APPENDIX C
ROAD TRAFFIC NOISE ASSESSMENT

LandCorp

29 October 2012

D R A F T

Murdoch Mixed Use Precinct Residential Development

Road Traffic Noise Assessment

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Road Traffic Noise Assessment

Prepared for

LandCorp

Prepared by

AECOM Australia Pty Ltd
3 Forrest Place, Perth WA 6000, GPO Box B59, Perth WA 6849, Australia
T +61 8 6208 0000 F +61 8 6208 0999 www.aecom.com
ABN 20 093 846 925

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Executive Summary

This report provides an assessment of road traffic noise impact for the proposed residential development within the Murdoch Mixed Use Precinct (MUP). The assessment has been based on the predicted noise levels at the affected residential buildings, and the associated outdoor living areas against nominated noise criteria.

The future year 2031 has been considered for the assessment of noise impact on the proposed residential development.

The assessment is based on the noise criteria from State Planning Policy (SPP) 5.4 (details refer to Section 2.1). These criteria are applicable for the proposed new MUP residential development affected by adjacent major traffic corridors, i.e. Kwinana Freeway and South Street.

The noise levels based on the $L_{A10,18hr}$ statistical noise descriptor have been predicted using the CoRTN algorithm as implemented by SoundPLAN 6.5 noise modelling software suite. The relevant modelling methodology and modelling parameters are documented in Section 3.0 and 4.0 of the report.

The modelling prediction results have shown that the seven proposed residential buildings along South Street and Kwinana Freeway have facades with predicted noise levels exceeding SPP 5.4 noise criteria. The predicted noise levels at the majority of the building floors at these façades exceed noise limit $L_{Aeq,\ 16hr}$ 60 dB(A), with a number of building floors exceed 63 dB(A). The predicted building façade noise levels with exceedence of SPP 5.4 noise criteria are presented in the table in Appendix D.

The noise levels at the outdoor living area for the proposed MUP residential development, i.e. the Murdoch Circle and the Conservation Zone, are predicted to comply with SPP 5.4 noise criteria.

Preliminary noise mitigation and insulation measure recommendations have been provided considering various predicted facade noise level scenarios, detailed in Section 7.0.

1.0 Introduction

1.1 Background

AECOM has been commissioned by LandCorp to undertake an assessment of road traffic noise impact on the proposed residential development within the Murdoch Mixed Use Precinct (MUP), located approximately 12 km south of the Perth CBD.

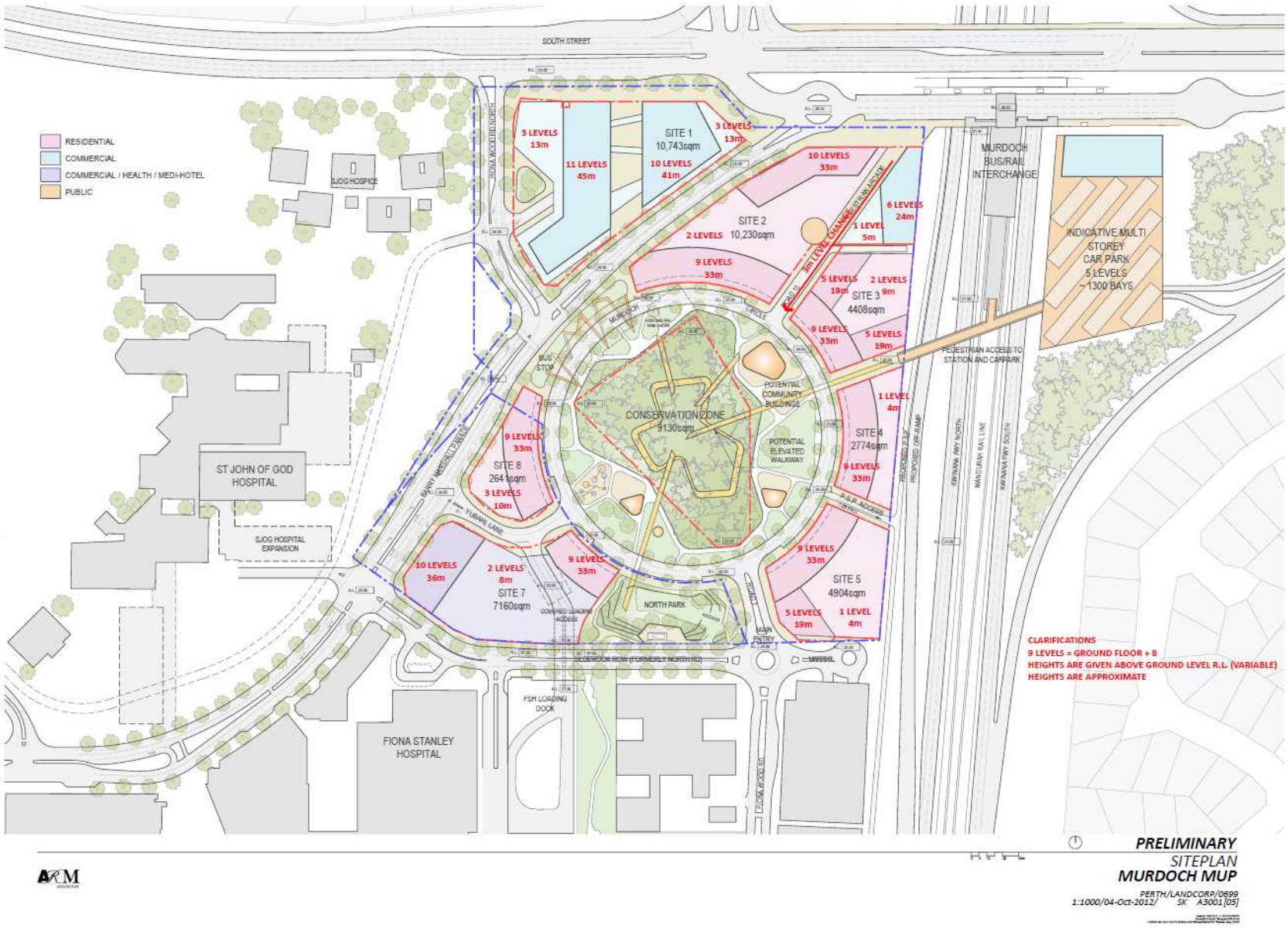
This report details prediction of the traffic noise impact on the proposed residential development and the comparison of predicted noise levels with appropriate assessment criteria, as well as the relevant noise mitigation and insulation measure recommendations.

1.2 Project Description

The Mixed Use Precinct (MUP) site is identified as the heart of the Murdoch Activity Centre (MAC) development, connecting Murdoch Station with the adjacent employment and health nodes and providing an innovative example of a mixed use, transit orientated development.

The proposed site layout design for the MUP has been prepared by LandCorp's architects, ARM, and has progressed through various stages of commentary. shows the proposed MUP site layout, number of storeys, and heights at the building development. It can be seen from the layout that the development mainly consists of a number of residential buildings and the associated podiums around the circular conservation zone, with commercial buildings located along South Street and Kwinana Freeway.

Figure 1 The proposed MUP site layout



Source: ARM on behalf of LandCorp

1.3 Scope of Works

The scope of works for the road traffic noise impact assessment for the MUP residential development is to include:

- Create a noise model to predict the noise levels for a future year traffic scenario (i.e. future year 2031 for the worst case), considering the noise emissions from adjacent major traffic corridors, including Kwinana Freeway and South Street;
- Predict received noise levels from road traffic sources for the proposed MUP residential buildings and associated outdoor living areas;
- Assessment the traffic noise impact on the residential development based on relevant noise criteria, namely SPP 5.4;
- Noise mitigation and insulation measures will be investigated and recommended if required.

2.0 Noise Criteria and the Applications

2.1 Outdoor Noise Criteria

The outdoor noise criteria applicable to the emission of road and rail transport noise, as received at a noise-sensitive land use such as residential dwellings or non-residential noise sensitive receivers such as schools and child care centres, are outlined in the *State Planning Policy 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning (SPP 5.4).* Table 1 lists the SPP 5.4 outdoor noise target and noise limit for both day time and night time period.

