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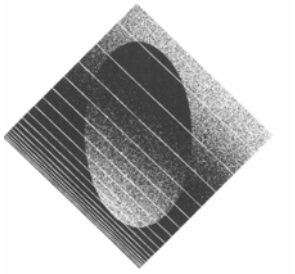

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DATE: 12th October 2007

PROJECT: **Ruapuna Park and Christchurch Kart Club Noise Assessment**

REPORT NO.: **002 2007217/218C**

PREPARED BY: Peter Ibbotson

REVIEWED BY: Stuart Camp

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1.0 EXECUTIVE SUMMARY

Christchurch City Council (CCC) is investigating the future options for motor sport activities in the peri-urban environment. This report examines the existing noise environment of the areas surrounding Ruapuna Park Motorsport Complex and the Christchurch Kart Club, and the noise environment of Ruapuna Park should the facility operate at its maximum capacity. Further, the report examines the noise environments for three possible relocation scenarios and the potential impact on residents and noise sensitive areas surrounding a possible relocation site.

A comprehensive review of local and international noise standards has been performed. The existing noise environment in the area surrounding Ruapuna Park has been measured, both during race and non-race day activity. Aircraft, traffic and quarry noise are significant sources of noise in the area. The existing noise environment in the area surrounding the Christchurch Kart Club has also been measured, and a report on the assessment of noise effects from the club has been reviewed,

Sophisticated computer software has been used to model noise levels from Rupuna Park as well as a possible relocation site for the Christchurch Kart Club and the Ruapuna Park in the nearby Pound Road Quarry at 8m below ground level. Detailed noise contours are given for several scenarios.

We have proposed criteria for assessing the "reasonableness" of noise when applied to the existing Ruapuna Park operation. Daytime noise levels are generally considered to be reasonable, however seven houses are exposed to raceway noise levels that are marginally above our reasonableness criteria. Three houses are exposed to speedway noise levels that are marginally above the reasonableness criterion during the daytime. This is consistent with the small number of complainants. Night operations at the speedway are currently considered unreasonable at twenty-one dwellings based on our criteria.

If Ruapuna Park was operating to maximum permitted capacity (with 200 large events per year), we would consider noise effects unreasonable.

The noise effects on residents in the surrounding area for the various possible relocation scenarios have been assessed. We consider that the current location of Ruapuna currently represents the best practicable option in terms of noise effects on existing dwellings. Relocation of the Kart Club and/or Ruapuna Park to the Pound Road Quarry will, in general, increase the adverse effects of noise from motorsport in the area. Mitigation to reduce these noise effects is not considered effective. On the basis of noise effects, we do not recommend relocation of either the Kart Club or Ruapuna Park to the Pound Road Quarry.

Contents

2.0 INTRODUCTION

2.1 Overview of Ruapuna Park Motorsport Complex and Kart Club Noise Assessment

The high demand for lifestyle blocks and residential land in Christchurch City is causing residential development to encroach on existing motorsport activities. This has caused some conflicts between the existing motorsport activities and the nearby residential land use. Christchurch Kart Club and Ruapuna Park Motorsport Complex are two facilities that have generated complaints regarding noise levels from adjacent residents.

Christchurch City Council (CCC) is investigating the effects of and future options for motor sport activities in the peri-urban environment. Christchurch City Council has requested that a noise assessment of the areas surrounding Ruapuna Park Motorsport Complex (hereafter "Ruapuna Park") is undertaken to establish the "reasonableness" of the noise for surrounding residents, a prediction of the noise environment should Ruapuna Park operate within the maximum permitted capacity as defined in the Christchurch City Plan, and a discussion of possible noise attenuation measures for the best acoustic outcomes in the area.

Additionally, the Christchurch City Council has requested an assessment of the noise environment surrounding the Christchurch Kart Club (hereafter "Kart Club") and an assessment of a number of possible relocation scenario options, including:

- Relocating the Kart Club to a possible site in the Pound Road Quarry while Ruapuna Park remains in its current location
- Relocating Ruapuna Park to the Pound Road Quarry site. In this scenario the Kart Club is not relocated to the Pound Road Quarry
- Relocating both the Kart Club and Ruapuna Park to the Pound Road Quarry Site

