



**MARSHALL DAY**  
Acoustics



**EDEN PARK - CONCERTS APPLICATION  
ASSESSMENT OF NOISE EFFECTS**

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**Project:** EDEN PARK – CONCERTS APPLICATION  
Assessment of Noise Effects

**Prepared for:** The Eden Park Trust Board  
PO Box 56906  
Dominion Road  
Auckland  
New Zealand

**Attention:** Mr Nick Sautner

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## 1.0 BACKGROUND

The Eden Park Trust Board (EPTB) is applying for consent to hold six amplified concerts at Eden Park in any 12 month period.

Marshall Day Acoustics (MDA) has been involved with noise at Eden Park since 1993. This has included the original application for night games in 1993, the 2015 RWC hearings, ongoing noise monitoring required by the various conditions of consent, presentation of evidence at the Auckland Unitary Plan Hearings, and a review of noise effects from the charity concert proposed to take place on Waitangi Day 2019.

On this occasion, MDA has been engaged by EPTB to examine the noise effects associated with concerts at Eden Park, to propose noise conditions and to advise on any necessary mitigation measures.

### 1.1 Special Event Noise Controls – NZ Wide

Community response to amplified music is influenced by a number of factors and varies significantly from individual to individual. However, it is generally agreed that if concerts are limited in frequency, duration and have a clear known cut-off time, they are accepted by the community at considerably higher noise levels than the noise limits applying to day to day activities. A short duration noise impact is considered reasonable when balanced against the wider community benefits of a large entertainment event.

This concept is reflected in the noise limits applying to most stadia around New Zealand. A summary of noise controls for ‘high noise events’ applying to stadia outside Auckland is attached as Appendix B (Auckland stadia are discussed separately below). In summary, the other New Zealand stadia are allowed between 3 to 30 high noise events per year, with noise limits ranging from 75 to 90 dB and cut off times from 10pm to 11:30pm.

### 1.2 Controls for other Auckland Stadia

The Auckland Unitary Plan (AUP) has adopted a ‘multi-stage’ approach to the setting of noise limits for the other major recreation facilities in Auckland. This ‘multi-stage’ approach sets higher noise limits for infrequent events and lower noise limits as the frequency of events increases. As discussed above, if high noise events are limited in frequency, duration and cut-off time, they are generally accepted by the community at considerably higher noise levels than the noise limits applying to day to day activities.

The AUP provides for concerts as a permitted activity at Western Springs, Mt Smart and North Harbour stadia and also for the Ellerslie Racecourse, ASB Showgrounds, Bruce Pullman Park and ECOLight Stadium (Pukekohe) – Counties Stadium. These are all outdoor facilities and are surrounded by residential properties with varying proximity. Eden Park is the only major stadium in Auckland where concerts are not a permitted activity.

A detailed summary of the ‘three stage special event’ noise controls adopted in the AUP for these facilities is included as Appendix C. A condensed summary of the noise limits specifically applying to outdoor concerts at these facilities, is provided in the following Table 1. Table 1 also shows the noise limits that apply to recreational parks under the Auckland wide ‘temporary activity rule’ (E40) and this is discussed below in section 1.3. The proposed conditions for Eden Park included at the end of this report are also summarised in Table 1.

**Table 1: Auckland High Noise Event Controls**

Facility	Events per year	Duration (Hours) <sup>1</sup>	Cut-off time <sup>2</sup>	Noise Limit (dB L <sub>Aeq</sub> )
Western Springs Stadium	6	6 + 2	10:00/11:00pm	82
Mt Smart Stadium	6	6 + 3	10:30pm	75
North Harbour Stadium	6	4 + 3	11:30pm	82
Ellerslie Racecourse, ASB Showgrounds, Bruce Pullman Park, ECOLight Stadium	5	6	10:30pm	75
Temporary Activity Rule E40.6.4; Auckland wide	15	6 + 2	11:00pm	80
Eden Park Proposed	6	6 + 3	10:30/11:00pm	75

1. Where two numbers are shown (x+y) the first (x) is the maximum duration of the concert noise and 'y' is the maximum duration of sound check/rehearsal