For new noise-sensitive developments, the noise criteria apply to the locations 1m from the most exposed, habitable façade of the proposed building, at each floor level, and within at least one outdoor living area on each residential lot.

Table 1 SPP 5.4 outdoor noise criteria applicable to noise-sensitive land use

Time of day	Noise Target	Noise Limit
Day (6 am–10 pm) - $L_{Aeq,16hr}$	55 dB(A)	60 dB(A)
Night (10 pm–6 am) – $L_{Aeq,8hr}$	50 dB(A)	55 dB(A)

The 5 dB(A) difference between the outdoor noise target and the outdoor noise limit, as prescribed in Table 1, represents an acceptable margin for compliance. The policy states that "*In most situations in which either the noise-sensitive land use or the major road or railway already exists, it should be practicable to achieve outdoor noise levels within this acceptable margin*".

2.2 Interpretation and application for new noise-sensitive developments

The SPP 5.4 details the interpretation and application of the noise criteria for new noise-sensitive developments, with supplementary information provided in the Implementation Guidelines for SPP 5.4.

2.2.1 Objectives

The SPP 5.4 specifies the outdoor noise criteria for new noise-sensitive developments, as listed in Table 1, in order to achieve the following objectives:

- acceptable indoor noise levels in noise-sensitive areas (for example, bedrooms and living rooms of houses, and school classrooms); and
- a reasonable degree of acoustic amenity in at least one outdoor living area on each residential lot.

2.2.2 Applications

The SPP 5.4 outlines a number of scenarios regarding the likely outdoor noise levels in a noise-sensitive development area, and the corresponding measured required to be implemented in order to achieve the objectives listed in Section 2.2.1. They are summarised in Table 2.

Table 2 Outdoor noise levels for a new noise-sensitive development and the subsequent measures required

Likely Outdoor Noise Levels	Measures Required
Meet the noise target	No further measures are required
Exceed the noise target, but within the 5 dB margin	- Mitigation measures should be implemented by the developer with a view to achieving the target levels in a least one outdoor living area on each residential lot - Where indoor spaces are planned to be facing any outdoor area in the margin, noise mitigation measures should be implemented to achieve acceptable indoor noise levels in those spaces, In this case, compliance with this policy can be achieved for residential buildings through implementation of the deemed-to-comply noise insulation measures (Package A, referring to Appendix F) detailed in the Implementation Guidelines

Likely Outdoor Noise Levels	Measures Required
Exceed the noise limit, but within 3 dB above the limit	- A detailed noise assessment in accordance with the guidelines should be undertaken by the developer - Customised noise mitigation measures should be implemented with a view to achieving the noise target in at least one outdoor living or recreation area on each noise-sensitive lot or, if this is not practicable, within the margin - Where indoor spaces will face outdoor areas that are above the noise limit, mitigation measures should be implemented to achieve acceptable indoor noise levels in those spaces. In this case, compliance with this policy can be achieved for residential buildings through implementation of the deemed-to-comply noise insulation measures (Package B, referring to Appendix F) detailed in the Implementation Guidelines
Exceed the noise limit, and more than 3 dB above the limit	- A detailed noise assessment in accordance with the guidelines should be undertaken by the developer - Customised noise mitigation measures should be implemented with a view to achieving the noise target in at least one outdoor living or recreation area on each noise-sensitive lot or, if this is not practicable, within the margin - Where indoor spaces will face outdoor areas that are above the noise limit, mitigation measures should be implemented to achieve acceptable indoor noise levels in those spaces. In this case, 'Quiet house design' concept (referring to referring Appendix F) is recommended, with the considerations of the interior layout arrangement and higher noise insulation measures. The implementations subject to detailed acoustics review during project design phase.

The SPP 5.4 states that if the policy objectives for noise-sensitive developments are not achievable, best practicable measures as presented in Section 2.3 should be implemented.

2.3 Reasonable and practicable noise mitigation measures

The following paragraphs are reproduced in full from SPP 5.4, and outline reasonable and practicable noise mitigation considerations for new noise-sensitive developments.

'5.8 Reasonable and practicable measures

This policy applies a performance-based approach to the management and mitigation of transport noise. It is recognised that in a number of instances it may not be reasonable and practicable to meet the noise target criteria. Where transport noise is above the target level, measures are expected to be implemented that best balance reasonable and practicable considerations, such as noise benefit, cost, feasibility, community preferences, amenity impacts, safety, security and conflict with other planning and transport policies. In these cases the community should also be consulted to assist in identifying best overall solutions. The guidelines assist in outlining ways in which some reasonable and practicable limitations can be addressed in a manner that also minimises transport noise.

It is further acknowledged that there may also be situations in which the noise limit cannot practicably be achieved, especially in the case of major redevelopment of existing transport infrastructure. Similarly, it may not be practicable to achieve acceptable indoor noise levels if the new development is located very close to the transport corridor. In these situations the primary focus should be on achieving the lowest level of noise, with other reasonable and practicable considerations being secondary to this objective.

In cases where the noise limit or indoor noise criteria cannot practicably be met, longer term strategies for land use planning, transport policy and vehicle emissions should be considered to minimise transport noise impact over time.'

3.0 Noise Modelling Methodology

Modelling prediction of the noise emissions from South Street and Kwinana Freeway was carried out using the UK Department of Transport, “Calculation of Road Traffic Noise” (CoRTN 1998) algorithms as implemented by SoundPLAN 6.5 noise modelling software suite. The modelling software suite allows for traffic volume and mix type of road surface, vehicle speed, road gradient, ground absorption, and shielding from ground topography and intervening structures such as noise barriers and existing dwellings to be taken into account.

Receiver locations, ground topography, future road alignment and other cadastral data (e.g. property boundaries) were derived from proposed site plan, aerial photographs, and electronic information supplied by BG&E Engineering, ARM Architecture and MRWA.

The noise model was developed for the future year 2031, when the traffic volumes, and as such, the noise emissions of these relevant major roads are predicted to be the highest compared with earlier future years.

3.1 Modelling parameters

The CoRTN calculation predicts noise levels based on the $L_{A10,\ 18hr}$ statistical descriptor. In Western Australia, road traffic noise assessments are based on the average energy based noise level criteria $L_{Aeq,16hr}$ for day time and $L_{Aeq,\ 8hr}$ for night time, i.e. the SPP 5.4 noise assessment criteria listed in Section 2.0. We have therefore incorporated the following conversion factors into the model.

3.1.1 L_{A10} to L_{Aeq} conversion factor

Previous noise monitoring results from a relevant project, i.e. Kwinana Freeway - Roe Highway to Leach Highway (Document No. 60100953.BS002.REP) have been used to calculate the average difference of 1.5 dB(A) between the $L_{A10,\ 18hr}$ and $L_{Aeq,\ 16hr}$ noise descriptors. This difference has been applied to the $L_{A10.\ 18hr}$ CORTN output to convert it to the $L_{Aeq,\ 16hr}$ noise descriptor relevant to road traffic noise assessment procedure in Western Australia.

3.1.2 Low volume correction factor

The CoRTN calculation algorithm implements a low volume correction to low traffic flow volumes (i.e. below 200 vehicles/hour) in order to account for the effect that intermittent traffic has on the $L_{A10,\ 18hr}$ statistical descriptor. Traffic volumes in this project have been adjusted to ensure the low volume correction factor is not triggered within the model. CoRTN output is balanced accordingly by applying an additional correction factor to all traffic strings with adjusted traffic volumes. This approach has been successfully used on previous projects and satisfactorily accounts for the L_{Aeq} prediction for both low and high-volume traffic flows.

3.1.3 Modified source height noise modelling

The CoRTN calculation algorithm assumes road traffic noise emission height of 0.5 m above road surface for all vehicle classes. This assumption can overestimate the effect of noise barriers, particularly on heavy vehicle routes, as heavy vehicle noise sources (namely engine and exhaust) have a significantly higher noise emission height. In order to account for the elevated heavy vehicle noise emission height, traffic volumes were split into light and heavy vehicles (Austroads Class 1 and 2, and 3-12 respectively). Light vehicle traffic strings were unmodified, while heavy vehicle traffic was modelled at a height of 1.5 m for heavy vehicle engines and 3.6 m for heavy vehicle exhausts. Corrections were applied to the outputs of the modified heavy vehicle traffic strings (-0.8 dB(A) for engine and -8.0 dB(A) for exhaust) in order to balance the combined output to 0 dB(A) (i.e. no additional gain from having two heavy vehicle noise source strings).These source height implementations are in accordance with the Implementation Guidelines for SPP 5.4.