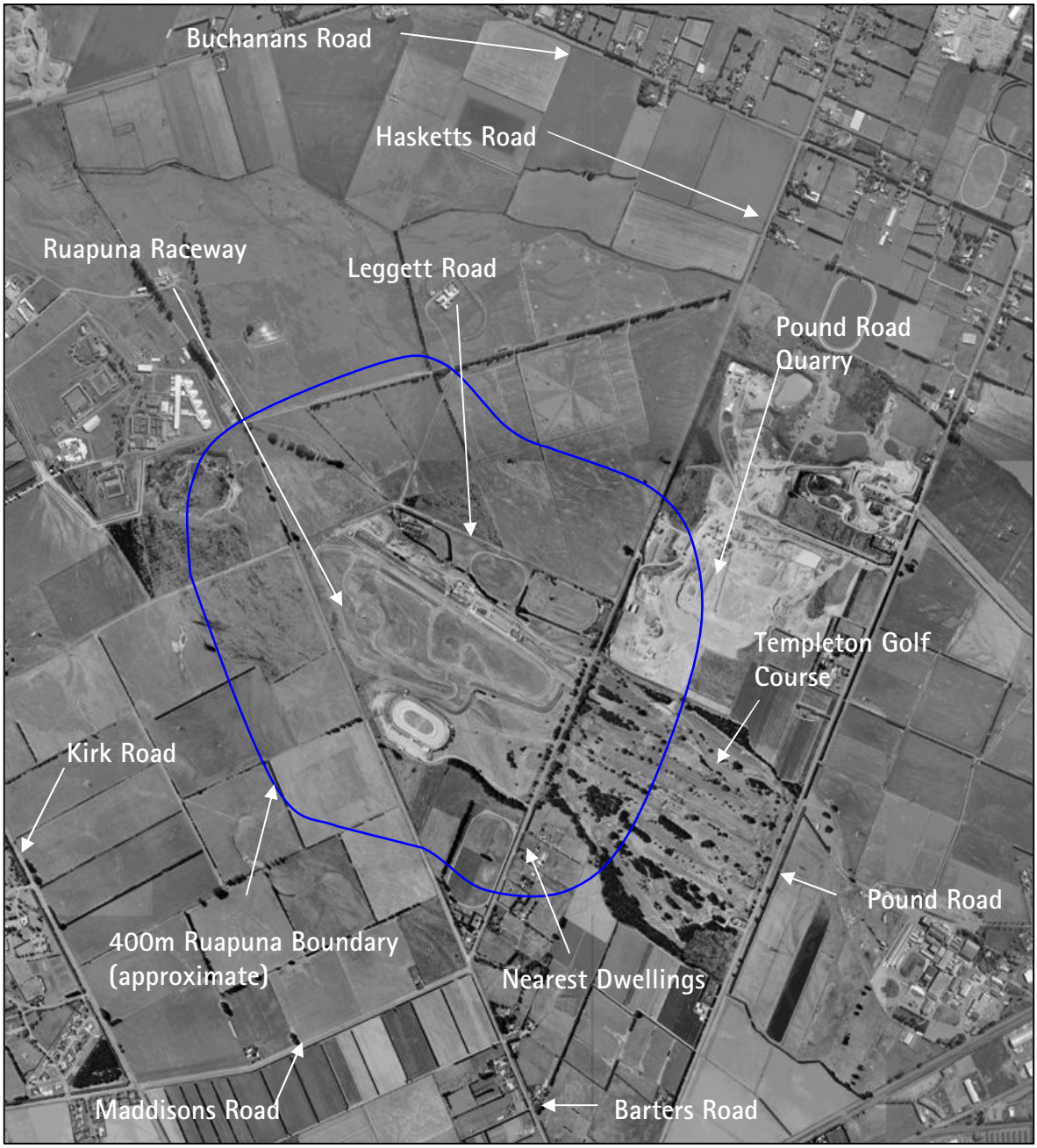
Photo 1 shows the location of the possible Pound Road quarry site in relation to Ruapuna Park.

This report examines the existing noise environment of the areas concerned, the noise levels likely to be generated by the various scenarios considered, and the potential impact on residents and noise sensitive areas surrounding the possible relocation site. The study considers possible mitigation measures around the existing Ruapuna Park and the relocation site. Construction noise and the change in traffic noise on nearby roads has not been considered.

The purpose of this report is to provide Christchurch City Council with information regarding the noise effects of all options, to facilitate discussion regarding the future of both clubs.

Drag racing at Ruapuna Park has not been incorporated in the noise assessment. This is because there were no drag racing events held during this study. Limited noise measurements previously undertaken by Council were insufficient for modelling purposes. From our review of this data we do not consider that inclusion of drag racing activities in this study would significantly affect the conclusions of this report.

Photo 1: Aerial View of Ruapuna Park (copyright Terralink International)



3.0 BACKGROUND

3.1 Christchurch Kart Club

Christchurch City Council has been exploring options for the future of the Christchurch Kart Club. Although Council officers have investigated a number of possible sites for relocating the Kart Club, only the Pound Road Quarry site has been identified as a viable option at this stage. Only this possible relocation site has been considered in this study.