2. The first cut-off time applies Sunday to Thursday and the second applies to Friday and Saturday nights

### 1.3 Temporary Activity Rule

The AUP Auckland-wide Temporary Activity rule E40.6.4 is also included in Table 1 above. This rule also adopts the 'short duration, infrequent, high noise limit' concept and applies to typical parks in residential areas around Auckland. In summary, the rule allows 12 events per year operating at up to 70 dB L<sub>Aeq</sub> and another 3 events per year up to 80 dB L<sub>Aeq</sub> at the residential receivers. The duration of events is a maximum of 6 hours (with an extra 2 hours for sound balancing) and the cut-off time is 11pm (all days). These noise limits have been included in the Table 1 summary above.

In my opinion, the Temporary Activity noise provisions form the basis of what the Council regards as a reasonable level of noise exposure that residents surrounding a public park might be exposed to from infrequent events. Normally, residents surrounding a nominated recreation facility such as Eden Park, could expect to experience noise levels higher than residents surrounding an Open Space Zone or parkland. However, I note that the Eden Park Precinct Activity Table excludes the Temporary Activity provisions from application.

### 1.4 Noise Limits at Eden Park

The Auckland Unitary Plan (AUP) noise rules for Eden Park are contained in the Eden Park Precinct provisions (Activity Table I310) and reproduced as Appendix D to this report. The Auckland-wide noise provisions (E25) do not apply to Eden Park. The noise rules for Eden Park are unique in amongst the other major recreation facilities in Auckland in that there is no relaxation of the noise limits for short duration infrequent events as there are for the other stadia discussed above. Other stadia have a general 'day to day' noise limit of 50 dB or 55 dB and much higher limits for rugby and concerts (as discussed above). All events at Eden Park (that are permitted, controlled or restricted discretionary activities) including sporting events, have to comply with the general day to day noise limit of 55dB L<sub>A10</sub> (and 40dB L<sub>A10</sub> after 10:30pm) at the residential boundary.

This stringent approach has been in place since the 1993 application for evening sports games at Eden Park. The only relaxation of noise limits at Eden Park has been for the 2011 Rugby World Cup and the 2015 Cricket World Cup, where slightly higher noise limits (+5dB) were obtained through resource consent applications for those events.

During the AUP hearings there was significant debate regarding the possibility of concerts at Eden Park. Noise evidence was presented by Chris Day supporting 6 concerts per year with a 75 dB noise limit. Caucusing took place between the various noise experts. A number of residents submitted against the concept of concerts at Eden Park.

After hearing the evidence and submissions, the IHP and Council decided to retain the discretionary activity status for up to 6 concerts per year in the AUP. While the Unitary Plan has specific noise limits that apply to permitted, controlled and restricted discretionary activities, there are no noise limits for concerts, leaving noise to be considered on a case by case discretionary activity basis. There is one unconnected statement in rule I310.6.1.1 (7) that refers to "75 dB noise events" with out any explanation in the rules as to what a "75 dB noise event" is. It appears, this reference suggests a 75 dB limit was intended for the 6 concerts.

Noise conditions for the proposed concerts are provided in section 4 of this report - they are more restrictive than for other concert venues in New Zealand.

## **2.0 NOISE MODELLING**

The main noise sources associated with large amplified concerts are; music through the loudspeaker systems, crowd noise during the event and during dispersion afterwards and 'bump in/bump out' noise before/after the event. Each of these three sources is examined in this section.

### **2.1 Sound System Noise**

Computer noise modelling of sound emanating from a concert sound system has been carried out using the internationally recognised sound modelling software SoundPLAN. This program utilises the algorithms contained in ISO 9613-2:1996 "*Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation*".

ISO 9613 considers a range of frequency dependent attenuation factors, including spherical divergence, atmospheric absorption, ground effect, and acoustic screening. It assumes meteorological conditions favourable to propagation from sources (downwind and wind speeds of 1 – 5 m/s in all directions), and as such, represents a conservative 'worst case' approach.

The digital terrain and surrounding houses used in the modelling was obtained from the Auckland Council GIS. The dimensions of the Eden Park buildings were obtained from architectural drawings with some areas verified by site inspection.