3.2 Modelling Inputs and Assumptions

3.2.1 Topography

Two data sets were combined into one set of elevation contours used to generate the Digital Ground Model (DGM) used in the *SoundPLAN* model for this noise assessment for the future year 2031. They are the elevation contours provided by MRWA covering the study area and the site elevation information provided by BG&E Engineering for this noise assessment study.

3.2.2 Traffic noise modelling strings

Future road design outlines applicable for the future year 2031 were used to construct ‘traffic strings’ (noise emission lines) for each lane along the modelled roads. On roads where multiple lanes were present, each road lane was modelled separately, with traffic volumes divided equally between the lanes.

3.2.3 Proposed building development

Proposed building outlines, including information of building heights and number of floors for each building, were digitised from the preliminary site plan supplied by ARM Architecture.

3.2.4 Ground absorption

All road surfaces were assumed to be reflective (hard) ground, with absorptive (soft) ground assumed elsewhere in the project area.

3.2.5 Road surface corrections

The road surfaces are a combination of Open Graded Asphalt (OGA) and Dense Graded Asphalt (DGA). All road lanes of Kwinana Freeway have Open Graded Asphalt surface, and South Street and other Freeway onramps and off-ramps have Dense Graded Asphalt surface. A summary of relative noise relationships between different types of assumed road pavement surfaces is presented in Table 3.

Table 3 Noise emissions from different road pavement surfaces relative to Dense Graded Asphalt.

Chip Seal			Asphalt		
14mm	10mm	5mm	Dense Graded	Stone Mastic	Open Graded
+3.5 dB(A)	+2.5 dB(A)	+1.5 dB(A)	0 dB(A)	-1.5 dB(A)	-2.5 dB(A)

4.0 Model Calibration and traffic noise modelling

The computer noise model of the future year 2031 were constructed based on the predicted traffic volumes, posted speed limits, ground topography and the proposed MUP residential development site plan layout.

4.1 Traffic Volume and Speed

The traffic data for the future year of 2031, including travel direction, Annual Average Weekday Traffic (AAWT) and heavy vehicle volumes as percentage of AAWT were derived from MRWA Transport Modelling Section. It is noted that vehicle volumes for the future year 2031 were calibrated based on the differences between the assigned volumes and the count volumes of year 2011 for both light and heavy vehicles. The uncelebrated light vehicle and heavy vehicle traffic volumes for the future year of 2031 were presented in Appendix B. The assigned and count daily traffic volumes of year 2011 for the two vehicle categories were also presented in Appendix C.

The 18 hours traffic volume was assumed to constitute 89% daily traffic volume for Kwinana Freeway and 94% was assumed for the rest of the roads. Designed posted speed limits were used as the speed model input.

Figure 2outlines the relevant parameters for the road sections that have been input for the noise models.

Figure 2 Road traffic data, speed limits and number of lanes for the future year 2031

Road name	2031 AAWT	% HV	Speed (km/h)	Lane Number
South Street Westbound – West of Kwinana Fwy and On/Off Ramps	23957	7	70	3
South Street Eastbound – West of Kwinana Fwy and On/Off Ramps	21235	7	70	3
South Street Westbound – West of Kwinana Fwy and East of On/Off Ramps	24130	7	70	3
South Street Eastbound – West of Kwinana Fwy and East of On/Off Ramps	20980	6	70	3
South Street Westbound – East of Kwinana Fwy	24130	7	70	3
South Street Eastbound – East of Kwinana Fwy	20980	6	70	3
South Street Northbound On Ramp	11688	6	70	1
South Street Northbound Off Ramp	7169	4	70	1
South Street Southbound On Ramp	6687	5	70	1
South Street Southbound Off Ramp	7993	3	70	1
Kwinana Fwy Northbound	66910	11	100	3
Kwinana Fwy Southbound	66171	10	100	3

4.2 Model Calibration

Comprehensive road noise model calibration procedure has been developed and executed in our previous noise model which covers the study area. Details can be referred to previous projects, i.e. Kwinana Freeway – Roe Highway to Leach Highway (Document No. 60100953.BS002.REP). The model calibration procedure was based on noise monitoring at a series of representative locations, and calibration factors were derived for different road types and sections by comparing un-calibrated noise model predictions against measured results.

This study adopts the model calibration results for the existing road strings that have been undertaken in the previous project. For the future year modelling scenario, the calibration factors were assumed unchanged for the road sections relevant to this assessment study.

The previous noise monitoring results also show that the difference between daytime ($L_{Aeq, 16hr}$) and night time ($L_{Aeq, 8hr}$) noise emissions is 5 dB(A) or more at all noise monitoring locations. Therefore, in line with MRWA guidelines, the night time noise emission targets will be achieved by meeting the daytime noise emission targets.

5.0 Results

Following the modelling methodology presented in the previous sections, received noise levels were predicted for the proposed residential and commercial building facades and outdoor areas. The receivers at the facades locate at the centre of each facade, 1.5 m above each floor and 1 m away from the façade.

5.1 Residential buildings

The seven proposed residential buildings along South Street and Kwinana Freeway have facades with predicted noise levels exceeding SPP 5.4 noise criteria. The predicted noise levels at the majority of the building floors at these façades exceed noise limit $L_{Aeq, 16hr}$ 60 dB(A), with a number of building floors exceed 63 dB(A).

The predicted building façade noise levels with exceedence of SPP 5.4 noise criteria are presented in the table in Appendix D.

5.2 Outdoor living area

The noise levels at the outdoor living area for the proposed MUP residential development, i.e. the Murdoch Circle and the Conservation Zone, are predicted to comply with SPP 5.4 noise criteria. However balconies located on facades with direct line of sight with roads (e.g. facing South Street and Kwinana Freeway) are likely exceed SPP 5.4 noise criteria.

5.3 Commercial buildings

The predicted façade noise levels at proposed three commercial buildings are also shown in Appendix D. The results show that the majority of the building floors of the commercial building facades that directly exposed to South Street or Kwinana Freeway have the received noise levels $L_{Aeq, 16hr}$ above 63 dB(A), with the highest predicted level up to 68 dB(A).

6.0 Noise Mitigation and Insulation Measures

In line with the SPP 5.4 noise criteria applications outlined in Section 2.2.2, for the case of indoor spaces being planned to be facing any outdoor area where the predicted façade noise level exceeding SPP 5.4 noise criteria, the recommended noise mitigation and insulation measures for the proposed residential development are summarised as follows:

- The predicted façade noise level exceeds the SPP 5.4 noise target, but within the 5dB margin. The implementation of the deem-to-comply noise insulation package A is recommended for indoor spaces. The details of the package A measures refer to Table 8 in Appendix F.
- The predicted façade noise level exceeds the SPP 5.4 noise limit, but within 3dB above the limit. The implementation of the deem-to-comply noise insulation package B is recommended for indoor spaces. The details of the package B measures refer to Table 9 in Appendix F.
- The predicted façade noise level exceeds the SPP 5.4 noise limit, and more than 3dB above the limit. In order to achieve acceptable noise levels within the internal noise-sensitive spaces, multiple insulation and mitigation measures might need to be implemented. The possible measures include higher noise insulation measures with upgraded glazing and where necessary, limiting the size of opening to habitable rooms to limit noise intrusion. Another possible and practical measure is the interior layout manipulation by locating the most noise-sensitive spaces away from the source of noise where possible and preferably separated from noise sources by service areas such as bathrooms, laundries and storerooms. The detailed measure implementation subject to detailed acoustics review during project design phase.

7.0 Conclusions

The road traffic noise impact from two major traffic corridors, i.e. South Street and Kwinana Freeway, on the proposed residential development within the Murdoch Mixed Use Precinct (MUP) has been assessed in this study. The assessment was based on the predicted noise levels at the affected residential buildings and the associated outdoor living areas for the future year 2031 scenario.