Refer to Photo 1 for details of the Pound Road Site and surrounding area. A concept plan for the Kart Club has been prepared with the following specification and is shown in Appendix 3:

- A minimum track length of 800 metres;
- Possible Kart numbers of 75 – 100 during race meetings with a possible track limit of 30-32 karts at one time;
- Up to 500 spectators per club day; and
- Hours of operation – 7 days per week for training/testing. Racing during the weekend. Daylight operation only.

A second stage of expansion could extend the track by a further 400 metres and include permanent pit shelters, covered pit facilities, and permanent public address facilities. The types of karts that will operate on the track include the following:

- 125cc Rotax
- 100cc Yamaha
- 80cc Cadet

During race meetings, we understand from our discussions with the Kart Club that a range of different types of races can occur – from 5 minute races to enduro races lasting around 2 hours. At the existing Carrs Road track we understand that during race days there is generally very little time between races. There is a track limit of 26 karts at one time. The track is used for racing approximately 70% of the time. The possible new track will operate in a similar manner and will have a track limit of possibly 30-32 karts at one time.

3.2 Ruapuna Site

The Christchurch City Plan includes specific rules to control noise generated from Ruapuna Raceway. Compliance with these noise standards have been assessed on a number of occasions and have been found to be compliant. Nonetheless, issues still remain around the long term operation of this facility and its compatibility with existing and future potential surrounding land uses. The reasonableness of the noise environment and noise mitigation options are, therefore key considerations for the

Council that need to be addressed. Consideration is being given to a possible option for relocating Ruapuna Park to within the existing Pound Road Quarry.

Ruapuna is used for a variety of different events. On a day with no organised races, the track could be used for driver training or race car testing. Organised events range from kart events all the way up to NZV8 series days which involve many different types of cars racing throughout the day. There is also a drag strip and a speedway on the site. The entire site is permitted to operate up until 2400 hours on up to 15 days per year and up to 2300 hours on 200 days per year (refer to Section 4.1.1).

We understand that in 2006 there were 43 "large events" in the racing calendar at the raceway and 14 "large events" at the speedway. Most large events at both the raceway and speedway fall on weekends; however on weekdays the track is regularly open for hire days, vehicle testing and other such activities. Although the raceway and speedway are likely to emit the highest levels of noise during large weekend events, given the relatively consistent weekday operation, noise during this time period must also be assessed.

As will be discussed in the following sections, the area surrounding Ruapuna Park currently receives significant noise from aircraft, quarries and road traffic.

Because a concept plan for the relocated raceway has not been prepared, we have assumed that the raceway would be similar in layout to the existing track. We have used the existing track design when assessing noise levels from inside the quarry.

4.0 LITERATURE REVIEW AND SUMMARY

The following literature review illustrates New Zealand and International guidelines on motorsport noise. The following section is comprehensive and serves to illustrate how the existing noise limits imposed on Ruapuna Park and the Christchurch Kart Club compare to other established guidelines.

4.1 Legislative Requirements

4.1.1 District Plan Noise Rules

Ruapuna Park, the possible Pound Road Quarry relocation site and the existing Kart Club site at Carrs Road lies within Christchurch City Council's jurisdiction. Under Volume 3, Part 11, Section 1.3.4 of the City Plan, the Kart Club and Ruapuna Park are provided with specific noise rules associated with their operation.

Our interpretation of the District Plan noise rules is that the rules are intended as a compromise between "ideal" noise levels and what can reasonably be achieved from the Park. The noise rules are not intended to represent a limit that will ensure zero noise effects; indeed it is unlikely that any noise limit could achieve this.

They can be summarised as follows:

1.3.4 Special exceptions to these rules

(a) Open Space 3 Zone (Ruapuna Raceway and Carrs Road Raceway)
Notwithstanding the provisions of Clause 1.3.3 and Table 1 the following exception shall apply:

Community standards
Any activity which exceeds the standard specified below shall be a ***discretionary activity***

(i) Carrs Road Raceway

1. *On not more than 120 days in any one calendar year, excluding Christmas Day and Boxing Day, operational noise levels shall not exceed 85dBA L_{max} and 65 dBA L_{10} (1 hour) between 0900 and 1700 hours except that these noise limits shall apply between 0900 and 1800 hours for official kart racing events that are fixed in the published annual calendar of the Christchurch Kart Club.*

2. *Operational noise levels of 85dBA L_{max} and 65 dBA L_{10} (1 hour) shall apply between the hours of 1300 and 1700 on one weekday in each week that is fixed in the published annual calendar of the Christchurch Kart Club.*

   For the purpose of this rule

   - *All noise levels are to be applied at the notional boundary of a residential unit, where "notional boundary" is defined in NZS6801:1991 "Measurement of Sound" as . . . "a line 20 metres from the facade of any rural dwelling or the legal boundary where this is closer to the dwelling."*
   - *Any reference to weekday shall mean between Monday and Friday excluding public holidays.*
   - *"Official kart racing events" shall mean those that comply as a KartSport New Zealand race meeting with a status of Group A to Group G event. Such events are identified, sanctioned and conducted in accordance with the KartSport New Zealand rules.*