The consent application for the 2015/16 redevelopment of Eden Park (New South and East Stands), included an acoustic barrier at the rear of the East Stand. There have been some practical difficulties with installation of the barrier however the barrier is now going to be installed and this will be in place before any concert (if consent is granted).

Modern rock concerts invariably use loudspeakers in the form of 'line arrays' - large vertical banks of speaker boxes with a slight curvature in the lower sections. The loudspeaker directivity for the noise modelling was based on 'line array directivity' and positioned as two-point sources at 12m high (the top of a typical line array). This 'point source at 12m' approach means the results are slightly conservative as in reality the lower speakers in the line array are well below 12m and would get additional shielding from the stands

The sound power of the source (sound system) was initially calibrated to 105 dBA at 30m (the mixing console) which is the upper end of what MDA has measured from a significant number of large rock concerts. This source level was originally modelled to determine the noise levels in the surrounding area in the worst case situation. A significant concert promoter, Paul Dainty, has confirmed that 100 dBA at the mixing console would be adequate for most concerts that would come to Eden Park. This slightly reduced source level has also been modelled.

MDA has modelled the concert sound emission from the park with three different stage arrangements. This modelling shows that when a stage is located at the east end of the field (facing to the west) compliance with the proposed 75 dBA noise limit can be achieved based on the slightly reduced internal sound level of 100 dB at the mixing. However, the EPTB would like to be able to host the louder rock bands occasionally. MDA has also modelled a west located stage (facing east) with 105 dB at the mixing console. This modelling shows that even with the noisiest bands, 75 dB can be achieved in the residential area using the west stage arrangement. A third 360 degree surround stage arrangement has also been modelled.

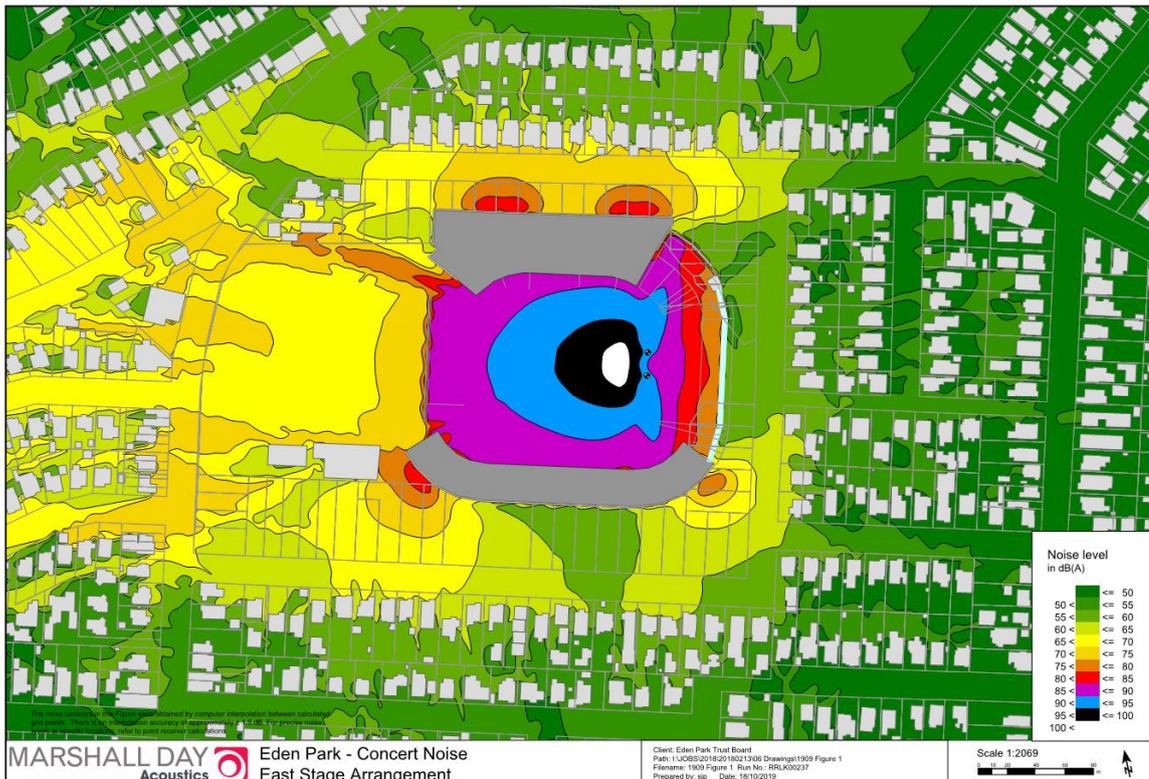
The following three concert arrangements have been modelled with different sound levels at the mixing console;