The assessment is based on the noise criteria from State Planning Policy (SPP) 5.4 (details refer to Section 2.1). These criteria are applicable for the proposed new MUP residential development affected by adjacent major traffic corridors, i.e. South Street and Kwinana Freeway.

The noise levels based on the $L_{A10,18hr}$ statistical noise descriptor have been predicted using the CoRTN algorithm as implemented by SoundPLAN 6.5 noise modelling software suite. The relevant modelling methodology and modelling parameters are documented in Section 3.0 and 4.0 of the report.

The modelling prediction results have shown that the seven proposed residential buildings along South Street and Kwinana Freeway have facades with predicted noise levels exceeding SPP 5.4 noise criteria. The predicted noise levels at the majority of the building floors at these façades exceed noise limit $L_{Aeq, 16hr}$ 60 dB(A), with a number of building floors exceed 63 dB(A). The predicted building façade noise levels with exceedence of SPP 5.4 noise criteria are presented in the table in Appendix D.

The noise levels at the public outdoor living area for the proposed MUP residential are predicted to comply with SPP 5.4 noise criteria.

Preliminary noise mitigation and insulation measure recommendations have been provided considering various predicted facade noise level scenarios, with details refer to Section 7.0.

Appendix A

Acoustic Glossary

D R A F T

Ambient Sound	The totally encompassing sound in a given situation at a given time, usually composed of sound from all sources near and far.
Audible Range	The limits of frequency which are audible or heard as sound. The normal ear in young adults detects sound having frequencies in the region 20 Hz to 20 kHz, although it is possible for some people to detect frequencies outside these limits.
Competent Acoustic Consultant	SPP 5.4 defines a competent acoustic consultant as a member of the AAS or the AAAC. AECOM staff in the Perth acoustics team is all members of the AAS, AECOM is a member company of AAAC.
Decibel [dB]	The level of noise is measured objectively using a Sound Level Meter. The following are examples of the decibel readings of every day sounds; 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB Forrest Place at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry
dB(A)	*A-weighted decibels* The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the “A” filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter. The sound pressure level in dB(A) gives a close indication of the subjective loudness of the noise.
L_{Amax}	The maximum sound pressure level measured over a given period.
$L_{Aeq,\ T}$	The logarithmic average sound pressure level over duration period T.
$L_{Aeq.\ 24hr}$	The logarithmic average sound pressure level over 24 hours.
$L_{Aeq,\ 16hr}$	The logarithmic average sound pressure level over 24 hours. In the context of SPP 5.4 this refers to the daytime levels (between 06.00 hours and 22 hours).
$L_{Aeq,\ 8hr}$	The logarithmic average sound pressure level over 8 hours. In the context of SPP 5.4 this refers to the night time levels (between 22.00 hours and 06 hours).
$L_{A10,\ 18hr}$	The A-weighted sound pressure level exceeded for 10% of the measurement period between 6.00am and midnight, as defined in CoRTN modelling algorithm.

Appendix B

Assigned Daily Traffic Volumes for Light and Heavy Vehicles for Future Year 2031

Kwinana Freeway/South St Interchange
Plot of 2031 FMM Truck volumes on V2012 y2031 network (Factor volumes x100)

Regional Operations Model (ROM) Network
Unadjusted Average Weekday 24-hour Traffic Volumes
Land Use Data sourced from DOP MLUFS
Traffic forecasts should be primarily used for relative comparison, not as absolute values.
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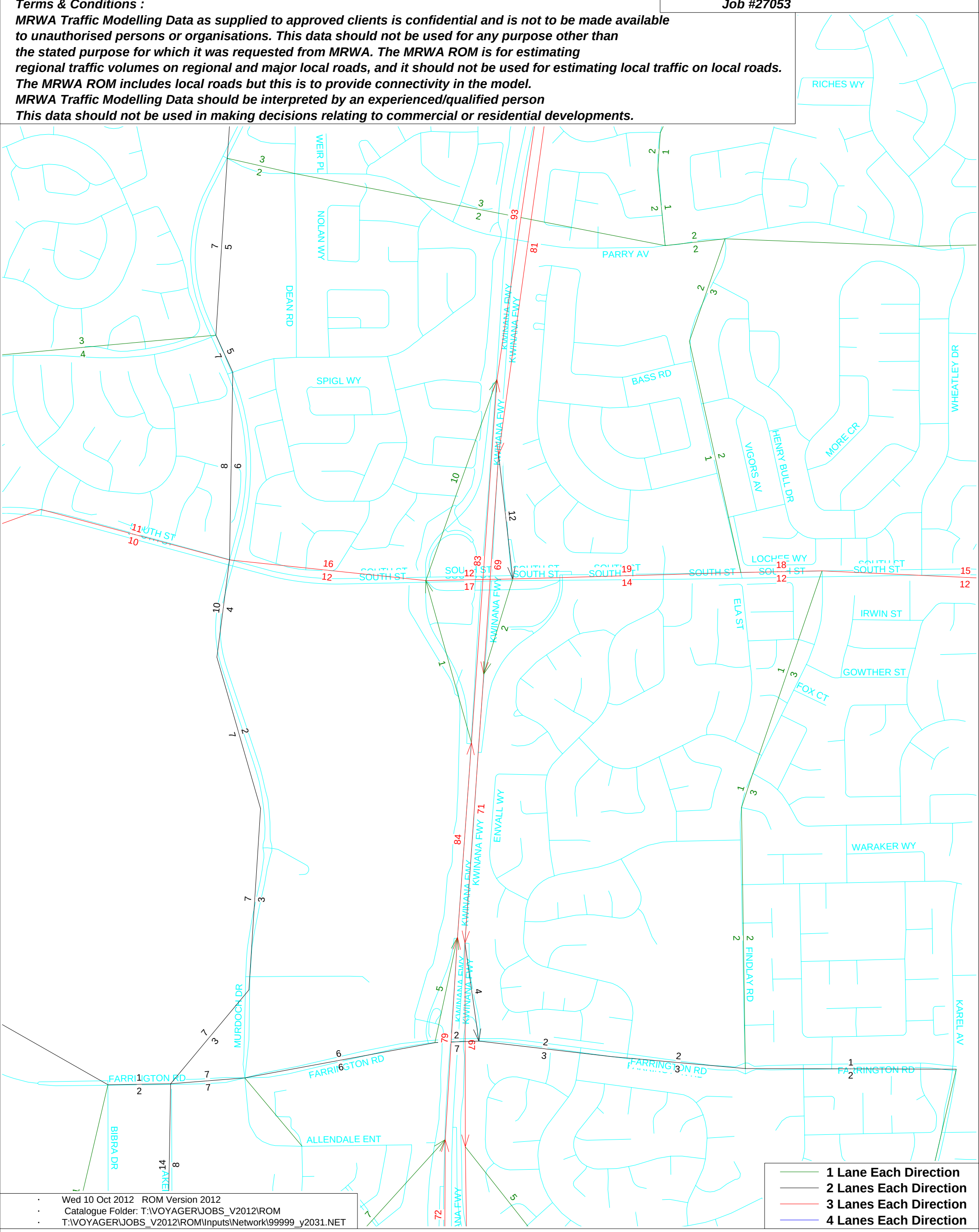
Main Roads Western Australia
Transport Modelling Section
Enquiries Graham Jacoby Ph 9323 4482
MRWA Reference
Job #27053



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Kwinana Freeway/South St Interchange - North bound 'off' ramp
Plot of 2031 volumes on V2012 y2031 network (Factor volumes x100)