(ii) Ruapuna Raceway

Operational noise levels of 90dBA L_{max} and 65dBA L_{10} (1 hour) to apply between the hours of 0900 and 2200 hours on any day of the calendar year, except that:

- *for up to 200 days in any calendar year, the permitted levels shall be 95dBA L_{max} and 80dBA L_{10} (1 hour), between the hours of 0900 and 2300;*

- *for up to 15 of those 200 days, these activities shall be permitted up to 2400 hours;*
- *on up to 5 of those 200 days, no L_{max} level shall be applied.*

All levels are to be applied at the boundaries of the Park. At all other times, the levels of the Open Space 3 Zone shall apply.

The Christchurch City Plan provides for a 400m exclusion zone around the Ruapuna Park boundary that makes the construction of a dwelling within this zone a non-complying activity. The Christchurch Kart Club has a 250m exclusion zone around the park boundary.

The areas surrounding Ruapuna Park are zoned Rural and Open Space 2. The Group One noise limits would be applicable to these areas outside of the scheduled exemptions discussed above. These noise limits are summarised in Table 1.

Table 1: Christchurch City Plan Noise Standards

	Development Standards				Critical Standards			
		Daytime	Night-time	L_{dn}		Daytime	Night-time	L_{dn}
Group 1 Zones Rural and Open Space 2	L_{10}	49 dBA	42 dBA	50 dBA	L_{10}	60 dBA	48 dBA	59 dBA
	L_{eq}	50 dBA	41 dBA		L_{eq}	57 dBA	49 dBA	
	L_{max}	75 dBA	65 dBA		L_{max}	85 dBA	75 dBA	
Group 2 Zones Open Space 3 Zones					L_{10}	60 dBA	48 dBA	59 dBA
					L_{eq}	57 dBA	49 dBA	
					L_{max}	85 dBA	75 dBA	

4.2 New Zealand Environmental Noise Standards

NZS 6802:1991 *"Assessment of Environmental Sound"*

The primary document used in New Zealand for assessing Environmental Noise is NZS 6802:1991 *Acoustics - Assessment of Environmental Sound*. This standard gives the guidelines for the protection of health and amenity in residential areas. The Standard provides for the assessment of environmental sound from steady and time-varying sources including industrial, commercial, residential and entertainment activities. While motor-sport activities are not specifically identified in the standard, it is considered that they fall within the broad definition of entertainment activities.

The standard gives the following guidance on desirable upper limits of exposure to environmental noise for the reasonable protection of community health and amenity:

- daytime intrusive noise levels should be no greater than 55 dBA (L_{10}).
- night-time intrusive noise levels should be no greater than 45 dBA (L_{10}).
- the intrusive noise (L_{10}) should not exceed the background sound level (L_{95}) by 10 dB or more (unless background sound levels are very low or very high).

The standard imposes a 5 dBA penalty on noises which are deemed to contain "special audible characteristics" such as tonal or impulsive qualities. The current standard is currently undergoing review. The current values of 55 dBA daytime and 45 dBA night-time are likely to be retained but expressed as L_{eq} and not L_{10}. This change is consistent with the World Health Organisation's guideline values for the avoidance of adverse health effects, which are discussed in Section 4.3 of this report.

NZS 6805:1992 *"Airport noise management and land use planning"*

Although this standard is only directly applicable to airport noise we have considered it because we believe that the overall philosophy of the standard may be applicable to motorsport noise.

The philosophy behind NZS6805 is to provide an *Airnoise Boundary* and an *Outer Control Boundary*, each relating to a "sound exposure" limit and each with their own associated land use planning controls.

- Airnoise boundary > 65dBA L_{dn} — Noise sensitive uses prohibited and existing should be provided with appropriate sound insulation.
- Outer Control boundary >55dBA L_{dn} — New noise sensitive properties should be designed with an appropriate level of sound insulation.

The parameter L_{dn} is essentially a measure of sound exposure over a 24 hour period. With this parameter, night-time noise sources are penalised by 10dBA in order to reflect the increased potential for sleep disturbance. This standard suggests that noise levels above 65 dBA L_{dn} can cause considerable disturbance to people and that noise levels between 55 and 65 dBA L_{dn} will also be disturbing.

It should be noted that the area surrounding Ruapuna Park is exposed to noise levels of greater than 55 dBA L_{dn} from aircraft noise at CIAL.

If this standard was applied to sources other than aircraft, the specific limits would have to be carefully considered, as the aircraft noise limits may not be relevant to motorsport noise.

