Lloyd George Acoustics
PO Box 717
Hillarys WA 6923
T: 9401 7770
www.lgacoustics.com.au

Noise Modelling Report - Perth Entertainment and Sporting Precinct

Burswood Park, Perth

Reference: 250310025-01B

Prepared for:
Main Roads Western Australia

CONTENTS

List of Tables

List of Figures

Appendices

EXECUTIVE SUMMARY

Lloyd George Acoustics was engaged by Main Roads Western Australia (Main Roads WA) to undertake an assessment of noise levels associated with the Perth Entertainment and Sporting Precinct (PESP) project located within Burswood Park, Perth.

The aim of the study was to provide an estimation of the predicted noise levels associated with an indicative motorsport event on the multi-use track (V8 Supercar race) and a 'Concert Event' within the outdoor amphitheatre.

Noise modelling of the multi-use track shows the upper floors of nearby residential apartment buildings would be most affected with *average* noise levels between 78 – 85 dB $L_{Aeq(1\text{-}hour)}$ and *maximum* noise levels between 84 – 91 dB L_{Amax} during a Supercars Australia race event.

Amphitheatre noise modelling indicates the 1st floor of residential apartment buildings would be most exposed to noise from a 'Concert Event' with predicted levels between 55 - 72 dB $L_{Aeq(5\text{-}min)}$ and 69 - 80 dB $L_{Ceq(5\text{-}min)}$ from the event sound system.

Appendix A presents detailed results of predicted noise levels at the nearest noise sensitive premises.

Appendix B presents noise contours associated with the multi-use track event and provides the extent of predicted noise levels 55 dB(A) or higher surrounding the PESP site.

1. INTRODUCTION

Lloyd George Acoustics was engaged by Main Roads Western Australia to undertake noise modelling for the Perth Entertainment and Sporting Precinct (PESP) located within Burswood Park, Perth - refer *Figure 1-1*.

Figure 1-1 PESP Site Location

The report aims to present the predicted noise levels associated with motorsport activity and outdoor concert events to the nearest noise sensitive premises (NSPs). Noise modelling should be considered indicative in nature as site-specific details (e.g., vehicle speeds, race duration, amphitheatre design, sound system specification etc.) are unknown at this stage.

Motorsport noise source data is taken from JACOBS noise assessment of the Newcastle 500 Supercar Championship (ref. '*Newcastle 500 Acoustic Advice'*, dated 3 August 2017). Amphitheatre sound system, or Public Address (PA) details are taken from manufacturer data and representative of large outdoor concerts held in Perth.

The results of the noise modelling will inform the creation of a Noise Management Plan (NMP) for the venue and/or proposed event(s) to be prepared once more site-specific detailed information is available.

Appendix A presents detailed results of predicted noise levels at the nearest noise sensitive premises.

Appendix B presents noise contours associated with multi-use track and provides the extent for noise levels predicted to be 55 dB(A) or higher.

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

1.1. Site Description

PESP (the *venue*) includes a multi-use track and outdoor amphitheatre capable of facilitating 15,000-20,000 people - refer *Figure 1-2*.

Figure 1-2 Site Map

Burswood Park is located on the Burswood Peninsula approximately 2.5 km east of Perth CBD and 6.0 km west of Perth Airport. Site surrounds are made up of recreation, commercial, entertainment and residential land use.

Nearest noise sensitive premises are located immediately east of the project boundary within the Town of Victoria Park – refer *Figure 1-3.*

Nearest noise sensitive premises (receivers) are discussed further in *Section 1.5.*

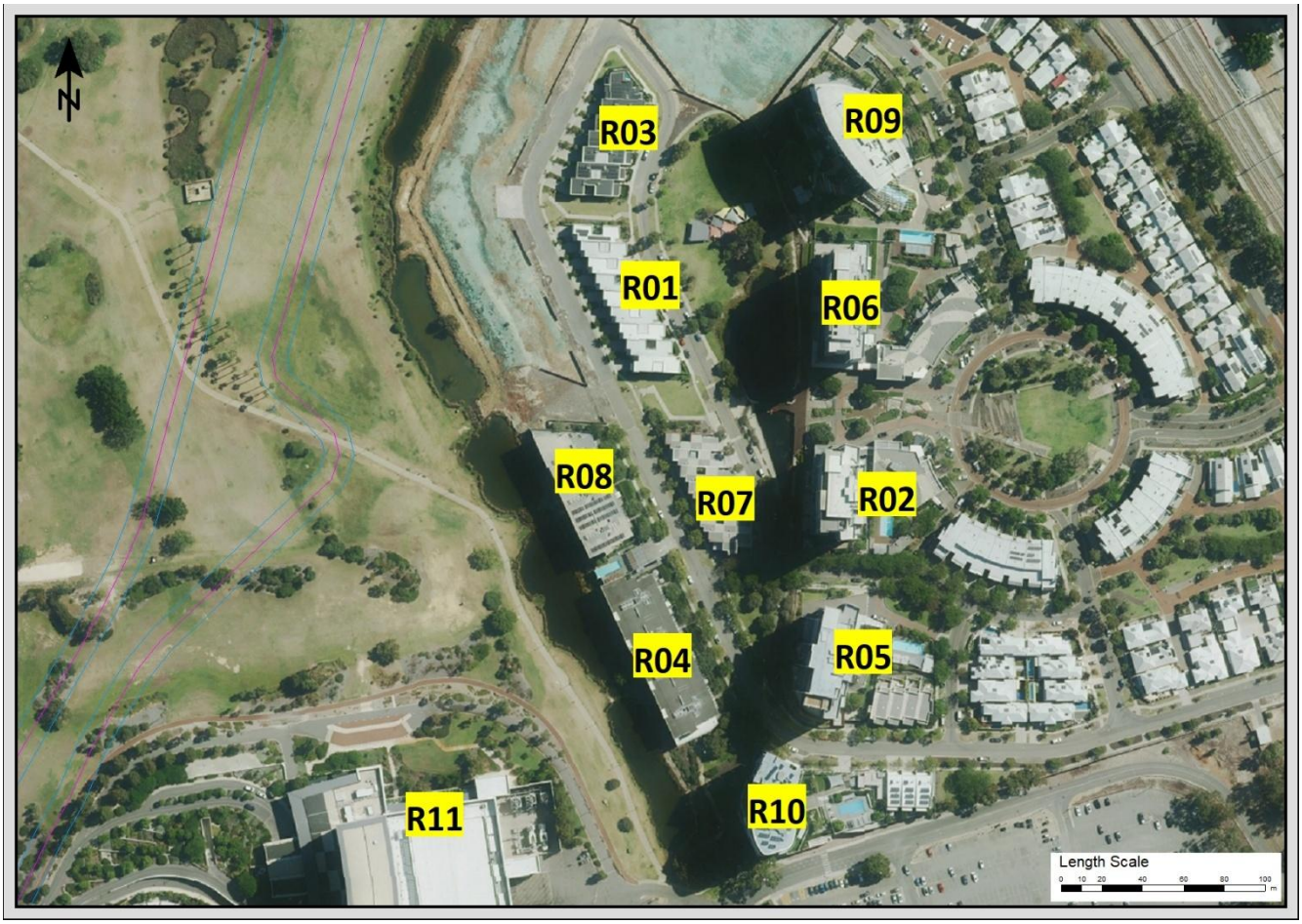


Figure 1-3 Nearest NSPs Map

1.2. Reference Documents

The following reference documents have been used in the assessment:

- *Environmental Protection (Noise) Regulations 1997* (EPNR);
- *"General Requirements of Automobiles"* - Confederation of Australian Motor Sport (CAMS);
- *"Guide to management of noise from motor sport venues"* - Department of Environmental Regulation (DER);
- *"Guide to management of noise from sporting, cultural and entertainment venues"* - Department of Environmental Regulation (DER);
- '*Newcastle 500 Acoustic Advice'* - JACOBS noise assessment, dated 3 August 2017;
- '*Wokolena Road Motor Sports Complex'* - GHD noise assessment, dated August 2013.

1.3. Operational Assumptions

The following assumptions have been used for the assessment.

1.3.1. Multi-use track (V8 Supercar event)

- 3.0 km (approx.) circuit length
- 67 laps per race;
- 1.5 hours (approx.) race duration;
- 24 x V8 Supercars per race;
- 140 km/hr average speed;
- Day (7.00am – 7.00pm) 'worst-case' meteorological conditions used for noise modelling.

1.3.2. Outdoor amphitheatre (Concert Event)

- PA system capable of appropriate coverage for 15,000 - 20,000 people;
- 5000 m^2 audience area (approx.);
- L/R line array flown 8m AGL with 8 x ground stacked subs;
- Night (7.00pm – 7.00am) 'worst-case' meteorological conditions used for noise modelling.

More detailed noise modelling assumptions are included in *Section 3.*

1.4. Assessment Limitations

The following assessment limitations are noted.

1.4.1. Multi-use track (V8 Supercar event)

Accuracy of noise predictions are limited as the speed and acceleration of each moving noise source (vehicle) around the multi-use track is unknown. More precise noise predictions may be undertaken once racetrack operational modelling has been carried and detailed vehicle movement data provided.

As such, a conservative approach of 129 dB(A) *average* and 142 dB(A) *maximum* sound power levels have been applied to each vehicle pass-by.