- East Stage – speakers facing west (100 dB @ 30m)
- West Stage – speakers facing east(105 dB @ 30m)
- Centre Stage – 360 degree speaker arrangement (100 dB @ 30m)

### 2.1.1 Sound System Modelling Results

The resulting noise contours for the three stage configurations discussed above are shown in large format in Appendix C and included below for convenience. Figure 1 below shows the predicted noise contours for the east stage configuration with the moderate source level (100 dB).

**Figure 1 – Predicted Concert Noise Levels – East Stage (100dBA @ 30m)**



The deep orange colour shows areas exposed to noise levels between 75 dB and 80 dB  $L_{Aeq}$ . The figure shows that all houses in the residential zone around Eden Park would be exposed to noise levels of less than 75 dB  $L_{Aeq}$ . There are however two properties in the north west corner of the Eden Park Precinct (zoned 'Major Recreation Facility') where the noise level is predicted to be 75 to 76 dB  $L_{Aeq}$ . The noise rules in the Eden Park Precinct section of the Unitary Plan (I310) apply "within the

boundary of any site in a residential zoned property”, thus the noise limits do not apply to this small group of properties however the effects on people living in these two buildings are discussed in section 3 of this report.

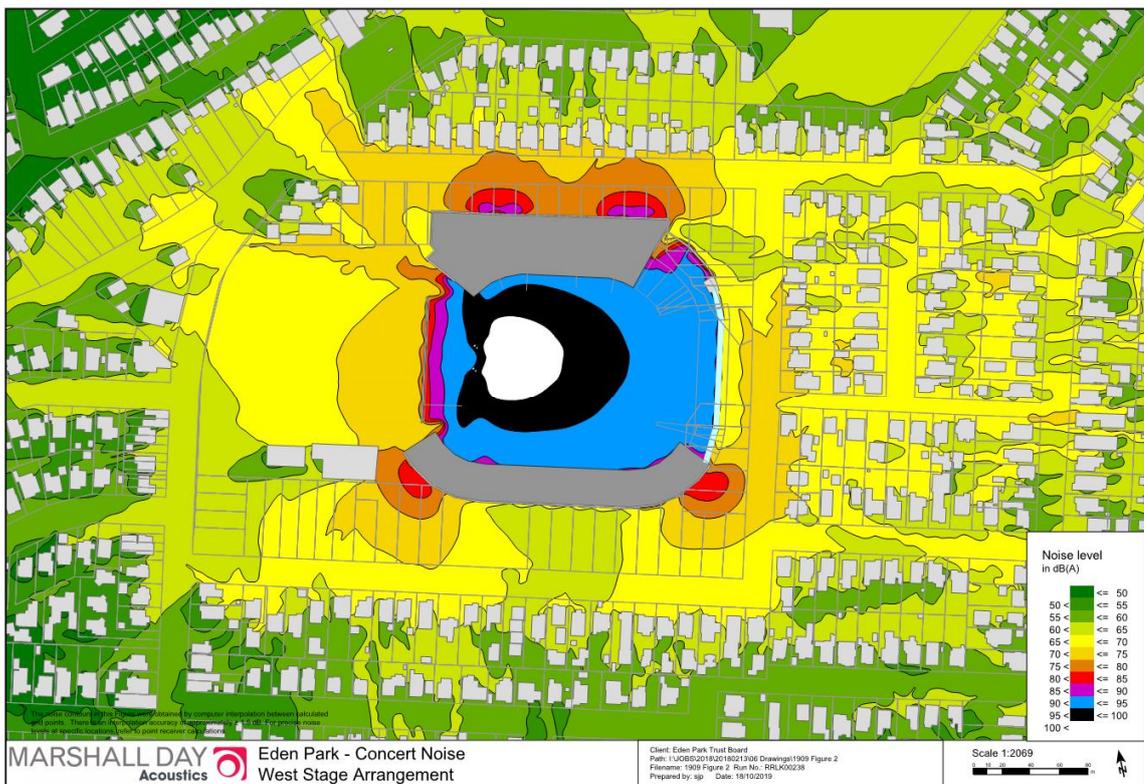
It is important to note that apart from approximately 20 houses exposed to 70 to 75 dB  $L_{Aeq}$ , the wider group of houses close to the stadium are mostly below 70 dB  $L_{Aeq}$ .