We note that Pukekohe Park Raceway has adopted a system similar to the NZS6805 system, where new dwellings inside a 65 dBA L_{dn} contour are prohibited and new dwellings inside the 55 dBA L_{dn} contour are required to treat their facades acoustically (Refer to Section 4.4.1).

4.3 Other Standards

As previously discussed in Section 4.0, the following section has been prepared to illustrate how the existing noise limits imposed on Ruapuna Park and the Christchurch Kart Club compare to other established guidelines.

4.3.1 *World Health Organisation Guidelines*

The World Health Organisation *Guidelines for Community Noise* (WHO, 1999) recommends guideline values for noise. In the context of noise emissions from the Kart Club and Ruapuna Park, the following values in Table 2 are considered to be relevant to the exposed residential community:

Table 2
WHO Guideline Values for the critical health effects of community or environmental noise (WHO 1999)

Specific Environment	Critical health effect(s)	L_{Aeq} dBA	Time base (hours)	L_{Amax} dBA
Outdoor living area	Serious annoyance, daytime & evening	55	16	-
	Moderate annoyance, daytime & evening	50	16	-
Outside bedrooms	Sleep disturbance, window open (outdoor values) night-time	45	8	60
Dwellings, indoors Inside bedrooms	Speech Intelligibility and moderate annoyance, daytime & evening	35	16	45
	Sleep disturbance, night-time	30	8	-

The noise levels shown in Table 2 indicate safe exposure levels for people who are exposed to the given level of noise every day. It seems to be the expectation in these guidelines that these limits apply to sources which occur every day. We can infer from this that if the noise exposure only occurs on one day out of ten on average, the L_{Aeq} noise exposure could be 10dBA higher. Under such conditions, the guideline value for daytime and evening noise could be 65dBA $L_{Aeq,16hr}$.

Also, the duration of the noise exposure from motor sport on this site would generally be less than the 16 hour value. For motor sports noise, the noise exposure from large events will generally be around 8 hours or less

The L_{Amax} guideline values relate to protection of sleep quality. For motor sport, this form of noise impact is best managed by having no events during the night-time period (10:00pm-7:00am).

4.4 Noise Limits on Other Racetracks

We have researched noise limits imposed on other raceways and kart tracks around New Zealand and Australia. The following is a summary of these noise limits.

4.4.1 Pukekohe Park Raceway

Pukekohe raceway is notable for being a racetrack of similar usage to Ruapuna. The raceway has held the Auckland V8 Championship event for a number of years. The Franklin District Plan sections 20.2 and 21.2 addresses the issue of motor racing noise from this track.

Franklin District Council has developed noise contours around Pukekohe Park Raceway. These are not part of the District Plan; the Council use them to comment on proposed subdivisions. The contours are shown as 55 dBA and 65 dBA lines. We understand these relate to an L_{dn} noise level, however the event the contours relate to is unknown. Council prohibits subdivision inside the 65 dBA contour and require all dwellings to be acoustically treated inside the 55 dBA contour. This is a similar approach to the NZS6805 standard for aircraft noise.

The 65 dBA contour is approximately 200 - 400 metres from the track and the 55 dBA contour is shown approximately 1000 – 1600 metres from the track. We note from our inspection of photos of the area surrounding Pukekohe that there appear to be dwellings located within 400 metres of the track and some dwellings are as close as 200 metres from the track. These dwellings would be expected to receive noise levels of greater than 65 dBA $L_{dn.}$

The plan does not impose any other noise limits or other specific restrictions on the use of the track for motor racing. The Council's policies in relation to the use of the track for motor racing are summarised as follows:

- Provision of summer racing programme before the start of the season.
- Parties to seek to agree on acceptable frequency of racing.
- Track managers required to publicly notify agreed racing programme.
- Noise levels and any complaints be monitored.
- Requirement for Council to be advised of any breach of compliance with the noise level standards set by the racing industry.
- Council to initiate enforcement action in the event of motor racing noise being unreasonable due to any departure from agreed programme, complaints or other circumstances causing serious concern.

We understand that noise issues with Pukekohe Park have generally been addressed through the above measures. We also understand that the noise enforcement work that the Franklin District Council have performed has generally reduced complaints in the area such that they now seldom occur.

The majority of people who live around Pukekohe Park are involved in horse breeding or racing to some extent. Pukekohe Park has historically been used for both motorsport and horse related activities and the two activities have depended upon each other somewhat for their mutual economic survival. This may mean that residents in the area surrounding Pukekohe are more tolerant to motorsport noise than they otherwise would be, as they have a "vested interest" in the park.