Regional Operations Model (ROM) Network
Unadjusted Average Weekday 24-hour Traffic Volumes
Land Use Data sourced from DOP MLUFS
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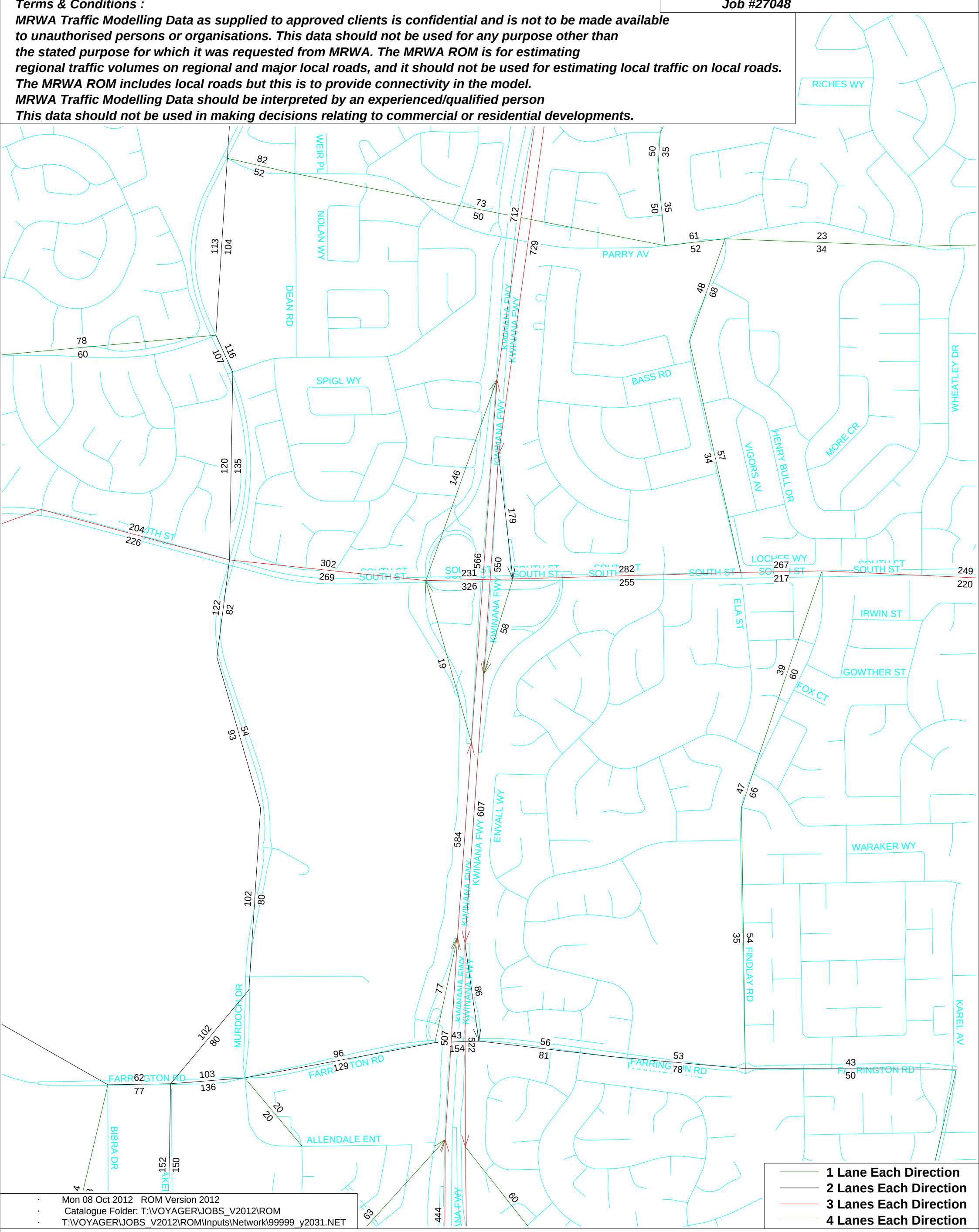
Job #27048



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Appendix C

Assigned and Count Daily Traffic Volumes of 2011 for Both Light and Heavy Vehicles

Kwinana Freeway/South St Interchange
Plot of 2011 FMM truck volumes & counts on V2012 y2011 network

Regional Operations Model (ROM) Network
Unadjusted Average Weekday 24-hour Traffic Volumes
Land Use Data sourced from DOP MLUFS
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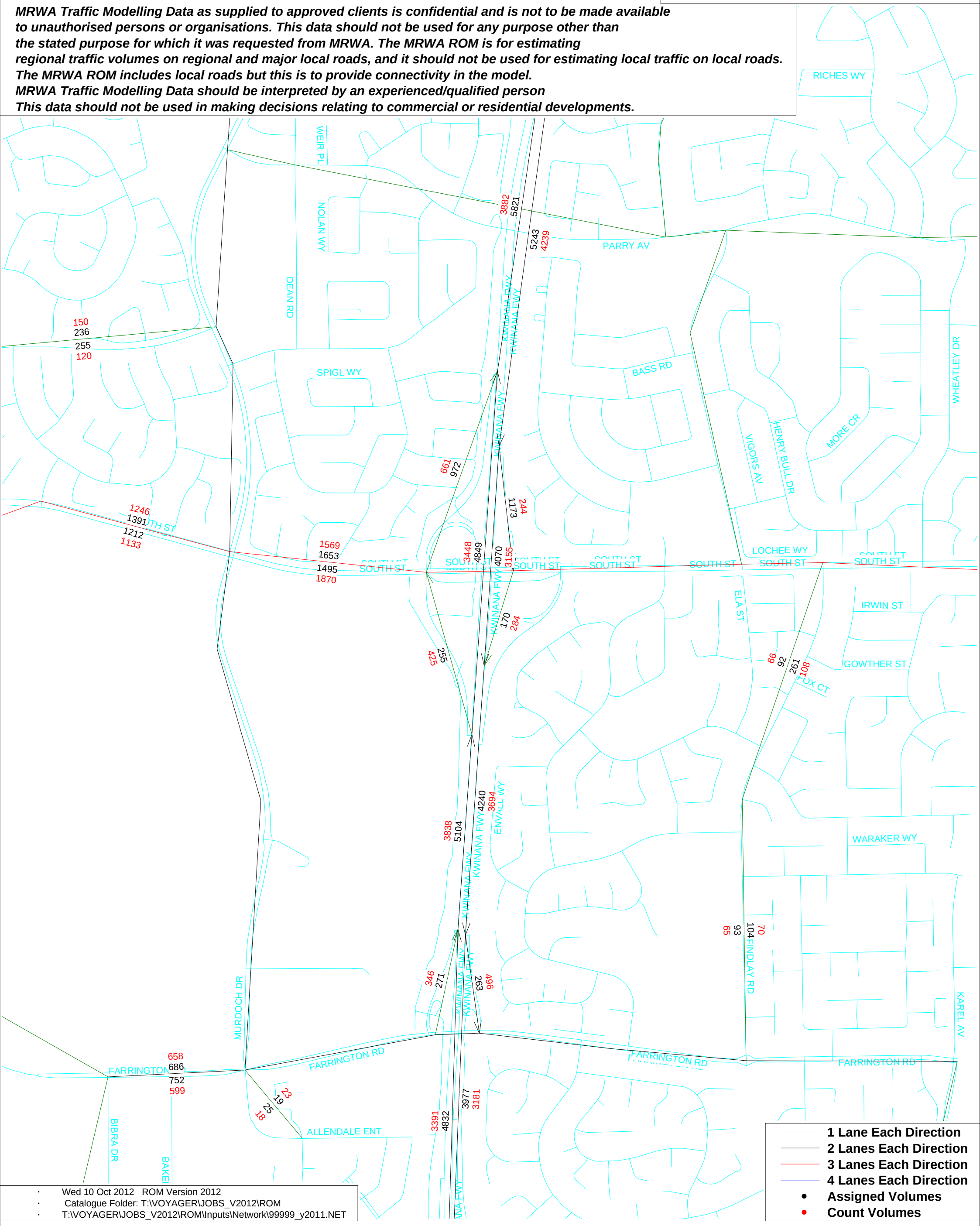
Enquiries Graham Jacoby Ph 9323 4482
MRWA Reference
Job #27053



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Kwinana Freeway/South St Interchange - North bound 'off' ramp
Plot of 2011 volumes & counts on V2012 y2011 network

Regional Operations Model (ROM) Network
Unadjusted Average Weekday 24-hour Traffic Volumes
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Main Roads Western Australia
Transport Modelling Section
Enquiries Graham Jacoby Ph 9323 4482
MRWA Reference
Job #27048