For completeness, the large buildings in the south west corner closest to the stadium (inside the Precinct) are non-residential (they are part of EPT’s operations on the No 2 field).

This east stage configuration is the most likely arrangement to be used for ‘moderate’ bands and the predictions show that levels can be contained to achieve 75 dB  $L_{Aeq}$  in the residentially zoned areas.

In order to host the louder bands, a west stage configuration has been developed as shown below.

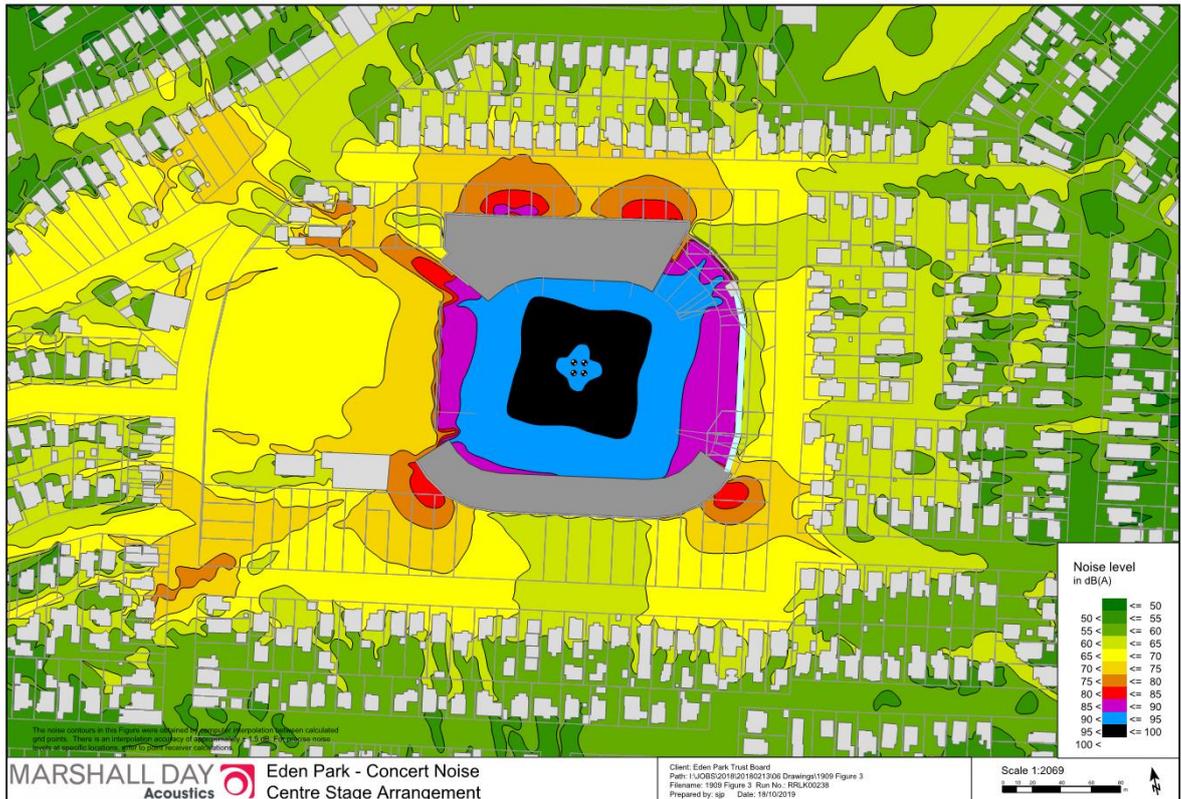
**Figure 2 - Predicted Concert Noise Levels – West Stage (105dBA @ 30m)**



With the west stage location and the louder band levels, the predicted noise level is below 70 dB  $L_{Aeq}$  in all residential use properties including the Eden Park Precinct properties to the north west. This includes the effect of the acoustic barrier on the east stand.