1.4.2. Amphitheatre 'Concert Event'

Loudspeaker design (PA) is outside the scope of this assessment. Example loudspeaker data has been used with no specialist input configuring or optimising the proposed sound system design.

No outdoor stage or amphitheatre structure has been modelled (on grade noise source only). Similarly, no temporary or permanent structures which may contribute to shielding and reduced noise levels have been included in the modelling.

1.5. Noise Sensitive Premises

1.5.1. Nearest Noise Sensitive Premises

The nearest noise sensitive premises (receivers) are identified as residential buildings located on Bow River Crescent and The Promenade, Burswood. Building heights and number of occupied floors per building have been estimated.

The nearest receivers on Bow River Crescent are multi-story apartment buildings located approximately 90m east from the multi-use track. Multiplex houses (typically 2-story) and high-rise apartment buildings are located 125m and 200m east of the multi-use track, respectively.

Crown Hotel is located on the southern boundary and is also considered a noise sensitive premises with hotel accommodation, noting only external façades are exposed to the PESP site, unlike the residential buildings, which include balconies and outdoor living areas.

Nearest noise sensitive premises are presented in *Table 1-1* and *Figure 1-4*.

Table 1-1: Nearest Noise Sensitive Premises

Receiver	Address	No. of Floors (estimated)	Distance to carriageway (m)
R01	02 -18 The Promenade, Burswood	2	120
R02	19 The Circus, Burswood	20	230
R03	20-32 The Promenade, Burswood	2	100
R04	23 Bow River Cres, Burswood	4	140
R05	26 Bow River Cres, Burswood	20	260
R06	30 The Circus, Burswood	20	250
R07	38-50 Bow River Cres, Burswood	2	150
R08	39 Bow River Cres, Burswood	4	90
R09	96 Bow River Cres, Burswood	19	230
R10	Aquarius Apartments, Burswood	14	250
R11	Crown Casino, Burswood	12	130

Distances shown above are at ground level (Ground Floor) and do not account for increased distance due to height (high-rise buildings). Further development may also occur in the future (e.g. Lot 9001 Bow River Crescent and 88 Bow River Crescent).

Figure 1-4 Nearest NSPs

1.5.2. Other Noise Sensitive Premises

Noise sensitive premises not listed in *Section 1.5.1* may also be impacted by PESP noise generating activities. Noise at greater distances around the PESP location can be reviewed with reference to the 55 dB(A) noise contour presented in *Appendix B*.

2. CRITERIA

Environmental noise in Western Australia is governed by the *Environmental Protection Act 1986*, through the *Environmental Protection (Noise) Regulations 1997* (the Regulations).

2.1. Regulations 7, 8 & 9

This group of regulations provide the prescribed standard for noise as follows:

"7. Prescribed standard for noise emissions

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

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

(b) must be free of –

(i) tonality; and

(ii) impulsiveness; and

(iii) modulation,

when assessed under regulation 9.

(2) For the purposes of subregulation (1)(a), a noise emission is taken to significantly contribute to a level of noise if the noise emission … exceeds a value which is 5 dB below the assigned level at the point of reception."

Tonality, impulsiveness and modulation are defined in regulation 9 (refer *Appendix A*). Under regulation 9(3), *"Noise is taken to be free of the characteristics of tonality, impulsiveness and modulation if -*

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

(b) the noise emission complies with the standard prescribed under regulation 7(1)(a) after the adjustments in the table [Table 2-1] … are made to the noise emission as measured at the point of reception."

Table 2-1: Adjustments Where Characteristics Cannot Be Removed

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

* These adjustments are cumulative to a maximum of 15 dB.

The assigned levels (prescribed standards) for all premises are specified in regulation 8(3) and are shown in *Table 2-2.* The L_{A10} assigned level is applicable to noises present for more than 10% of a representative assessment period, generally applicable to "steady-state" noise sources. The L_{A1} is for short-term noise sources present for less than 10% and more than 1% of the time. The L_{Amax} assigned level is applicable for incidental noise sources, present for less than 1% of the time.

Table 2-2: Baseline Assigned Levels

Premises Receiving Noise	Time Of Day	Assigned Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise sensitive premises: highly sensitive area[1]	0700 to 1900 hours Monday to Saturday (Day)	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sunday and public holidays (Sunday)	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours all days (Evening)	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	35 + influencing factor	45 + influencing factor	55 + influencing factor
Noise sensitive premises: any area other than highly sensitive area	All hours	60	75	80
Commercial Premises	All hours	60	75	80
Industrial and Utility Premises	All hours	65	80	90

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

It must be noted the assigned levels above apply outside the receiving premises and at a point at least 3 metres away from any substantial reflecting surfaces. The assigned levels are statistical levels and therefore the period over which they are determined is important. The Regulations define the Representative Assessment Period (RAP) as "*a period of time of not less than 15 minutes, and not exceeding 4 hours*, *determined by* an *inspector* or *authorised person to be appropriate for the assessment of a noise emission, having regard to the type and nature of the noise emission"*.

An inspector or authorised person is a person appointed under Sections 87 & 88 of the *Environmental Protection Act 1986* and include Local Government Environmental Health Officers and Officers from the Department of Water Environmental Regulation. Acoustic consultants or other environmental consultants are not appointed as an inspector or authorised person.

The influencing factors varies according to major and secondary roads and commercial and industrial zoning within 450 metres of a residence. As such, the assigned level is variable such that for the purpose of this exercise, the influencing factor has been considered to be 0.

2.2. Regulation 16A

The Regulations acknowledge that motor sport activities are unlikely to achieve compliance with the assigned levels. To address this, the Regulations specifically provide allowances for motor sport venues through a process of approvals defined in regulation 16A. Excerpts from regulation 16A relevant to the project are reproduced below.

"16AA Approval of noise management plan: motor sport venue

(1) The occupier of a motor sport venue may apply to the CEO for approval of –

(a) a noise management plan for the venue; or

(b) an amendment of an approved noise management plan for the venue.

(3) The CEO may, in writing —

(a) if the application is for the approval of a noise management plan — approve, or refuse to approve, the noise management plan for the motor sport venue; or

(b) if the application is for an amendment of an approved noise management plan — approve, or refuse to approve, the amendment.

(4) Before making a decision under subregulation (3) the CEO —

(a) must give the following a reasonable opportunity to make a submission on whether or not the plan or amendment should be approved —

(i) the occupier of any noise sensitive premises within 1 km of the motor sport venue;

(ii) the local government of each district in which noise emissions received from the venue are likely to fail to comply with the standard prescribed under regulation 7; and

(b) may give any other person the CEO considers appropriate in the circumstances a reasonable opportunity to make a submission on whether or not the plan or amendment should be approved.

(5) An approval of a noise management plan under subregulation (3) —

(a) may be granted subject to conditions imposed by the CEO; and

(b) subject to subregulation (6) and regulation 16AC, has effect for the period specified in the approval.

(7) The CEO must not approve a noise management plan for a motor sport venue unless the plan —

(a) contains a map (current at the time of the application) showing the motor sport venue, including the area where motor vehicles or motor vessels are raced or prepared for racing and car parks used by competitors in races at and visitors to the venue; and

(b) contains a description of the types of racing activities that can reasonably be expected to be conducted at the venue and classes of vehicles or vessels that can reasonably be expected to race at the venue; and

(c) sets out limitations on the racing activities to be conducted and the times during which racing activities may be conducted; and

(d) contains details of reasonable and practicable measures to be implemented to control noise emissions from the venue during the conduct of a racing activity at the venue; and

(e) contains details of when and the manner in which notice of racing activities at the venue is to be published or distributed to members of the public; and

(f) specifies the persons who will be responsible for implementing the approved noise management plan and sets out each person's responsibilities; and

(g) contains a complaint response procedure.

(9) Regulation 7 does not apply to noise emitted from a motor sport venue during the conduct of a racing activity at the venue if the racing activity is conducted in accordance with an approved noise management plan, excluding any ancillary measure, for the venue."

2.3. Regulation 18

Regulation 18 sets out an approval process for sporting, cultural, or entertainment events where noise levels are unlikely to achieve compliance with the assigned levels. In most cases, regulation 18 is used for outdoor concerts or festivals that include musical performances.

With regulation 18 approval, event noise emissions are permitted to exceed the assigned levels provided that the occupier or applicant complies with the event's conditions of approval.

"Regulation 18

(3) Where the CEO is satisfied that a proposed sporting, cultural or entertainment event that is to be open to the public -

(a) is likely to result in the emission of noise in contravention of the standard prescribed under regulation 7; and

(b) would lose its character or usefulness if it were required to comply with that standard,

the CEO may approve the event, subject to such conditions as the CEO thinks fit, for the purposes of this regulation."

2.4. Regulation 19B

Regulation 19B is typically sort where events occur regularly and the occupier believes the approval will provide certainty as to the types and number of events that they can hold per year.

The approval allows the occupier of a venue or public place to exceed the assigned levels – referred to as *notifiable events* - under designated conditions and for an approved period, typically no less than three (3) years and not more than five (5) years.

2.5. Regulation Guidelines

In applying the Regulations detailed above, further guidance is obtained from the following *Department of Water and Environmental Regulation* (DWER, formally DER) publications:

- *"Guide to management of noise from motor sport venues*" - Department of Environmental Regulation (DER), dated July 2014;
- *"Guide to management of noise from sporting, cultural and entertainment venues"* - Department of Environmental Regulation (DER), dated October 2014.