4.4.2 *Western Springs Speedway*

Western Springs Speedway was the subject of an independent commissioner's enquiry into the "reasonableness" of noise from the track in 2006. In the commissioners report it is noted that the experts agreed that a noise level of 65 dBA L_{eq} from the speedway would be considered an "acceptable" level of noise. However other limits of 75 dBA L_{eq} (for 10 races per year) were also suggested. It was noted by the commissioner that the current noise emissions are much higher than this and that these noise limits would not be achievable. It is likely that 65 dBA L_{eq} was considered an acceptable level of noise at least in part because it would represent a significant reduction in noise level over the existing situation.

The noise limit imposed on the speedway by the commissioner was initially 87 dBA L_{eq} for 60 percent of the total races in one night and 84 dBA L_{eq} for the remaining 40 percent. The noise limit is being progressively reduced to 80 dBA L_{eq}. This noise level applies at the site boundary.

The commissioner imposed strict limits on the number of events that could occur at the site, presumably because the noise limits are much higher than that considered "acceptable". The number of events at the speedway has been limited to 12 per year with two practice days. All events must finish before 10pm and two events must finish before 6pm. There must be at least 12 race-free days between events.

4.4.3 *Auckland Kart Club Incorporated*

This Kart Club was the focus of Environment Court action in 1992. Residents approximately 400 metres from the track claimed the noise level was unreasonable. Noise levels from the track varied significantly with wind direction, however it was found that the noise level from the track was generally below 60 dBA L_{10} under conditions of still or light winds. The noise level measured was up to 67 dBA L_{10} under downwind conditions. Background noise levels in the area ranged between 41 – 50 dBA L_{95} and 46 – 56 dBA L_{10}

The decision of the Court found that a noise limit of 60 dBA L_{10} was *"reasonable" within the meaning of section 16 and section 322(1) of the [Resource Management] act".* However the decision notes that the limit is at times unfavourable to both the Kart Club and the nearby residents.

4.4.4 *Environment Protection Policy – Australian Capital Territory (ACT)*

The ACT EPA has published an Environment Protection Policy that relates specifically to noise from motorsport. The guideline opens with the following statement:

Noise is intrinsic to motorsport. While a number of steps, such as use of more effective mufflers and, in favourable topographic situations, the erection of sound barriers can be taken to reduce the adverse impact of noise from motor sports, noise in excess of the ***zone standard*** *is inevitable at existing ACT facilities.*

The policy applies to only existing racetracks in the ACT. The existing facilities include the Fairbairn Park Cluster, a number of facilities including Fairbairn Park, Sutton Park, the National Capital Motor Sports Facility and Kowen Forest.

The policy states that the following factors contribute to the degree of adverse impact on residential areas from noise from motor sport events:

- The level of the noise;
- The number of events each year;
- The time at which the event takes place;
- The spread of events during the year; and
- The amount of warning ('prior notification') provided to residents about upcoming events.

The standard works by allocating **credits** to each event. The number of credits used depends on the amount of exceedence of the zone noise standard at the compliance location. The number of credits allocated to racetracks varies between 27 credits for a "cluster" of racetracks at Fairbain Park to 7 credits for two tracks at Stromlo Forest/Pipeline. The following table summarises this:

Table 3
Event Credits Require to Stage Event

Maximum noise permitted above zone noise standard at the compliance location	Number of credits required to stage each event
2.5 dBA	0.5
5 dBA	1
7.5 dBA	1.5
10 dBA	2
12.5 dBA	2.5
15 dBA	3
17.5 dBA	3.5
20 dBA	4