Some acts prefer to utilise a centre stage with a 360 degree surround audience, so this arrangement has been modelled also with the results shown in Figure 3 below.

Figure 3 – Predicted Concert Noise Levels – Centre Stage (100dBA @ 30m)

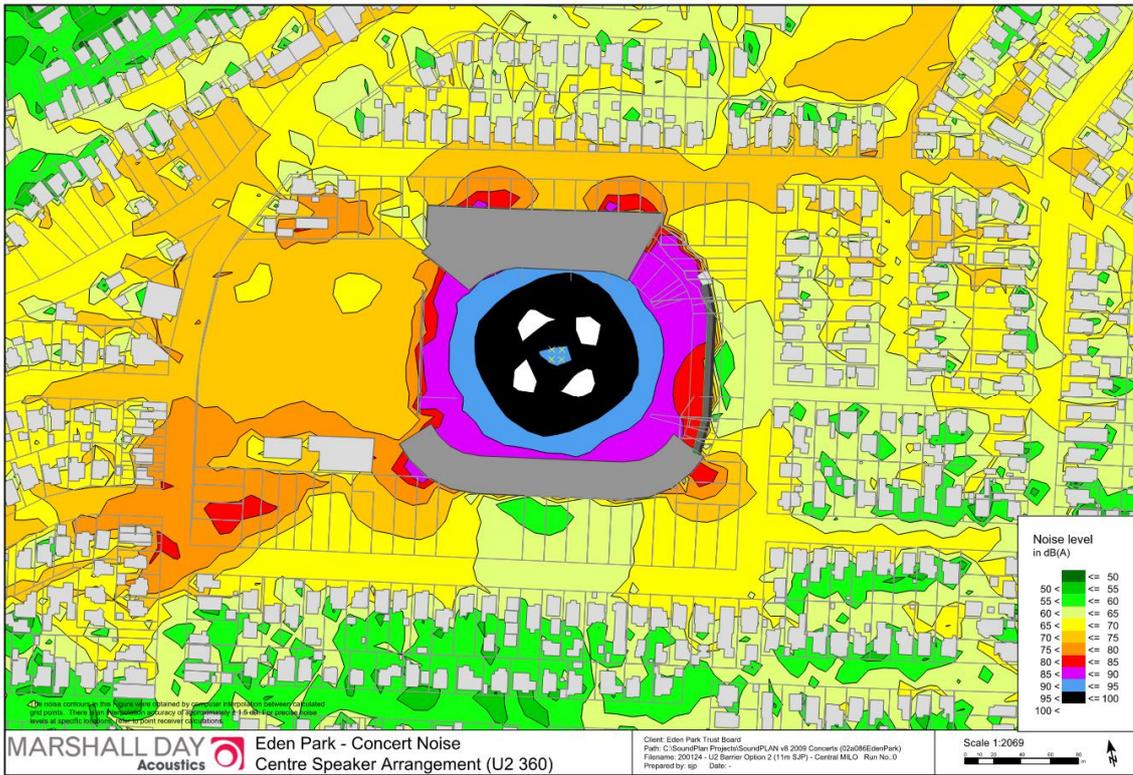


The centre stage modelling shows the noise levels can be contained to 75 dB or less in the residential zone with a slight exceedance in the Eden Park Precinct houses in the north west corner. The effects on these properties are discussed in section 3 below.

The centre stage modelled above had the sound source located at 12m above ground. As discussed, this is the height of the top of a normal concert line array system. The U2 Vertigo Tour in 2006 utilised a unique ‘claw rig’, where the top of the loudspeakers was 27m above ground in a 360 degree coverage. While we understand that it is unlikely that this height will be used in the future, the Council have asked for this arrangement to be modelled.