3. METHODOLOGY

Computer modelling using *SoundPLAN 9.1* has been used to predict the noise emissions from the project to nearby receivers. Motorsport vehicle noise was modelled using the *CONCAWE* algorithm due to the size of the assessment area and required distance for noise propagation calculation.

Amphitheatre noise was modelled using *ISO 9613-2:2024* algorithm for its ability to integrate detailed loudspeaker data into noise propagation calculations. Input data required in the model are listed below and discussed in *Section 3.1* to *Section 3.4*:

- Meteorological Information;
- Topographical data;
- Ground Absorption; and
- Noise source levels.

3.1. Meteorological Conditions

Meteorological information utilised for the assessment is provided in *Table 3-1* (Motorsport) and *Table 3-2* (Amphitheatre) and are considered to represent worst-case conditions for noise propagation during day and night-time periods.

Table 3-1: Meteorological Conditions (CONCAWE) Used for Motorsport Modelling

Parameter	Day (7.00am to 7.00pm)[2]
Temperature (°C)	20
Humidity (%)	50
Wind Speed (m/s)	4
Wind Direction[1]	All
Pasquil Stability Factor	E

Notes:
1. The modelling package allows for all wind directions to be modelled simultaneously.
2. The conditions above are as defined in *Guideline: Assessment of Environmental Noise Emissions*; May 2021

Table 3-2: Meteorological Conditions (ISO 9613-2:2024) Used for Amphitheatre Modelling

Parameter	Night (7.00pm to 7.00am)
Temperature (°C)	15
Humidity (%)	50
Wind Speed (m/s)	Up to 5
Wind Direction*	All

* The modelling package allows for all wind directions to be modelled simultaneously.

3.2. Topographical Data

Topographical data was provided by Main Roads WA (sourced from Landgate) and also adapted from publicly available sources (e.g. *Google*). Surrounding buildings were incorporated in the noise model as these can provide noise shielding as well as reflection paths.

Elevations and the number of floors per building have been estimated using *Google*. Typical residential buildings are modelled at 3.5m per floor with receivers located 1.5m above each floor level height.

3.3. Ground Absorption

The ground absorption has been modelled to be 0.1 (10%), noting that 0.0 represents hard reflective surfaces such as water and 1.0 represents absorptive surfaces such as grass.

3.4. Source Sound Levels

Noise source levels used in the modelling are provided in *Table 3-3.*

Table 3-3: Noise Source Levels, dB

Description	Octave Band Centre Frequency (Hz)								Overall dB(A)
	63	125	250	500	1k	2k	4k	8k	
Scenario 1 –*Multi-use track (V8 Supercar event)*									
V8 Supercar pass-by, L_{eq}	133	129	126	127	125	120	115	109	**129**
V8 Supercar pass-by, L_{max}	146	143	139	140	138	133	128	123	**142**
Scenario 2 - *Amphitheatre 'Concert Event'*									
Concert, 100 dB(A) / 110 dB(C) @30m, $L_{eq(5\text{-}min)}$	105	104	99	96	95	90	85	82	**100**

The following is noted in relation to *Table 3-3:*

- V8 Supercars modelled as a moving-point source at a height of 0.5m;
- V8 Supercars sound power levels are per vehicle;
- V8 Supercars spectrum from GHD assessment '*Wokolena Road Motor Sports Complex'* dated August 2013;
- Multi-use track includes 1.0m high concrete safety barrier either side;
- Concert sound pressure levels provided as 5-min *average* ($L_{Aeq(5\text{-}min)}$) at 30m directly in front of stage;
- Concert line arrays modelled at a height of 8.0m and sub-array at ground level;
- Concert spectrum based on 'Modern Music' d&b audiotechnik reference spectra.

V8 Supercar pass-by *average* (L_{Aeq}) and *maximum* (L_{Amax}) sound power levels are taken from JACOBS noise assessment '*Newcastle 500 Acoustic Advice'* dated 3 August 2017. For this assessment, the logarithmic average of the maximum sound power values presented in *Appendix B – Monitoring Results* summary table have been used – refer *Figure 3-1.*

Summary of monitoring results

Speed	Operating condition	Sound Power Level								
		L_{Aeq} dB(A)			L_{AMax} dB(A)			L_{CPeak} dB(C)		
		Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
High	Moderate acceleration	119	126	129	131	139	143	144	153	156
Mid	High acceleration	125	126	128	138	140	145	152	162	167
Low	Braking	111	116	122	116	127	134	139	149	159
Low	Low acceleration	111	121	131	122	131	140	138	147	153
Low	High acceleration	118	126	131	126	137	143	140	152	160
				129 dB(A)			142 dB(A)			

Figure 3-1 Logarithmic Average of Measured Values

3.5. Operational Scenarios

3.5.1. Scenario 1 – Multi-use track (V8 Supercar event)

Motorsport noise emissions (vehicles) are assessed using 1-hour *A-Weighted, Equivalent Continuous Sound Levels*, $L_{Aeq(1\text{-}hour)}$ and maximum noise levels, L_{AMax} as these metrics are accessible and understandable descriptors of noise experienced during an indicative V8 Supercar race.

Maximum noise levels, L_{AMax} have been assessed using a conservative sound power level of 142 dB(A). It is noted this level would theoretically exceed the maximum sound pressure level provided within CAMMS *Technical Appendix (Schedule B)* requirement.

Supercar Championship races are typically 1.5 hours in duration and occur once a day over a 3-day period to include qualifying and practice. Other race event types e.g., sprint cars, motorcycles etc. also typically occur over the 3-day event, however, V8 Supercars are considered the most likely to result in noise impacts and therefore are an appropriate and conservative representation of all motorsport events held on the multi-use track during this event.

As discussed in *Section 1.4.1* assessment against other noise descriptors (L_{A10}, L_{A1} etc.) may be carried out once modelled vehicle speeds and detailed race data is known.

3.5.2. Scenario 2 – Amphitheatre 'Concert Event'

The outdoor amphitheatre is assessed using 5-min, *A-Weighted*, $L_{Aeq(5\text{-}min)}$ and C-*Weighted Equivalent Continuous Sound Levels*, $L_{Ceq(5\text{-}min)}$ as these noise descriptors are commonly used for event noise management in Western Australia and are referenced within guidance provided by DWER.

4. RESULTS

Summary of predicted noise levels at the most affected noise sensitive premises are presented below.

4.1. Scenario 1 – Multi-use track (V8 Supercar event)

Table 4-1 summarises the most affected noise sensitive premises (per building) for Scenario 1 – Multi-use track (V8 Supercar event) noise. Detailed results of predicted noise levels for all receivers are included in *Appendix A*.

Table 4-1: Scenario 1 Predicted Levels, dB(A)

Receiver	Address	Most Exposed Floor within Building	Predicted Noise Levels, $L_{Aeq(1\text{-}hr)}$	Predicted Noise Levels, L_{Amax}
R01	02 -18 The Promenade, Burswood	Level 1	83	87
R02	19 The Circus, Burswood	Level 13	81	85
R03	20-32 The Promenade, Burswood	Level 1	84	89
R04	23 Bow River Cres, Burswood	Level 3	82	87
R05	26 Bow River Cres, Burswood	Level 15	81	86
R06	30 The Circus, Burswood	Level 17	82	86
R07	38-50 Bow River Cres, Burswood	Level 1	78	84
R08	39 Bow River Cres, Burswood	Level 2	84	91
R09	96 Bow River Cres, Burswood	Level 15	82	86
R10	Aquarius Apartments, Burswood	Level 13	80	85
R11	Crown Casino, Burswood	Level 6	85	91

Noise contour plots are provided in *Figure 4-1* and *Figure 4-2* showing the *average* ($L_{Aeq(1\text{-}hour)}$) noise levels at ground level (1.5m AGL) and 20m above ground level, respectively.

Noise contour plots are also provided in *Figure 4-3* and *Figure 4-4* showing the *maximum* (L_{Amax}) noise levels at ground level (1.5m AGL) and 20m above ground level, respectively.