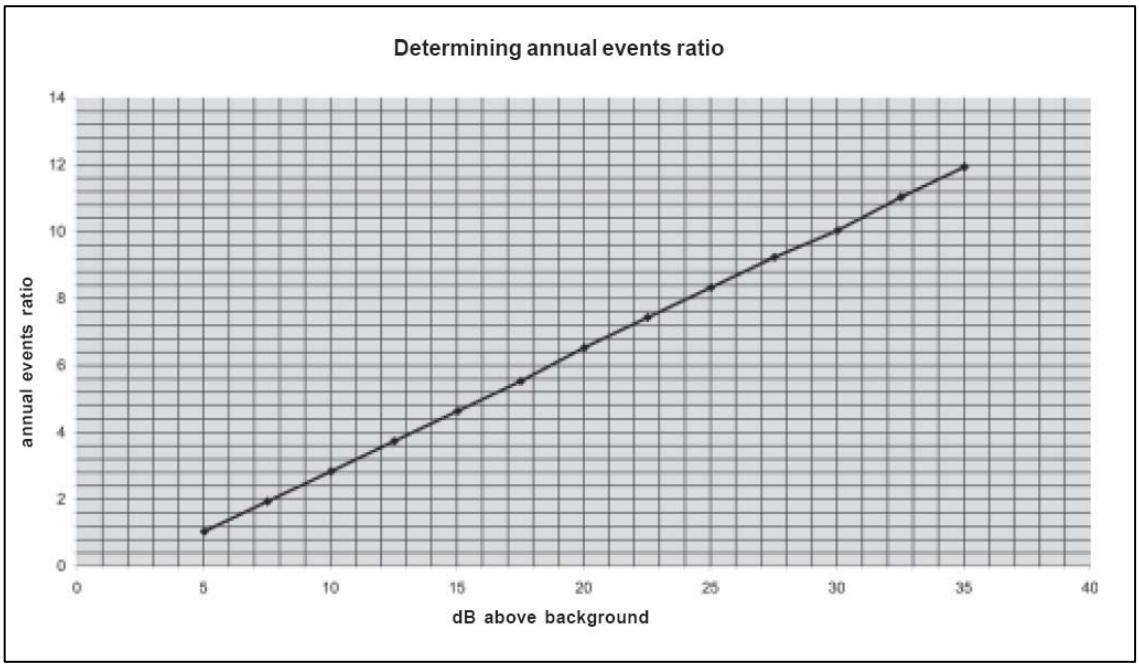
The maximum permitted noise level that can be obtained using event credits is 65 dBA L_{eq}. At facilities where the compliance location has a zone noise standard of 45 dBA up to 4 event credits can be used for any one event. Using the above credits, events can be held in the daytime (9pm – 5pm) or evening (5pm – 10pm). Where a single event occurs across both of these time periods, it is treated as two separate events and twice the number of credits are deducted. Events may not be held on more than 2 consecutive days, more than 2 consecutive weekends or more than 2 weekends in any month.

4.4.5 *New South Wales*

The most relevant document in New South Wales with regard to motorsport noise is the *Noise Guide for Local Government*, an advisory document intended for use by Council offices.

This document offers a specific case study which describes a noise management plan included as a development condition that allowed Council to regulate the noise emissions from one particular site. To prepare this noise management plan an event schedule was developed in an attempt to achieve a balance between how loud each motor racing event was and how often they occur. In the example given, Council decided that 50 events with a noise level of "background plus 5dB" would be permitted in any 12 month period. Where events were likely to be noisier than this, the number of events would reduce in accordance with Graph 1 below which is taken from the Guide. An event that exceeds the background noise level by 8dBA would count as two events. An excess of 30dBA is deemed to have a noise exposure equivalent to 10 events.

Graph 1
Annual Events Ratio Vs. Noise Level



The case study also notes that the community is generally more sensitive to noise from new facilities than from existing facilities which affected the number of events allowed by Council for the new facility.

4.4.6 *Western Australia*

As part of the planning process for Kwinana International Motorplex, the Western Australian EPA published a series of recommendations and reviews. The complex involves drag racing, dirt track speedway, and motocross.

The report found the following that when the expected $L_{Aeq, (4\ hour)}$ noise levels in surrounding areas were compared with dose-response curves (Miedema, 1998) the percentage of people highly annoyed would be as shown in Table 4. The report suggested that the intermittency of the noise events (two hours per event, two events per week for 25 weeks of the year) could result in even higher annoyance figures than in the table below. It should be noted that the dose-response curves used related to people's response to aircraft, traffic and rail noise, rather than specifically to motorsport noise and we believe some caution should be taken before placing too much reliance on these figures, especially for drag racing noise which is relatively short term.

Table 4

Annoyance Figures for Various Noise Levels

Race/Vehicle Type	Predicted Noise Level L_{Aeq} dB(A) (PER p 5.12)	% of people highly annoyed (PER fig 5.23)
Medina		
Drag racing	48	8%
Speedway	43	7%
Hope Valley		
Drag racing	72	55%
Speedway	66	34%
Wattleup		
Drag racing	54	12%
Speedway	51	9%

The report makes reference to the NSW EPA guidelines for new speedways and the following noise limits that would be applied (Refer to Section 4.4.5):

Table 5
EPA Noise Limits

Noise level restriction at residential boundary	Number of events per year
Background + 5dB(A)	50
Background + 10dB(A)	20
Background + 15dB(A)	10
Background + 30dB(A)	5

The background noise levels (L_{95}) in the area surrounding the complex are 35 – 40 dBA L_{95}. Even if the complex was limited to 5 events per year, the Motorplex was predicted not to meet the EPA criteria.

The EPA concluded that noise from the facility would be a significant social issue. It is understood that an exemption from the Environmental Protection Regulations was sought by the proponent and a noise management plan developed which included a series of proposed noise limits and a percentage of the time that these limits could be exceeded. It would appear that these limits are based on the specific noise studies for the proposed development and measurements at existing facilities. These limits relate to drag racing, speedway and the public address system.

The noise management plan includes:

- Proposed noise mitigation measures
- Noise criteria at specified external locations
- Noise monitoring and complaints procedures
- Limitations on the days and times of motor sports events.