RICHES WY
WEIR PL
NOLAN WY
DEAN RD
3702
6410
4262
3742
50551
49607
50570
51678
PARRY AV
6207
6056
4813
5839
4666
4031
5502
4839
5240
6894
6035
5315
SPIGL WY
KWINANA FWY
BASS RD
WHEATLEY DR
VIGORS AV
HENRY BULL DR
MORE CR
12146
15058
16544
6637
19385
23571
24034
20571
21427
30392
27905
24959
SOUTH ST
237791
234549
34026
39743
32347
23877
24726
20520
20632
26278
22618
19175
IRWIN ST
ELA ST
4443
5330
2350
7619
2013
3681
5474
2298
GOWTHER ST
BASS ST
ENNALL WY
WARAKER WY
45409
36899
38469
43940
4506
3007
2232
5898
MURDOCH DR
6334
6249
6762
6328
2395
2163
2206
3977
INDLAY RD
KAREL AV
11559
10613
13105
12218
FARRINGTON RD
848
1096
1096
838
ALLENDALE ENT
38724
30650
31707
39493
BIBRA DR
BAKER

1 Lane Each Direction
2 Lanes Each Direction
3 Lanes Each Direction
4 Lanes Each Direction
Assigned Volumes
Count Volumes

- Mon 08 Oct 2012 ROM Version 2012
- Catalogue Folder: T:\VOYAGER\JOBS_V2012\ROM
- T:\VOYAGER\JOBS_V2012\ROM\Inputs\Network\99999_y2011.NET

Appendix D

Proposed Residential and Commercial Building Mark-up and Predicted Received Noise Levels at Building Facades

RESIDENTIAL
COMMERCIAL
COMMERCIAL / HEALTH / MEDI-HOTEL
PUBLIC

SOUTH STREET

FIONA WOOD RD NORTH

SJOG HOSPICE

ST JOHN OF GOD HOSPITAL

SJOG HOSPITAL EXPANSION

FIONA STANLEY HOSPITAL

CB-1
3 LEVELS 13m
11 LEVELS 45m

CB-2
SITE 1
10,743sqm
3 LEVELS 13m
10 LEVELS 41m

RB-1
10 LEVELS 33m
SITE 2
10,230sqm
2 LEVELS
9 LEVELS 33m

CB-3
6 LEVELS 24m
1 LEVEL 5m

3m LEVEL CHANGE

PEDESTRIAN ARCADE

ROAD 10

RB-2
5 LEVELS 19m
2 LEVELS 9m

RB-3
9 LEVELS 33m

SITE 3
4408sqm

RB-4
5 LEVELS 19m

MURDOCH CIRCLE

EXISTING FSH TANK UNDER

BUS STOP

CONSERVATION ZONE
9130sqm

POTENTIAL COMMUNITY BUILDINGS

POTENTIAL ELEVATED WALKWAY

RB-5
1 LEVEL 4m
SITE 4
2774sqm
9 LEVELS 33m

PROPOSED D.S.P.

PROPOSED OFF-RAMP

P.S.P. ACCESS 7.26 WIDE

RB-6
9 LEVELS 33m
SITE 5
4904sqm

RB-7
9 LEVELS 19m
1 LEVEL 4m

MURDOCH BUS/RAIL INTERCHANGE

INDICATIVE MULTI STOREY CAR PARK
5 LEVELS
~ 1300 BAYS

PEDESTRIAN ACCESS TO STATION AND CARPARK

KWINANA FWY NORTH

MANDURAH RAIL LINE

KWINANA FWY SOUTH

RB-8
9 LEVELS 33m
SITE 8
2641sqm
3 LEVELS 10m

BARRY MARSHALL PARADE

YUBARL LANE

RB-9
10 LEVELS 36m
2 LEVELS 8m
SITE 7
7160sqm

9 LEVELS 33m

COVERED LOADING ACCESS

NORTH PARK

ROAD 7

MAIN ENTRY

BEDBROOK ROW (FORMERLY NORTH RD)

MARRIOT

FSH LOADING DOCK

FIONA WOOD RD

CLARIFICATIONS
9 LEVELS = GROUND FLOOR + 8
HEIGHTS ARE GIVEN ABOVE GROUND LEVEL R.L. (VARIABLE)
HEIGHTS ARE APPROXIMATE

0 5 10 20 30m

ARM ARCHITECTURE

PRELIMINARY

SITEPLAN
MURDOCH MUP

PERTH/LANDCORP/0699
1:1000/04-Oct-2012/ SK A3001[05]

jwatson 04/10/12 11:57:18 [PRINT]
SK-A3001[05]-A1-"Siteplan.PDF (FILE)
L:\0699 Murdoch MUP\[CAD\AutoCAD\work\SK-A3001-Siteplan.dwg (CAD)

D R A F T

Table 4 Received Noise Levels at the Facades of the Proposed MUP Residential Buildings (RB) and Commercial Buildings (CB).

Yellow – Levels exceeding 55 dB(A); Brown – Exceeding 60 dB(A); Red – Exceeding 63 dB(A);

Building	Façade Direction	Received Noise Level at Building Levels $L_{Aeq, 16hr}$, dB(A)										
		Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Level 9	Level 10	Level 11
RB - 1	North	50.0	62.3	63.5	64.1	64.5	64.7	64.8	64.8	64.8	64.7	
	Northwest	57.7	60.5	61.2	61.5	61.8	61.9	62.0	62.0	62.0	62.0	N/A
	East	N/A		55.8	57.6	58.8	59.5	59.8	60.2	60.7	61.4	
RB - 2	North	51.1	52.4	54.2	55.8	56.7	N/A					
	East	N/A		51.6	55.8	58.6						
RB - 3	East	N/A		49.1	50.4	51.4	56.0	60.7	62.2	62.9	N/A	
	South	54.8	56.7	58.4	59.2	59.5	59.6	59.7	59.7	59.8		
RB - 4	North	N/A		54.2	59.0	61.0	N/A					
	East	68.0	68.2	68.2	68.1	68.0						
	South	61.2	63.3	64.7	64.9	65.0						
RB - 5	North	53.9	54.9	55.7	56.1	56.4	56.8	57.6	58.5	59.3	N/A	
	East	N/A	62.7	65.9	66.4	66.5	66.5	66.5	66.4	66.4		
	South	50.3	56.9	58.9	60.2	60.6	60.7	60.8	60.8	60.8		
RB - 6	North	49.8	57.3	58.9	59.8	60.1	60.2	60.2	60.2	60.2	N/A	
	East	N/A	53.6	61.7	64.0	64.7	64.9	65.0	65.0	64.9		
RB - 7	East	N/A	57.3	61.3	62.8	63.3	N/A					
	South	57.2	60.0	61.1	61.6	61.9						
CB - 1	North	67.3	67.4	67.2	66.9	66.6	66.2	65.9	65.5	65.2	64.9	64.6
	East	53.3	54.0	54.3	54.6	54.7	54.7	54.6	54.6	54.6	55.0	55.1
	West	N/A			47.4	53.3	55.6	56.8	57.6	58.0	58.3	58.4
CB - 1	North	67.6	67.7	67.6	67.3	66.9	66.6	66.2	65.9	65.5	65.2	
	East	N/A			53.1	61.9	63.4	63.6	63.6	63.4	63.3	N/A
	West	54.5	55.2	55.5	55.7	55.6	55.5	55.3	55.1	54.8	54.7	
CB - 1	North	59.2	64.9	66.3	66.5	66.4	66.4					
	East	67.7	67.9	68.0	68.0	67.9	67.8					
	South	59.9	60.6	63.2	63.9	63.9	64.1					

Appendix E

Predicted Outdoor Noise Levels 1.5 m above the Ground in the Study Area

AECOM

www.aecom.com

0 15 30 60

metres

Legend

LAeq, 16hr - Free Field (dB)

- < 55
- 55 - 56
- 56 - 57
- 57 - 58
- 58 - 59
- 59 - 60
- 60 - 61
- 61 - 62
- 62 - 63
- 63 - 64
- 64 - 65
- 65 - 66
- 66 - 67
- 67 - 68
- > 68
- Proposed Buildings
- Roads

Murdoch Mixed Use Precinct - Residential Development
Predicted RoadTraffic - LAeq, 16hr
Free Field Noise Levels @ 1.5m AGL

PROJECT ID	60220889
CREATED BY	MMcL
LAST MODIFIED	MMcL 29/10/12

Figure

02

Appendix F

Practical Noise Mitigation and Insulation Measure Considerations - SPP 5.4 Implementation Guidelines

The Implementation Guidelines for SPP 5.4 present a number of practical noise mitigation and insulation measures applicable to different likely outdoor noise level scenarios as listed in Table 2, in order to achieve the objectives as in Section 2.2.1. They are reproduced as follows for reference.