Figure 4-1: Scenario 1 - Ground Floor (1.5m AGL), dB $L_{Aeq(1\text{-}hour)}$

Multi-use track (V8 Supercar event)

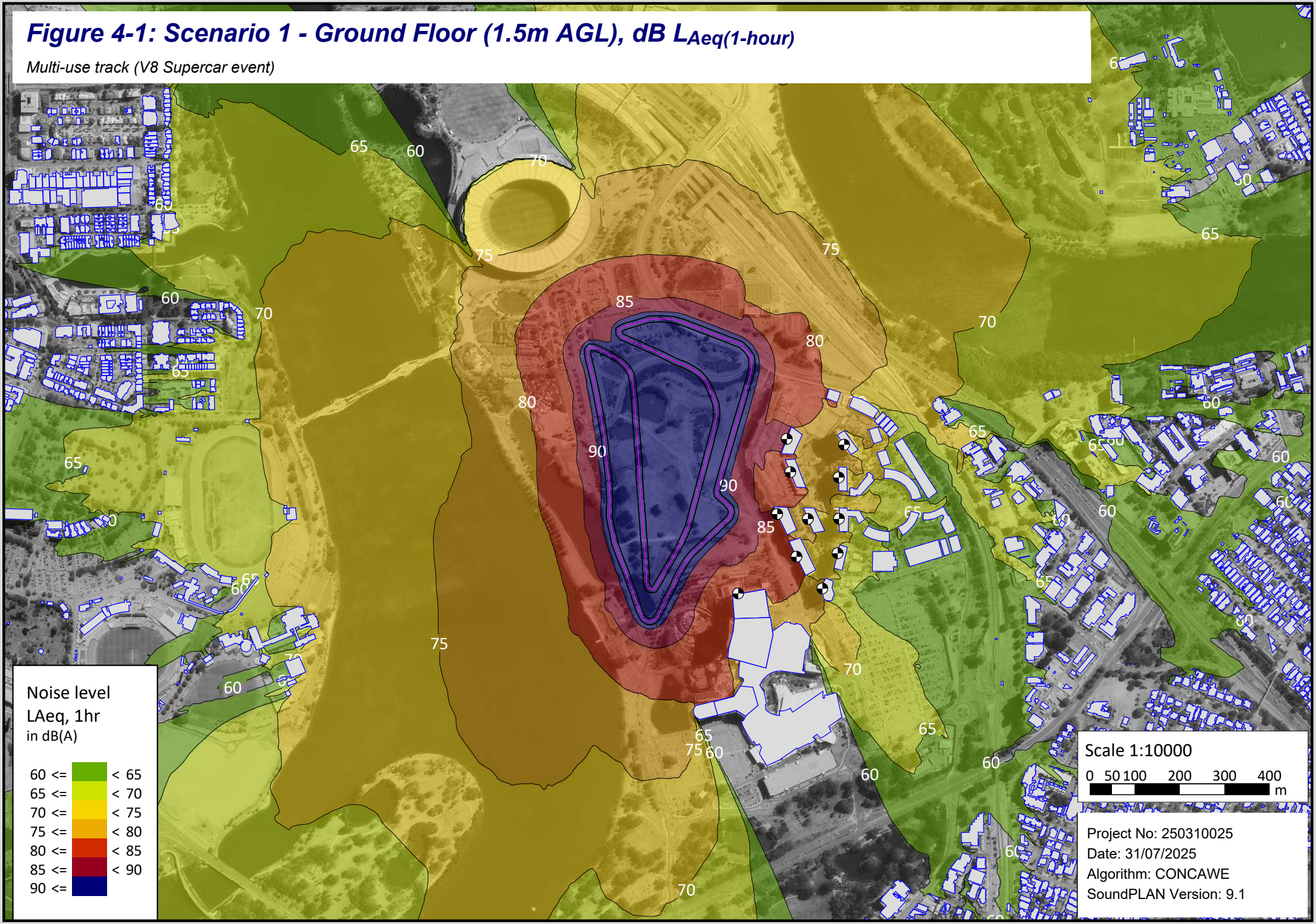


Figure 4-2: Scenario 1 - 20m AGL, dB $L_{Aeq(1\text{-}hour)}$

Multi-use track (V8 Supercar event)

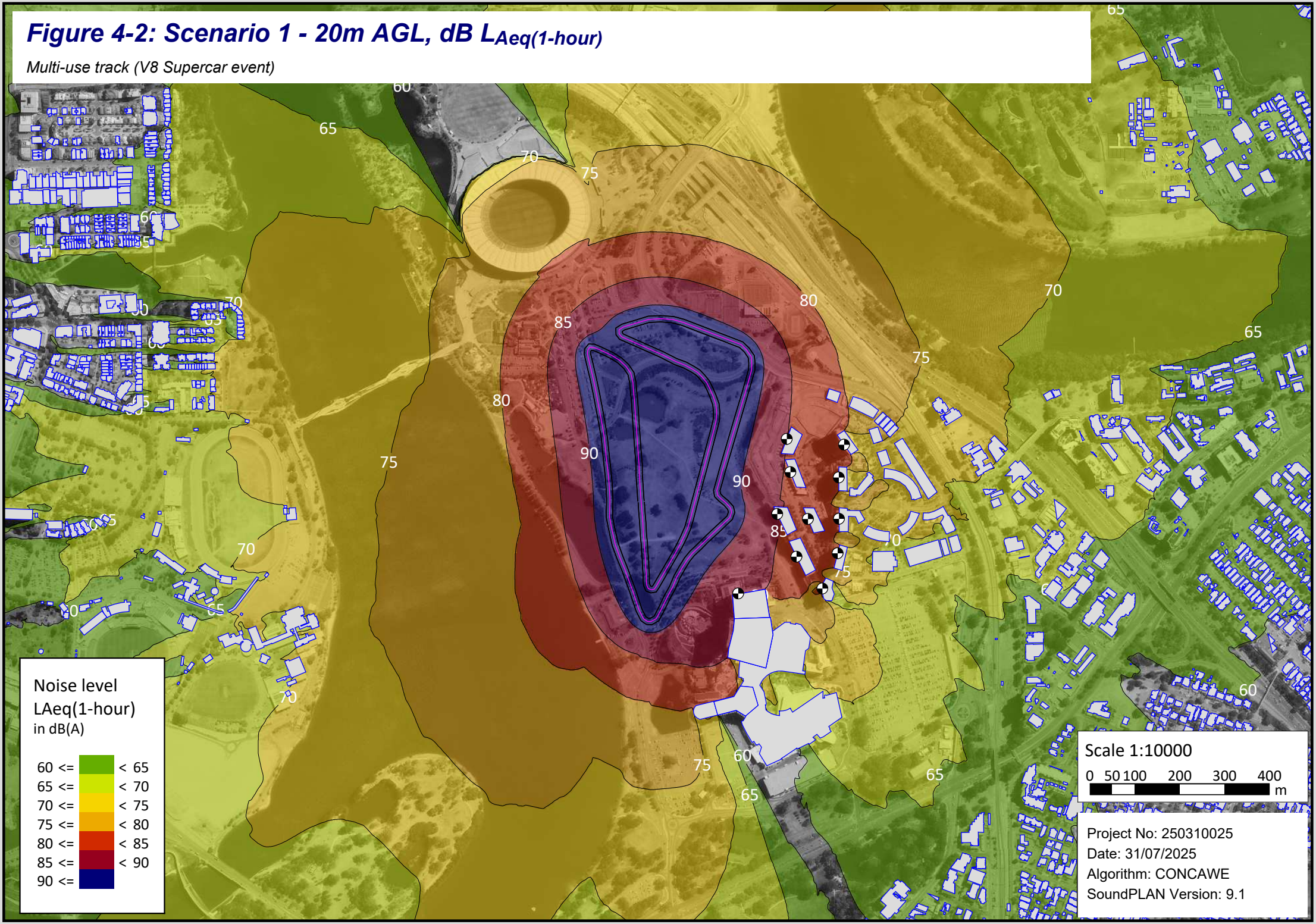


Figure 4-3: Scenario 1 - Ground Floor (1.5m AGL), dB L_{Amax}

Multi-use track (V8 Supercar event)