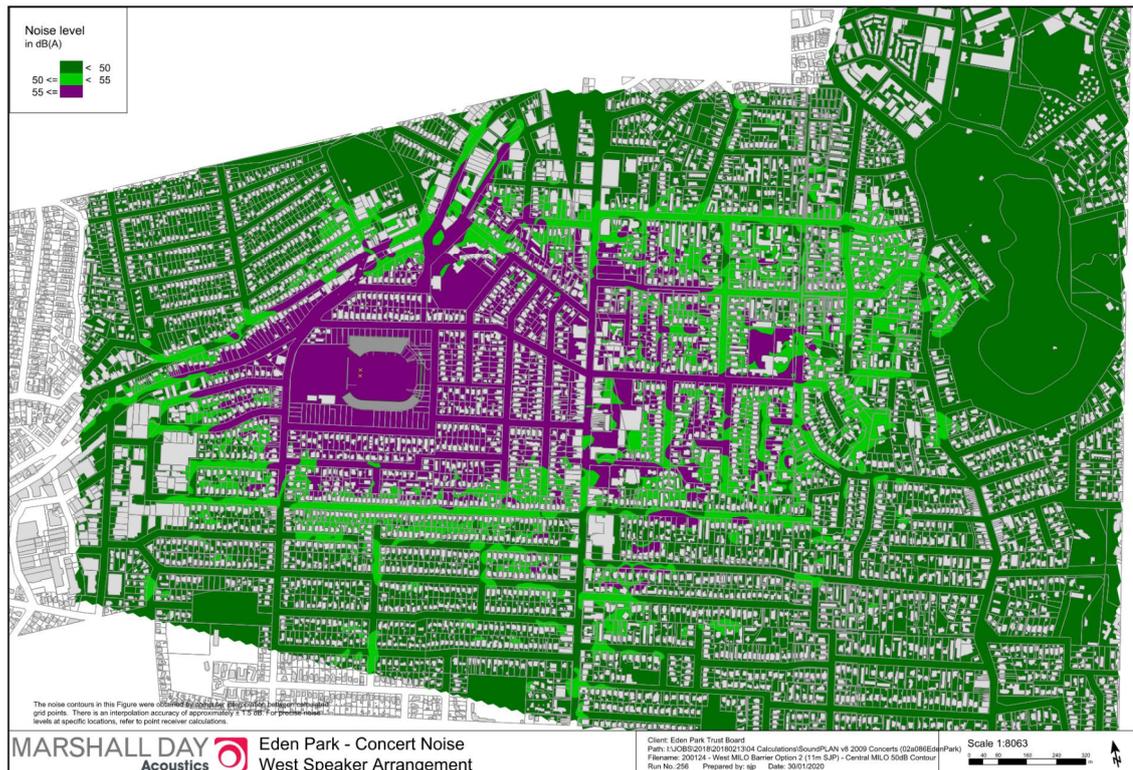
The results are shown below in Figure 4. The proposed noise limit of 75 dB is exceeded at the ‘Eden Park’ houses to the north west and approximately 10 residential sites to the west, on or close to Sandringham Road. The exceedance is only 1 or 2 dB and this could be avoided by controlling the output at the mixing desk by this amount.

Figure 4 – Predicted Concert Noise Levels – ‘U2’ Stage Speakers at 27m High (100dBA @ 30m)



The Council has also requested a plan showing the extent of the 50 dB  $L_{Aeq}$  contour. We have modelled this for the west stage arrangement as this would be used for the louder bands (105 dB @ 30m). The 55 dB  $L_{Aeq}$  contour is also plotted in Figure 5 (55 dB is the ‘day noise limit’ for Eden Park). The sites in the purple area are inside the 55 dB contour.

Figure 5 – Predicted Concert Noise Levels – West Stage (105dBA @ 30m)



## 2.2 Crowd Noise

Crowd noise is specifically exempt from the noise controls in the precinct plan. This is consistent with other stadia and is because the level of noise emission from the crowd cannot be controlled to comply with a noise limit. However, it is important to consider the effects of crowd noise in an application such as this thus the noise levels are reported in this section and the effects are discussed in section 3.

Previous measurements of crowd noise during rugby matches, recorded noise levels of 65 to 68 dB in the residential area during the loudest activities such as a try being scored. This was with a crowd size of approximately 40,000. It is expected that a concert crowd would generally not produce as much vocal effort as during a try but perhaps towards the end of a concert it might be similar.