4.4 "Quiet House" design

Where all practicable steps to avoid or minimise transport noise have been taken but the external noise levels impacting on proposed noise-sensitive developments are predicted to exceed the "target" level criteria, specific noise amelioration measures should be considered in conjunction with the development of new buildings. The purpose of these measures is to:

- provide for at least one protected outdoor area; and
- minimise the extent of noise insulation needed in order to meet the indoor noise level standards.

4.4.1 Design and construction considerations

Measures that should be considered in order to ameliorate the impact of transport noise include:

- *Screen walls:*
  Designing walls to screen part or all of the affected property;

- *Outdoor living areas:*
  Locating outdoor living areas so as to maximise the screening effects of buildings and any barrier walls;

- *Interior layout:*
  Locating the most noise-sensitive activity spaces (bedrooms, living, entertainment, kitchen, dining) so as to minimise the intrusion of noise into such spaces;

- *Openings to habitable rooms:*
  Using upgraded glazing and, where necessary, limiting the size and height of openings to habitable rooms, to limit noise intrusion.

<u>Screen walls</u>

Where development backs onto a major transport corridor and from which access is not permitted, it is normal practice to provide for a continuous wall along the property boundary in conjunction with the original subdivision of the land. The height and construction of such walls as well as their continuity are critical to their effectiveness in reducing noise intrusion. In flat terrain they should normally have a minimum height of around 2.4 metres in order to provide an effective noise screen for immediately adjacent outdoor living areas and adjacent ground floor openings to habitable rooms (see section 4.3).

Where a continuous screen wall is not practicable - for example, where a development faces a major transport corridor - screen walls generally need to have return sections to enclose the area that is intended to be protected.

In general, screen walls will be ineffective at reducing noise levels above ground floor level, and where multi-storey buildings are proposed, appropriate noise reduction measures need to be incorporated in the design and construction of the walls of the building themselves. Such noise reduction measures will also be required for those walls or wall sections for which screening is impractical, which will generally include walls facing transport corridors from which vehicular access is provided.

While screen walls can detract from the visual amenity of the transport corridor and any adjacent access road, this can be minimised by the appropriate design and landscaping. This usually involves some degree of articulation or visual relief, coupled with suitable planting to reduce the adverse visual impact of the walls and minimise their attraction as the object of graffiti. It should be noted, however, that landscape planting alone is relatively ineffective at reducing noise transmission, and it should be seen only as a visual amenity measure.

Outdoor living areas

In many ways, outdoor living areas are the most susceptible to noise from adjacent transport corridors as they are by their nature open and therefore difficult to protect.

Unless such areas can be effectively enclosed by screen walls, they should be located on the opposite side of the building from the transport corridor, i.e. furthest away from the noise source and screened from the noise source by the building itself. This arrangement should generally be sought for residential development that faces a major transport corridor, including property that is separated from the corridor by an access road.

The impact of noise in relation to outdoor living can also be reduced by a choice of housing that places less emphasis on outdoor living areas. This is the case under the medium density codes, and in particular for areas coded R50 and above, where an outdoor living area of only 16 m^2 applies compared with a minimum of 30 m^2 or more under the low density codes.

Interior layout

Noise-sensitive spaces such as bedrooms, dedicated entertainment rooms and living areas should be situated away from the source of noise where possible, and preferably separated from such sources by service areas such as garages, store rooms, bathrooms and laundries. Where these measures are impractical, consideration needs to be given to the design and use of openings, particularly those to habitable rooms.

Openings to habitable rooms

The policy requires that where practicable, buildings should be designed and constructed so as to ensure that indoor noise levels of affected noise-sensitive premises accord with the criteria in the policy.

The most common approaches to acoustic treatment of the building envelope are:

- providing mechanical ventilation or airconditioning so windows can remain closed;
- upgrading glazing thickness;
- improving doors that open from habitable rooms to outdoors; and
- improving roof insulation.

The extent of noise insulation needed at the openings to habitable rooms will depend on how successful the "quiet house" measures have been in reducing outdoor noise levels. Where outdoor noise levels are above the "target" level, by no more than 8dB(A), these guidelines propose two "deemed-to-comply" packages that may be implemented to ensure the indoor noise standards are met

for residential development without requiring detailed specification. At higher noise levels, specialist acoustic advice will be needed.

It should be noted that where noise levels are above the "target", it will not be possible to meet the indoor noise levels standards without windows being closed. This means providing mechanical ventilation or airconditioning.

These issues are discussed in section 4.5 below.

4.4.2 Other design considerations

Care needs to be taken with the integration of the foregoing measures with other design requirements to ensure that safety, functionality and energy efficiency are not compromised in the pursuit of noise reduction. For example, designs with climate requirements may suggest a need for the location of living areas and/or orientation of openings that are not conducive to noise amelioration. In such circumstances, additional measures may be necessary to provide a satisfactory level of noise reduction, or it may be necessary to accept some compromise in relation to either or both of the conflicting design requirements.

In cases in which new living and sleeping areas are to be located in close proximity to a railway or major road, consideration also needs to be given to reducing the maximum passby noise levels, in addition to the "average" L_{Aeq} noise levels, to acceptable levels. This may be done in consultation with the Department of Environment and Conservation.

4.5 Noise insulation – "deemed to comply" packages for residential development

The following "deemed-to-comply" packages outline noise insulation measures designed to ensure that the indoor noise standards in the policy are achieved for residential developments in areas where outdoor noise levels will exceed the "target" noise levels by up to 8dB(A). These packages have been designed for developments adjacent to major roads and passenger railways, where noise levels are likely to be higher during the day than at night. In the case of freight rail, where noise levels are likely to be fairly constant over the 24-hour period, these packages can be adapted. See section 4.8 of the guidelines for guidance on developments adjacent to freight railways.

The deemed-to-comply specifications are intended to simplify compliance with the noise criteria, and the relevant package should be required as a condition of development. However, this should not remove the option to pursue alternative measures or designs. Departures from the deemed-to-comply specifications need to be accompanied by acoustic certification from a competent person, to the effect that the development will achieve the requirements of the policy.

Superior construction standards, such as those specified in the deemed-to-comply packages, are now becoming more prevalent in residential buildings; and they do not significantly increase the cost of building. A similar standard of construction has been recommended by the Western Australian Planning Commission for new housing in areas forecast to be seriously affected by aircraft noise.[4] That recommendation followed a comprehensive assessment of the efficacy and costs of noise attenuation measures, taking into account the recent changes in industry building standards as well as changes to the *Building Code of Australia*.

[4] Statement of Planning Policy No 5.1, *Land Use Planning in the Vicinity of Perth Airport* and the accompanying report on *Aircraft Noise Insulation for Residential Development in the Vicinity of Perth Airport*, February 2004.

Where transport noise levels are more than 8dB above the noise "target", i.e. 3dB above the noise "limit", or where noise-sensitive development other than residential is proposed, a detailed assessment should be prepared by a competent person. The report should specify the level of noise reduction required and the noise insulation measures needed to comply with the policy. The approval may require that the construction drawings be checked for compliance with the detailed assessment, and that follow-up verification be carried out to certify compliance.

4.5.1 Package A: noise levels within the "margin"

The following noise insulation package (Table 8) is designed to meet the indoor noise standards for residential developments in areas adjacent to major roads or passenger railways where noise levels exceed the noise "target" but are within the "limit".