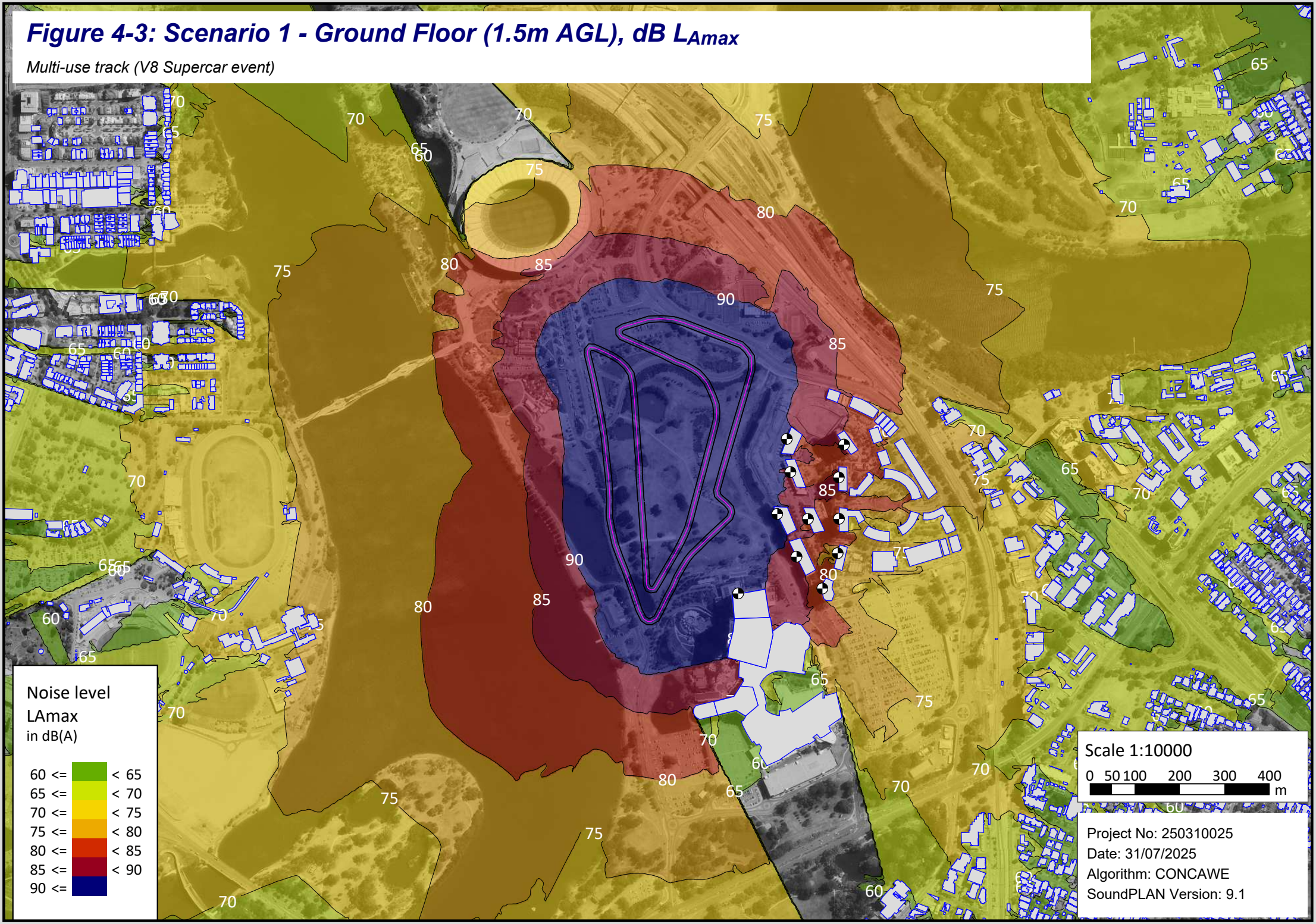
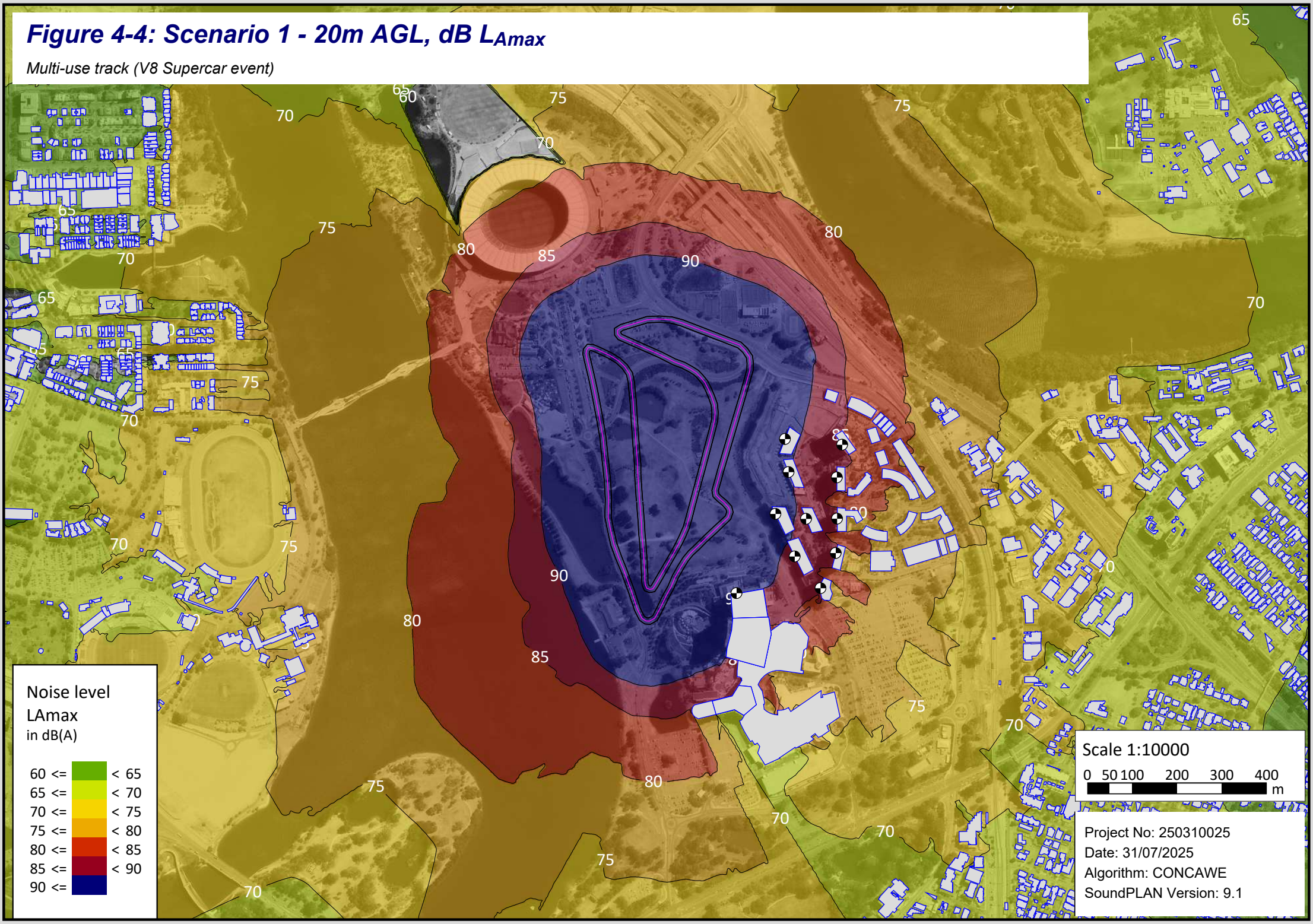


Figure 4-4: Scenario 1 - 20m AGL, dB L_{Amax}

Multi-use track (V8 Supercar event)



4.2. Scenario 2 – Amphitheatre 'Concert Event'

Table 4-2 summarises the most affected noise sensitive premises (per building) for Scenario 2 – Amphitheatre 'Concert Event'. Detailed results of predicted noise levels for all receivers are included in *Appendix A*.

Table 4-2: Scenario 2 Predicted Levels, dB(A)

Receiver	Address	Most Exposed Floor within Building	Predicted Noise Levels, $L_{Aeq(5\text{-}min)}$, dB	Predicted Noise Levels, $L_{Ceq(5\text{-}min)}$, dB
R01	02 -18 The Promenade, Burswood	Level 1	70	79
R02	19 The Circus, Burswood	Level 10	65	76
R03	20-32 The Promenade, Burswood	Level 1	72	80
R04	23 Bow River Cres, Burswood	Level 3	62	77
R05	26 Bow River Cres, Burswood	Level 14	63	75
R06	30 The Circus, Burswood	Level 4	66	77
R07	38-50 Bow River Cres, Burswood	Level 1	55	69
R08	39 Bow River Cres, Burswood	Level 3	67	80
R09	96 Bow River Cres, Burswood	Level 3	67	77
R10	Aquarius Apartments, Burswood	Level 13	63	76
R11	Crown Casino, Burswood	Level 11	67	80

Noise contour plots are provided in *Figure 4-5* and *Figure 4-6* showing $L_{Aeq(5\text{-}min)}$ noise levels at ground floor (1.5m) and 20m above ground level respectively.