Based on this maximum vocal effort, the largest capacity concert crowd of 60,000 could produce a noise level of 67 to 70 dB – approximately 2 dB louder than a rugby try. This difference of 2 dB would not be discernible and would happen rarely. Most concert crowd sizes are expected to be approximately 40,000, thus the concert crowd noise is expected to be generally similar in level to a rugby match or one day cricket event.

## 2.3 Load In/Pack Down Noise

The process of load in and pack down is described in the AEE and the traffic report. In terms of noise effects, the two main activities that have the potential to affect noise levels in the residential area are trucks accessing the site and then establishment and disestablishment of equipment and temporary structures on the main field. Most of this activity will take place during the daytime and will be similar to other activities that currently occur at Eden Park and will have no difficulty complying with the daytime noise limits. However, the large concert acts often need to pack down immediately after the end of the concert through the night to head for their next venue. This night-time activity is examined in more detail and this includes measurements of the pack down noise from the U2 concert held at Mt Smart Stadium on the 9 November 2019.

The day to day noise limits for Eden Park would apply to these activities. The noise rules for Eden Park in the AUP are different to all the other 'general noise rules' throughout the plan. These differences cause difficulties with implementation of the rules. To explain, clause I310.6.1 states "The noise (rating) level shall not exceed the noise limits in Table I310.6.1. The 'Noise Rating Level' is defined in NZS 6802:2008 as being derived specifically from measurements of  $L_{Aeq}$ . Unfortunately, Table I310.6.1.1 specifies noise limits in  $L_{A10}$  which causes an immediate conflict with  $L_{Aeq}$  in the Noise Rating Level.

To add to the difficulties, it is widely accepted that  $L_{A10}$  is an inappropriate measure for the assessment of short duration intermittent noise events such as truck noise. If the  $L_{A10}$  level is calculated for one truck departure in a 15 minute period the truck will have no effect on the  $L_{A10}$  level as the noise takes place for less than 90 seconds (10% of the 15 minute measurement period). This shows the deficiency of the  $L_{A10}$  parameter in that no matter how loud the truck is or how close a house is, a single truck will comply with the  $L_{A10}$  noise limit.

For these reasons  $L_{Aeq}$  and  $L_{Amax}$  have been used for the assessment of noise effects from load in/pack down activities.

### **Truck Noise**

Trucks carrying equipment and staging will arrive at the Eden Park site from the South/West via the North-Western Motorway. For the load in, the trucks would arrive during the daytime, entering the site via the Sandringham Road bus parking bay. They would then drive through the carpark on the southern side of the south stand. At the south east corner, the trucks would drive under the stand into the enclosed tunnel that runs the full length of the south stand. The trucks would park in the tunnel and the contents would be unloaded by forklifts and transported directly on to the field.

The arrival truck path is shown below in Figure 4 along with the predicted  $L_{Aeq(15\text{ min})}$  noise contours. These contours are based on a sound power level of 105 dB  $L_{WA}$  (moving point source) from measurements of several trucks at Mt Smart and assume 1 truck in a 15 minute period. This sound power level is consistent with MDA previous measurements of B-train trucks used in the food industry.

**Figure 4 – Daytime Truck Movements  $L_{Aeq(15\text{ min})}$**



It is understood that depending on the size of the concert, between 5 and 25 trucks would be involved with transporting the equipment and staging of a rock concert immediately following the event. These trucks will be on site before the performance, with as many as possible stacked in the tunnel under the stands. At the end of the concert the trucks would be loaded in this enclosed location through the early hours of the morning. The noise of this loading activity is not expected to be high and it is enclosed within the tunnel.

The trucks would depart intermittently when fully loaded, leaving the tunnel at the west end of the south stand and exiting the site on to Sandringham Road through the gate at the north west corner as shown in Figure 5 below.

Figure 5 shows the  $L_{Aeq(15\text{ min})}$  noise contours and Figure 6 shows the  $L_{Amax}$  contours based on the same measured sound power level of 105 dB  $L_{AW}$  and one truck per 15 minute period.