D R A F T

Table 8

Area type	Orientation	Package A measures
Indoors		
Bedrooms	Facing road/rail corridor	• 6 mm laminated glazing • Casement or awning windows • No external doors • Closed eaves • No vents to outside walls/eaves • Mechanical ventilation/airconditioning (see 4.5.3)
	Side-on to corridor	• 6 mm laminated glazing • Closed eaves • Mechanical ventilation/airconditioning
	Away from corridor	No requirements
Living and work areas[5]	Facing corridor	• 6 mm laminated glazing • Casement or awning windows • 35 mm (minimum) solid core external doors with acoustic seals[6] • Sliding doors must be fitted with acoustic seals • Closed eaves • No vents to outside walls/eaves • Mechanical ventilation/airconditioning
	Side-on to corridor	• 6 mm glazing • Closed eaves • Mechanical ventilation/airconditioning
	Away from corridor	No requirements
Other indoor areas	Any	No requirements
Outdoors		
Outdoor living area[7]	Facing corridor	• Minimum 2.0 m high solid fence (e.g. Hardifence, pinelap, or Colorbond) • Picket fences are not acceptable
	Side-on to corridor	
	Away from corridor	No requirements

[5] These deemed-to-comply guidelines adopt the definitions of indoor spaces used in AS 2107-2000. A comparable description for bedrooms, living and work areas is that defined by the Building Guide of Australia as a "habitable room". The Building Guide of Australia may be referenced if greater clarity is needed. A living or work area can be taken to mean any "habitable room" other than a bedroom. Note that there are no noise insulation requirements for utility areas such as bathrooms. The Building Guide of Australia describes these utility spaces as "non-habitable rooms".

[6] Glazing panels are acceptable in external doors facing the transport corridor. However these must meet the minimum glazing requirements.

[7] The Policy requires that at least one outdoor living area be reasonably protected from transport noise. The protected area should meet the minimum space requirements for outdoor living areas, as defined in the Residential Design Codes of Western Australia.

4.5.2 Package B: noise within 3dB above the "limit"

The following noise insulation package (Table 9) is designed to meet the indoor noise standards for residential developments in areas adjacent to major roads or passenger railways where transport noise levels exceed the noise "limit" but by no more than 3dB (See Table 1 in policy).

Table 9

Area type	Orientation	Package B measures
Indoors		
Bedrooms	Facing road/rail corridor	• 10 mm laminated glazing • Casement or awning windows • No external doors • Closed eaves • No vents to outside walls/eaves • Mechanical ventilation/airconditioning (see 4.5.3)
	Side-on to corridor	• 6 mm laminated glazing • Casement or awning windows • Closed eaves • Mechanical ventilation/airconditioning
	Away from corridor	No requirements
Living and work areas[6]	Facing corridor	• 10 mm laminated glazing • Casement or awning windows • 40 mm (minimum) solid core external doors with acoustic seals[9] • Sliding doors must be fitted with acoustic seals • Closed eaves • No vents to outside walls/eaves • Mechanical ventilation/airconditioning
	Side-on to corridor	• 6 mm laminated glazing • Casement or awning windows • Closed eaves • Mechanical ventilation/airconditioning
	Away from corridor	No requirements
Other indoor areas	Any	No requirements
Outdoors		
Outdoor living area[10]	Facing corridor	• Minimum 2.4 m solid fence (e.g. brick, limestone or Hardifence) • Colorbond and picket fences are not acceptable
	Side-on to corridor	
	Away from corridor	No requirements

4.5.3 Mechanical ventilation/airconditioning

[8] These deemed-to-comply guidelines adopt the definitions of indoor spaces used in AS 2107-2000. A comparable description for bedrooms, living and work areas is that defined by the Building Guide of Australia as a "habitable room". The Building Guide of Australia may be referenced if greater clarity is needed. A living or work area can be taken to mean any "habitable room" other than a bedroom. Note that there are no noise insulation requirements for utility areas such as bathrooms. The Building Guide of Australia describes these utility spaces as "non-habitable rooms".

[9] Glazing panels are acceptable in external doors facing the transport corridor. However these must meet the minimum glazing requirements.

[10] The Policy requires that at least one outdoor living area be reasonably protected from transport noise. The protected area should meet the minimum space requirements for outdoor living areas, as defined in the Residential Design Codes of Western Australia.

Where outdoor noise levels are above the "target", both packages A and B require mechanical ventilation or airconditioning to ensure that windows can remain closed in order to achieve the indoor noise standards.

In implementing packages A and B, the following need to be observed:

- Evaporative airconditioning systems will meet the requirements for packages A and B provided attenuated air vents are provided in the ceiling space. Without such vents, these systems require windows to remain open.
- Refrigerative airconditioning systems need to be designed to achieve fresh air ventilation requirements.
- Air inlets need to be positioned facing away from the corridor where practicable.
- Ductwork needs to be provided with adequate silencing, particularly in higher noise areas, to prevent noise intrusion.

4.6 Reasonable and practicable considerations

The policy requires consideration and implementation of all "reasonable" and "practicable" noise mitigation measures to achieve the noise target and acceptable indoor noise levels. Where it can be demonstrated that it is neither practicable nor reasonable to reduce noise levels to the noise target, then higher noise levels may be acceptable, but longer term noise management strategies may need to be considered.

"Practicable" considerations for the purposes of the policy normally relate to the engineering aspects of the noise mitigation measures under evaluation. These may include:

- limitations of the different mitigation measures to reduce transport noise;
- safety issues (such as impact on crash zones or restrictions on road vision);
- topography and site constraints (such as space limitations);
- drainage requirements;
- access requirements (for driveways, pedestrian access etc);
- maintenance requirements; and
- suitability of the building for acoustic treatments.

For example, if there is insufficient space between a road and a residence then it would not practicable to build an earth bund as a noise mitigation measure, given the technical requirements for the bund to be built at a certain slope.

See also the definition of "practicable" in the *Environmental Protection Act 1986*[11].

"Reasonableness" considerations, for the purposes of the policy, would be based on understanding and balancing a range of factors, and then agreeing on the best overall outcome, taking a triple bottom line approach to the assessment of these factors.

A judgment about whether a noise mitigation measure is reasonable might include a consideration of:

[11] "Practicable" is defined in the *Environmental Protection Act 1986* to mean "reasonably practicable having regard to, among other things, local conditions and circumstances (including costs) and to the current state of technical knowledge".

- the noise reduction benefit provided;
- the number of people protected;
- the cost of mitigation;
- existing and future noise levels, including changes in noise levels;
- community views and impacts;
- aesthetic and visual impacts;
- compatibility with other planning policies;
- differences between metropolitan and regional situations; and
- the benefits arising from the proposed development.

The purpose of considering "reasonableness" concerns is to achieve the best balanced outcome with respect to noise abatement. Assessment should involve careful and thorough consideration of a wide range of factors, not just one criterion. The assessment should identify the social, economic and environmental aspects of the benefits, and the disbenefits of implementing the noise mitigation measure. In some cases it may be helpful to quantify performance against each factor, thereby enabling a more objective decision to be made.

An assessment of reasonableness should also clearly demonstrate that efforts have been made to resolve conflicts, without compromising on the need to protect noise amenity. For example, if residents are concerned about the height of a transport noise barrier, have reasonable efforts been made to design, relocate or vegetate the barrier to address these concerns?

It is preferable that reasonableness arguments be presented in triple bottom line terms. For instance, rather than arguing that a transport noise barrier should not be built because residents want their views to be retained, "reasonableness" considerations would cause an investigation into the cost of building a transparent barrier, which would enable residents' views to be retained and their noise amenity to be protected. In another case, the benefits of differing noise mitigation options could be compared by calculating the cost per unit of noise reduction provided by the barrier ($/dB), or the cost per residence ($/residence), or a combination of these ($/dB/residence).

Effective community consultation is critical in noise mitigation planning, and should be considered a vital element in any reasonableness assessment where it is proposed that residual noise impacts will remain even after the application of appropriate noise mitigation measures. This principle applies to developers, who should consult with local government, existing residents and road/rail authorities, and to new transport infrastructure providers, with a responsibility to engage with impacted residents and the local government. Stakeholders should be able to participate in the selection of the most appropriate noise mitigation option in an open, equitable and effective way.

Any case outlining reasonable and practicable considerations must be justifiable and so should be well documented. A submission outlining the reasonable and practicable considerations should help to facilitate a determination on the matter and should assist in communicating that decision to the community in a transparent way.