Figure 4-5: Scenario 2 - Ground Floor (1.5m AGL), dB $L_{Aeq(5\text{-}min)}$

Amphitheatre 'Concert Event' assuming 100 dB(A) / 110 dB(C) @30m from stage

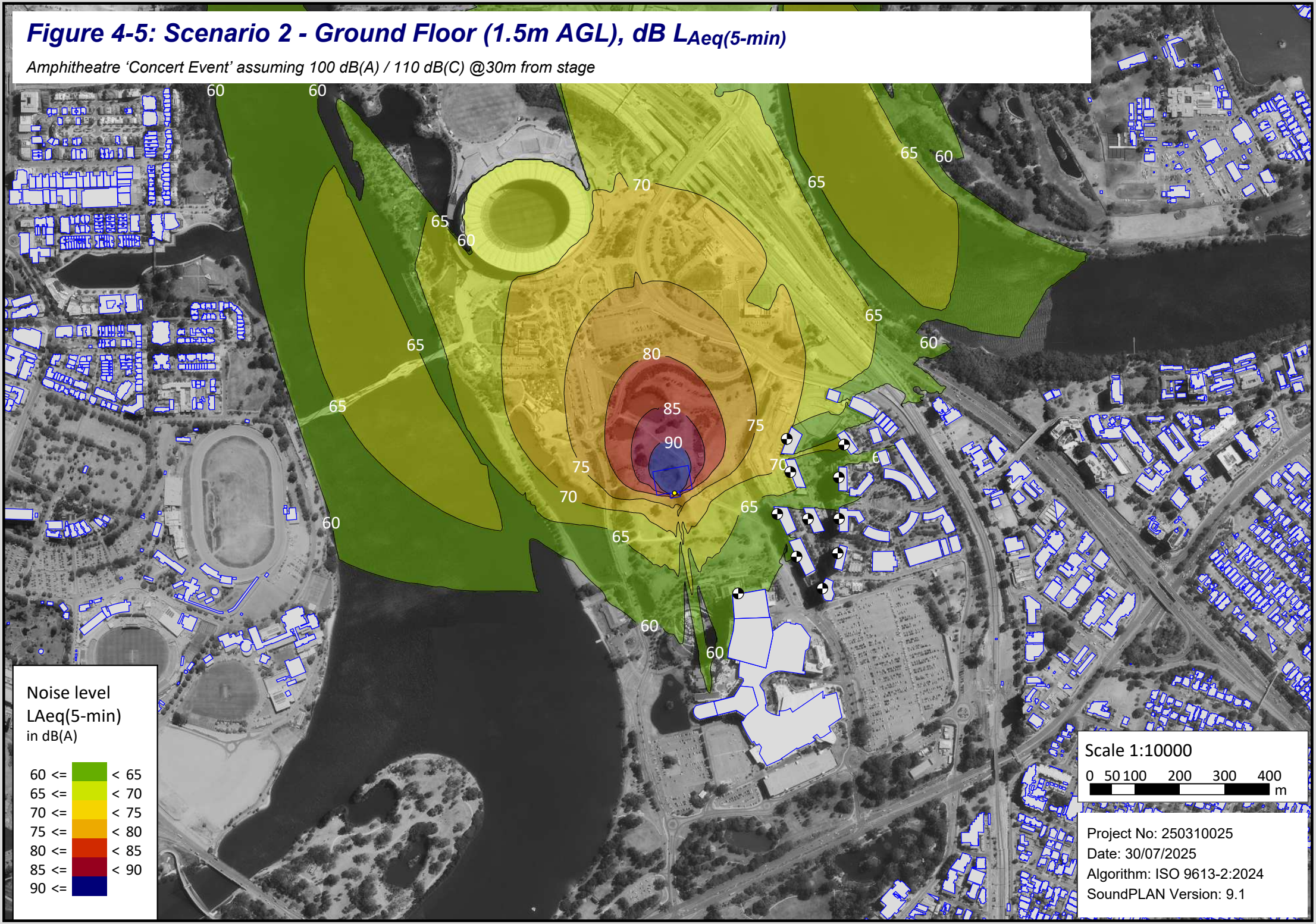
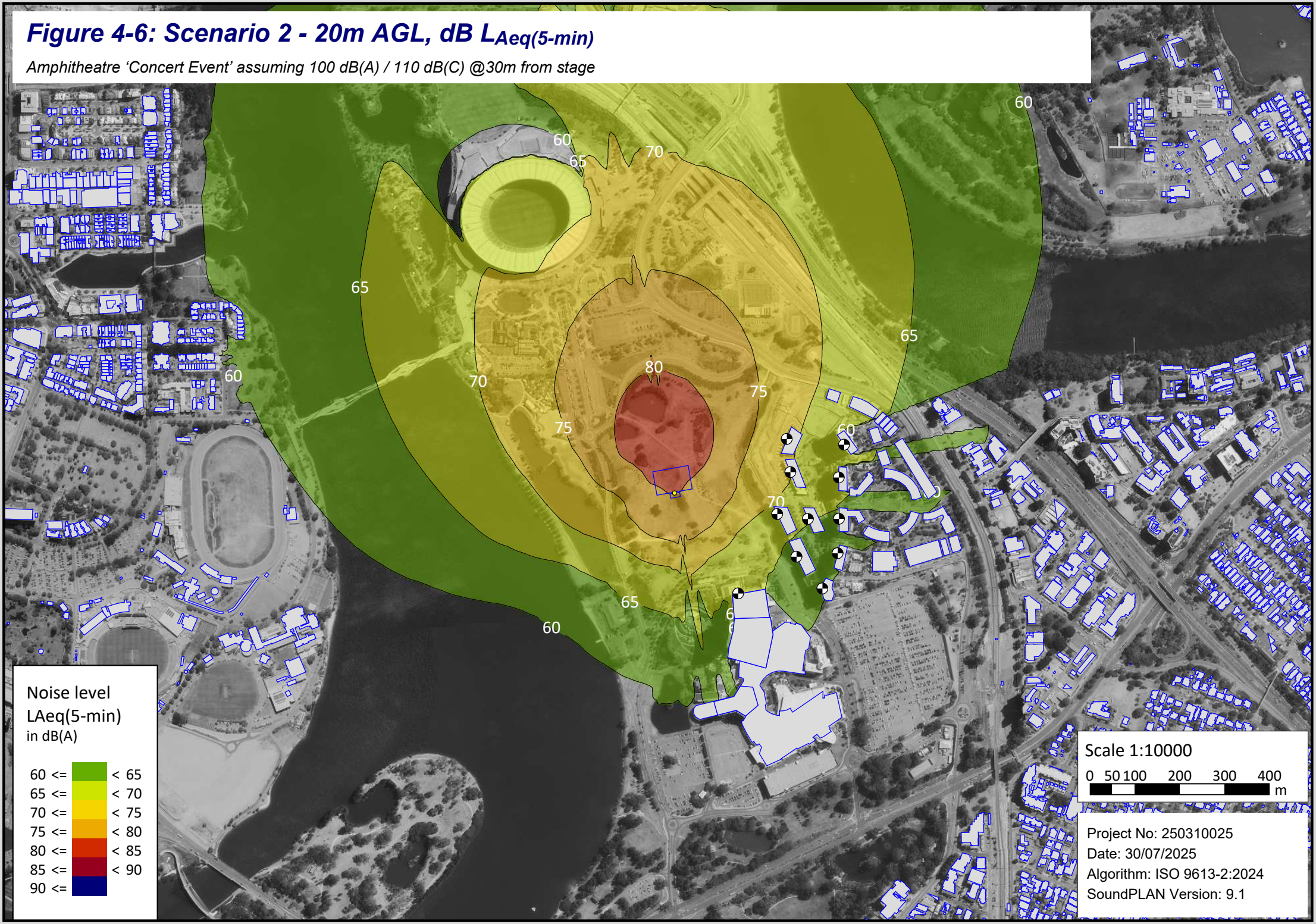


Figure 4-6: Scenario 2 - 20m AGL, dB $L_{Aeq(5\text{-}min)}$

Amphitheatre 'Concert Event' assuming 100 dB(A) / 110 dB(C) @30m from stage



5. CONCLUSION

Noise modelling has been carried out to predict noise levels associated with the PESP at the nearest NSPs. The noise modelling is preliminary in nature and does not include the use of potential noise mitigation in the form of amphitheatre design, temporary or permanent noise walls, earth bunds, PESP structures or shielding by any other means.

Appendix A presents detailed results of predicted noise levels at the nearest noise sensitive premises.

Appendix B presents noise contours associated with multi-use track and provides the extent of noise levels predicted to be 55 dB(A) or higher.

APPENDIX A – DETAILED RESULTS

Table A1: Detailed Results - Scenario 1 - Multi-use track (V8 Supercar)

NSP	Name	Floor	Scenario 1 – Multi-use track (V8 Supercar)	
			$L_{Aeq, 1hr}$, dB	L_{Amax}, dB
R01	02-18 The Promenade	Ground Floor	82	87
R01	02-18 The Promenade	Level 1	83	87
R02	19 The Circus	Ground Floor	73	81
R02	19 The Circus	Level 1	76	82
R02	19 The Circus	Level 2	77	82
R02	19 The Circus	Level 3	78	82
R02	19 The Circus	Level 4	79	83
R02	19 The Circus	Level 5	79	83
R02	19 The Circus	Level 6	79	84
R02	19 The Circus	Level 7	79	84
R02	19 The Circus	Level 8	80	85
R02	19 The Circus	Level 9	80	85
R02	19 The Circus	Level 10	80	85
R02	19 The Circus	Level 11	80	85
R02	19 The Circus	Level 12	80	85
R02	19 The Circus	Level 13	81	85
R02	19 The Circus	Level 14	81	85
R02	19 The Circus	Level 15	81	85
R02	19 The Circus	Level 16	81	85
R02	19 The Circus	Level 17	81	85
R02	19 The Circus	Level 18	81	85
R02	19 The Circus	Level 19	81	85
R03	20-32 The Promenade	Ground Floor	83	89
R03	20-32 The Promenade	Level 1	84	89
R04	23 Bow River Cres	Ground Floor	80	87
R04	23 Bow River Cres	Level 1	81	87
R04	23 Bow River Cres	Level 2	81	87
R04	23 Bow River Cres	Level 3	82	87
R05	26 Bow River Cres	Ground Floor	70	76
R05	26 Bow River Cres	Level 1	73	78

NSP	Name	Floor	Scenario 1 – Multi-use track (V8 Supercar)	
			$L_{Aeq, 1hr}$, dB	L_{Amax}, dB
R05	26 Bow River Cres	Level 2	75	81
R05	26 Bow River Cres	Level 3	77	83
R05	26 Bow River Cres	Level 4	78	83
R05	26 Bow River Cres	Level 5	79	84
R05	26 Bow River Cres	Level 6	79	84
R05	26 Bow River Cres	Level 7	79	84
R05	26 Bow River Cres	Level 8	79	84
R05	26 Bow River Cres	Level 9	79	85
R05	26 Bow River Cres	Level 10	80	85
R05	26 Bow River Cres	Level 11	80	85
R05	26 Bow River Cres	Level 12	80	85
R05	26 Bow River Cres	Level 13	80	85
R05	26 Bow River Cres	Level 14	80	86
R05	26 Bow River Cres	Level 15	81	86
R05	26 Bow River Cres	Level 16	81	86
R05	26 Bow River Cres	Level 17	81	86
R05	26 Bow River Cres	Level 18	81	86
R05	26 Bow River Cres	Level 19	81	86
R06	30 The Circus	Ground Floor	75	83
R06	30 The Circus	Level 1	78	84
R06	30 The Circus	Level 2	79	86
R06	30 The Circus	Level 3	80	85
R06	30 The Circus	Level 4	80	84
R06	30 The Circus	Level 5	80	84
R06	30 The Circus	Level 6	80	84
R06	30 The Circus	Level 7	80	84
R06	30 The Circus	Level 8	80	85
R06	30 The Circus	Level 9	81	85
R06	30 The Circus	Level 10	81	86
R06	30 The Circus	Level 11	81	86
R06	30 The Circus	Level 12	81	86

