SPECIFICATION BLOCKS LISTED ON SHEET A01.
WINDOW SCHEDULE
WINDOW | SIZE (W x H) | SILL
W1 | 1800 x 2100 | 0
W2 | 900 x 2100 | 0
W3 | 2700 x 2100 | 0
W4 | 1800 x 1100 | 1000
W5 | 1800 x 1100 | 1000
W6 | 1800 x 600 | 1500
W7 | 2000 x 1100 | 380
W8 | 2700 x 1100 | 1000
18 FOR DEVELOPMENT APPLICATION 08.08.2017
17 FOR COORDINATION 04.08.2017
16 FOR COORDINATION 02.08.2017
No. REVISION DATE
LOT 1, DP 349727,
27–61 NIKKO ROAD, WARNERVALE
KINGSTON PROPERTY FUND PTY LTD
HOUSING DEVELOPMENT
TH3 – TOWNHOUSE 3
TYPICAL PLANS & ELEVATIONS
1:100 at A1
11 of 17
1028
A11
SHADDOCK
ARCHITECTS


6650
3 BED TOWNHOUSE
bed 1
6.3 x 3.6
CPT
bed 2
3.1 x 3.0
CPT
bed 3
3.1 x 3.0
CPT
upper floor plan
facade 1 & 2
terrace
CFT
living
6.4 x 3.6
CPT
lounge/
bed 4
4.2 x 5.2
CPT
garage
3.2 x 5.8
stc
drive
stc
ground floor plan
facade 1 & 2
13400
3 BED TOWNHOUSE
9100
3 BED TOWNHOUSE
TH4 – TOWNHOUSE 4
3 BEDROOM TOWNHOUSE
upper floor plan
facade 3
ground floor plan
facade 3
facade 1
61
facade 2
14, 17, 39, 44, 47, 56
facade 3
45, 46
section a–a
LEGEND:
AW AWNING
CPT CARPET
CFT CERAMIC FLOOR TILES
ED ENTRY DOOR
EFL ENTRY FLOOR LEVEL
EG EAVES GUTTER
FB FACE BRICK
FCL FINISHED CEILING LEVEL
GD GARAGE DOOR
LCL LIVING CEILING LEVEL
LFL LIVING FLOOR LEVEL
RT ROOF TILE
STC STEEL TROWELLED CONCRETE
TS TIMBER SCREEN
UCL UPPER CEILING LEVEL
UFL UPPER FLOOR LEVEL
W.. WINDOW...
WB TIMBER WEATHERBOARDS
BASIX:
FOR BASIX REQUIRMENTS REFER TO BASIX CERTIFICATE AND SPECIFICATION BLOCKS LISTED ON SHEET A01.
WINDOW SCHEDULE
WINDOW | SIZE (W x H) | SILL
W1 | 1800 x 2100 | 0
W2 | 1800 x 1100 | 1000
W3 | 2700 x 2100 | 0
W4 | 900 x 2100 | 0
W5 | 900 x 1100 | 1000
W6 | 1800 x 1100 | 1000
W6.1 | 1800 x 2100 | 0
W7 | 1800 x 1100 | 1000
W8 | 1800 x 600 | 1500
W9 | 2000 x 1100 | 380
W10 | 2700 x 1100 | 1000
W11 | 900 x 300 | 1800
W12 | 900 x 300 | 1800
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18 FOR DEVELOPMENT APPLICATION 08.08.2017
17 FOR COORDINATION 04.08.2017
16 FOR COORDINATION 02.08.2017
No. REVISION DATE
LOT 1, DP 349727,
27–61 NIKKO ROAD, WARNERVALE
KINGSTON PROPERTY FUND PTY LTD
HOUSING DEVELOPMENT
TH4 – TOWNHOUSE 4
TYPICAL PLANS & ELEVATIONS
1:100 at A1
12 of 17
1028
A12
SHADDOCK
ARCHITECTS