NSP	Name	Floor	Scenario 1 – Multi-use track (V8 Supercar)	
			$L_{Aeq, 1hr}$, dB	L_{Amax}, dB
R06	30 The Circus	Level 13	81	86
R06	30 The Circus	Level 14	81	86
R06	30 The Circus	Level 15	81	86
R06	30 The Circus	Level 16	81	86
R06	30 The Circus	Level 17	82	86
R06	30 The Circus	Level 18	82	86
R06	30 The Circus	Level 19	82	86
R07	38-50 Bow River Cres	Ground Floor	77	83
R07	38-50 Bow River Cres	Level 1	78	84
R08	39 Bow River Cres	Ground Floor	83	90
R08	39 Bow River Cres	Level 1	83	91
R08	39 Bow River Cres	Level 2	84	91
R08	39 Bow River Cres	Level 3	84	91
R09	96 Bow River Cres	Ground Floor	77	84
R09	96 Bow River Cres	Level 1	79	85
R09	96 Bow River Cres	Level 2	80	84
R09	96 Bow River Cres	Level 3	80	85
R09	96 Bow River Cres	Level 4	80	84
R09	96 Bow River Cres	Level 5	80	84
R09	96 Bow River Cres	Level 6	80	84
R09	96 Bow River Cres	Level 7	80	85
R09	96 Bow River Cres	Level 8	81	85
R09	96 Bow River Cres	Level 9	81	86
R09	96 Bow River Cres	Level 10	81	86
R09	96 Bow River Cres	Level 11	81	86
R09	96 Bow River Cres	Level 12	81	86
R09	96 Bow River Cres	Level 13	81	86
R09	96 Bow River Cres	Level 14	81	86
R09	96 Bow River Cres	Level 15	82	86
R09	96 Bow River Cres	Level 16	82	86
R09	96 Bow River Cres	Level 17	82	86

NSP	Name	Floor	Scenario 1 – Multi-use track (V8 Supercar)	
			$L_{Aeq, 1hr}$, dB	L_{Amax}, dB
R09	96 Bow River Cres	Level 18	82	86
R10	Aquarius Apartments	Ground Floor	74	80
R10	Aquarius Apartments	Level 1	75	80
R10	Aquarius Apartments	Level 2	75	81
R10	Aquarius Apartments	Level 3	76	82
R10	Aquarius Apartments	Level 4	78	83
R10	Aquarius Apartments	Level 5	78	83
R10	Aquarius Apartments	Level 6	78	83
R10	Aquarius Apartments	Level 7	78	83
R10	Aquarius Apartments	Level 8	78	83
R10	Aquarius Apartments	Level 9	79	84
R10	Aquarius Apartments	Level 10	79	84
R10	Aquarius Apartments	Level 11	79	84
R10	Aquarius Apartments	Level 12	79	85
R10	Aquarius Apartments	Level 13	80	85
R11	Crown Casino	Ground Floor	82	87
R11	Crown Casino	Level 1	83	88
R11	Crown Casino	Level 2	83	88
R11	Crown Casino	Level 3	83	88
R11	Crown Casino	Level 4	84	89
R11	Crown Casino	Level 5	84	90
R11	Crown Casino	Level 6	85	91
R11	Crown Casino	Level 7	85	91
R11	Crown Casino	Level 8	85	91
R11	Crown Casino	Level 9	85	91
R11	Crown Casino	Level 10	85	91
R11	Crown Casino	Level 11	85	91

Table A2: Detailed Results - Scenario 2 - Amphitheatre 'Concert Event'

NSP	Name	Floor	Scenario 2 – Amphitheatre 'Concert Event'	
			$L_{Aeq, 5\text{-}min}$, dB	$L_{Ceq, 5\text{-}min}$, dB
R01	02-18 The Promenade	Ground Floor	68	79
R01	02-18 The Promenade	Level 1	70	79
R02	19 The Circus	Ground Floor	56	70
R02	19 The Circus	Level 1	59	72
R02	19 The Circus	Level 2	62	75
R02	19 The Circus	Level 3	63	75
R02	19 The Circus	Level 4	63	75
R02	19 The Circus	Level 5	63	75
R02	19 The Circus	Level 6	64	75
R02	19 The Circus	Level 7	64	75
R02	19 The Circus	Level 8	64	76
R02	19 The Circus	Level 9	65	76
R02	19 The Circus	Level 10	65	76
R02	19 The Circus	Level 11	65	76
R02	19 The Circus	Level 12	65	76
R02	19 The Circus	Level 13	64	76
R02	19 The Circus	Level 14	64	75
R02	19 The Circus	Level 15	64	75
R02	19 The Circus	Level 16	64	75
R02	19 The Circus	Level 17	63	75
R02	19 The Circus	Level 18	63	75
R02	19 The Circus	Level 19	62	75
R03	20-32 The Promenade	Ground Floor	69	79
R03	20-32 The Promenade	Level 1	72	80
R04	23 Bow River Cres	Ground Floor	59	76
R04	23 Bow River Cres	Level 1	60	75
R04	23 Bow River Cres	Level 2	61	76
R04	23 Bow River Cres	Level 3	62	77
R05	26 Bow River Cres	Ground Floor	51	68
R05	26 Bow River Cres	Level 1	54	70
R05	26 Bow River Cres	Level 2	57	72

NSP	Name	Floor	Scenario 2 – Amphitheatre 'Concert Event'	
			$L_{Aeq, 5\text{-}min}$, dB	$L_{Ceq, 5\text{-}min}$, dB
R05	26 Bow River Cres	Level 3	60	74
R05	26 Bow River Cres	Level 4	60	74
R05	26 Bow River Cres	Level 5	61	74
R05	26 Bow River Cres	Level 6	61	75
R05	26 Bow River Cres	Level 7	62	75
R05	26 Bow River Cres	Level 8	62	75
R05	26 Bow River Cres	Level 9	62	75
R05	26 Bow River Cres	Level 10	63	75
R05	26 Bow River Cres	Level 11	63	75
R05	26 Bow River Cres	Level 12	63	75
R05	26 Bow River Cres	Level 13	63	75
R05	26 Bow River Cres	Level 14	63	75
R05	26 Bow River Cres	Level 15	63	75
R05	26 Bow River Cres	Level 16	63	75
R05	26 Bow River Cres	Level 17	63	75
R05	26 Bow River Cres	Level 18	63	75
R05	26 Bow River Cres	Level 19	63	75
R06	30 The Circus	Ground Floor	62	75
R06	30 The Circus	Level 1	66	75
R06	30 The Circus	Level 2	66	76
R06	30 The Circus	Level 3	66	76
R06	30 The Circus	Level 4	66	77
R06	30 The Circus	Level 5	66	77
R06	30 The Circus	Level 6	66	77
R06	30 The Circus	Level 7	66	77
R06	30 The Circus	Level 8	66	77
R06	30 The Circus	Level 9	66	76
R06	30 The Circus	Level 10	66	76
R06	30 The Circus	Level 11	65	76
R06	30 The Circus	Level 12	65	76
R06	30 The Circus	Level 13	65	76
R06	30 The Circus	Level 14	64	76

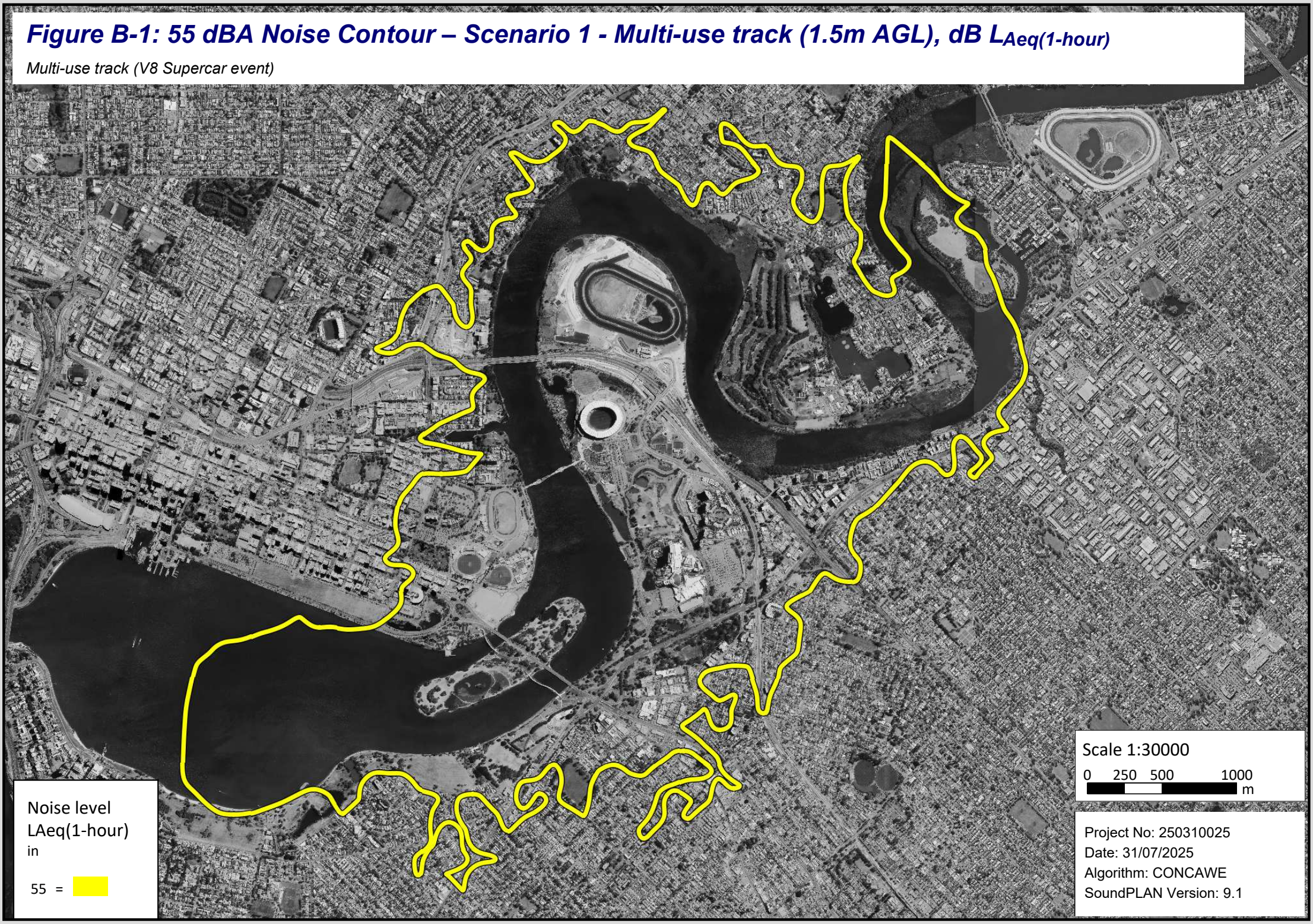
NSP	Name	Floor	Scenario 2 – Amphitheatre 'Concert Event'	
			$L_{Aeq, 5\text{-}min}$, dB	$L_{Ceq, 5\text{-}min}$, dB
R06	30 The Circus	Level 15	64	76
R06	30 The Circus	Level 16	63	76
R06	30 The Circus	Level 17	63	75
R06	30 The Circus	Level 18	62	75
R06	30 The Circus	Level 19	62	75
R07	38-50 Bow River Cres	Ground Floor	53	67
R07	38-50 Bow River Cres	Level 1	55	69
R08	39 Bow River Cres	Ground Floor	63	78
R08	39 Bow River Cres	Level 1	64	78
R08	39 Bow River Cres	Level 2	66	79
R08	39 Bow River Cres	Level 3	67	80
R09	96 Bow River Cres	Ground Floor	65	76
R09	96 Bow River Cres	Level 1	67	76
R09	96 Bow River Cres	Level 2	67	76
R09	96 Bow River Cres	Level 3	67	77
R09	96 Bow River Cres	Level 4	67	77
R09	96 Bow River Cres	Level 5	67	77
R09	96 Bow River Cres	Level 6	67	77
R09	96 Bow River Cres	Level 7	67	77
R09	96 Bow River Cres	Level 8	66	77
R09	96 Bow River Cres	Level 9	66	77
R09	96 Bow River Cres	Level 10	66	76
R09	96 Bow River Cres	Level 11	65	76
R09	96 Bow River Cres	Level 12	65	76
R09	96 Bow River Cres	Level 13	65	76
R09	96 Bow River Cres	Level 14	64	76
R09	96 Bow River Cres	Level 15	64	76
R09	96 Bow River Cres	Level 16	63	76
R09	96 Bow River Cres	Level 17	63	75
R09	96 Bow River Cres	Level 18	63	75
R10	Aquarius Apartments	Ground Floor	57	74
R10	Aquarius Apartments	Level 1	58	74

NSP	Name	Floor	Scenario 2 – Amphitheatre 'Concert Event'	
			$L_{Aeq, 5\text{-}min}$, dB	$L_{Ceq, 5\text{-}min}$, dB
R10	Aquarius Apartments	Level 2	59	75
R10	Aquarius Apartments	Level 3	60	75
R10	Aquarius Apartments	Level 4	60	75
R10	Aquarius Apartments	Level 5	60	75
R10	Aquarius Apartments	Level 6	61	75
R10	Aquarius Apartments	Level 7	61	75
R10	Aquarius Apartments	Level 8	61	75
R10	Aquarius Apartments	Level 9	62	75
R10	Aquarius Apartments	Level 10	62	76
R10	Aquarius Apartments	Level 11	62	76
R10	Aquarius Apartments	Level 12	63	76
R10	Aquarius Apartments	Level 13	63	76
R11	Crown Casino	Ground Floor	61	77
R11	Crown Casino	Level 1	62	77
R11	Crown Casino	Level 2	64	79
R11	Crown Casino	Level 3	64	79
R11	Crown Casino	Level 4	65	79
R11	Crown Casino	Level 5	65	79
R11	Crown Casino	Level 6	65	80
R11	Crown Casino	Level 7	66	80
R11	Crown Casino	Level 8	66	80
R11	Crown Casino	Level 9	66	80
R11	Crown Casino	Level 10	66	80
R11	Crown Casino	Level 11	67	80

APPENDIX B - 55 dB(A) NOISE CONTOUR

Figure B-1: 55 dBA Noise Contour – Scenario 1 - Multi-use track (1.5m AGL), dB $L_{Aeq(1\text{-}hour)}$

Multi-use track (V8 Supercar event)



APPENDIX C – TERMINOLOGY

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

- **Background Noise**

The underlying level of noise present in ambient noise, generally excluding the noise source under investigation, when extraneous noise is removed.

- **Decibel (dB)**

The decibel is the unit that describes the sound pressure levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

- **A-Weighting**

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

- **Sound Power Level (L_w)**

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

- **Sound Pressure Level (L_p)**

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

- **L_{ASlow}**

This is the noise level in decibels, obtained using the A-frequency weighting and the S (slow) time weighting. Unless assessing modulation, all measurements use the slow time weighting characteristic.

- **L_{AFast}**

This is the noise level in decibels, obtained using the A-frequency weighting and the F (fast) time weighting. This is used when assessing the presence of modulation.

- **L_{APeak}**

This is the greatest absolute instantaneous sound pressure level in decibels using the A-frequency weighting.

- **L_{Amax}**

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

- **L_{A1}**

The L_{A1} level is the A-weighted noise level exceeded for 1 percent of the measurement period and is considered to represent the average of the maximum noise levels measured.

- **L_{A10}**

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

- **L_{A90}**

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

- **L_{Aeq}**

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

- **One-Third-Octave Band**

Means a band of frequencies spanning one-third of an octave and having a centre frequency between 25 Hz and 20000 Hz inclusive.

- **Representative Assessment Period**

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

- **L_{Amax} assigned level**

Means an assigned level, which, measured as a L_{ASlow} value, is not to be exceeded at any time.

- **L_{A1} assigned level**

Means an assigned level, which, measured as a L_{ASlow} value, is not to be exceeded for more than 1 percent of the representative assessment period.

- **L_{A10} assigned level**

Means an assigned level, which, measured as a L_{ASlow} value, is not to be exceeded for more than 10 percent of the representative assessment period.

- **Tonal Noise**

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

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

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

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

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

This is relatively common in most noise sources.

- **Modulating Noise**

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

– a variation in the emission of noise that —

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

(b) is present for at least 10% of the representative assessment period; and

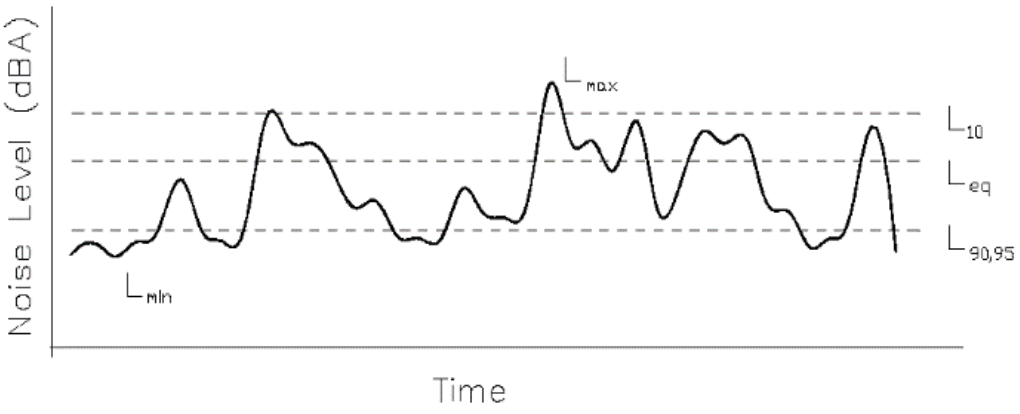
(c) is regular, cyclic and audible.

- **Impulsive Noise**

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

– a variation in the emission of a noise where the difference between L_{Apeak} and L_{Amax} is more than 15 dB when determined for a single representative event.

- **Chart of Noise Level Descriptors**



- **Typical Noise Levels**