The noise criteria are expressed in terms of the noise limits as specified in the WA *Environmental Protection (Noise) Regulations 1997*. These limits are allowed to be exceeded for up to 8.1% of any four-hour period. In addition, the $L_{A,slow}$ noise level cannot exceed 75dBA for more than 1.1% of any four-hour period or 99dBA at any time at the worst affected dwellings. For drag racing, the $L_{A,slow}$ noise level during a race would be slightly less than the L_{Amax}.

4.4.7 Victoria

Sporting activities are specifically exempt from *State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1* (SEPP N-1). There are currently no Victorian guidelines for the control of noise from motor sport. It is common practice in Victoria to refer to Chapter 152 of the NSW *Environmental Noise Control Guidelines.*

Precedents in Victoria

An opinion was prepared by the Victorian EPA for a planning matter regarding Winton Raceway near Wangaratta in central Victoria. This raceway would be considered similar in use to Ruapuna Park. Although it is not an official EPA guideline, it does provide some guidance on noise limits that would be acceptable to the Victorian EPA. In particular it states that "*the maximum acceptable noise level for daytime circuit racing should be approximately 65dBA outdoors.*" The document indicates that as the number of events per year increases, lower noise limits would be required. The document refers to a minimum noise limit of 50dBA which would, presumably, apply at venues where there are more frequent events.

4.4.8 *Case study: Calder Park Raceway, Victoria*

The following case study looks at the Calder Park raceway in Victoria. The situation with this racetrack is very similar to Ruapuna, in that it is an existing racetrack in a formerly rural area that is being encroached upon by residential development. It is an example of how noise from a well-established existing venue can be managed.

The Calder Park Raceway began as a single circuit in 1962, developing into what is now a complex of motor sport tracks, including a dragway. It is located in the city of Brimbank, north-west of Melbourne. Ambient noise levels are quite high, as the raceway is next to the Calder Highway, a busy rural highway and is sometimes affected by aircraft noise.

The nearest suburb currently affected by noise from Calder Park is to the south at a distance of approximately 500m.

The nearest affected residential property is the Whittle residence, located on land zoned for rural use adjacent to the Calder Freeway at a distance of approximately 100m from the Calder Park Raceway property boundary and approximately 200m from the National Circuit race track.

The Organ Pipes National Park Visitor Centre is located approximately 600m north-east of Calder Park. The Organ Pipes are a set of basalt columns located in a national park.

The Calder Park motor sports complex operates up to seven days per week and hosts a variety of events including drag racing, circuit racing, speedway, racing practice, various car club meetings and concerts.

Noise barriers in the form of spectator stands, earth mounds, concrete retaining walls and combinations of all three shield most of the adjacent area from noise. These barriers are up to 20m in height. This would appear to be the most significant difference between this site and Ruapuna Park; bunding surrounding Ruapuna is only a few metres in height.

In order to manage development of the Calder Park site, including noise emissions, Brimbank City Council issued an amended planning permit in July 2004. This permit states that:

- All events must be of no more than one day's duration, except for one three-day race event and one three-day concert
- There must be no more than three major events during any calendar month between 15 October and 15 April (the racing season) with a maximum of 18 events
- There must be no more than two major events during any calendar month between 15 October and 15 April involving jet-powered vehicles, nitro-burning vehicles or formula one vehicles
- There must be no more than one major event during any calendar month between 16 April and 14 October
- There must be no more than 24 major events in any calendar year, of which no more than 6 can be concerts and no more than 12 can be events involving jet-powered vehicles, nitro-burning vehicles or formula one vehicles
- Motor sport events can only take place between 9:00am and 7:00pm except on Friday, Saturday and one Sunday per calendar month, when racing can be extended to 11:00pm. However, racing can only be extended on one night per month during the non-racing season.

Major events mean any competitive motor racing event (testing, practice, qualifying or racing) in which Group 1 drag cars and motorcycles, touring cars and single seaters, super speedway cars (AUSCAR, NASCAR) or competition motorcycles operate. Music concerts and sprint horse racing events are also defined as major events. Major meetings do not relate to state, club or multi-club competitions.

Noise limits for residential land are specified for motor sport events. These are reproduced in Table 6.

Table 6
Noise limits for motor sport events at Calder Park Raceway

	Day (9.00am to 6.00 pm)	Evening (6.00pm to 11.00pm)
In a no wind situation at the boundary of any residentially zoned land	65dBA L_{eq}	60dBA L_{eq}
In a situation where the wind is blowing from the direction of the raceway towards the residentially zoned land at the boundary of such residentially zoned land	75dBA L_{eq}	70dBA L_{eq}

These criteria are the same as in an earlier planning permit, dated 1984. Events involving jet-powered vehicles, nitro-burning vehicles or formula one vehicles are exempted from these criteria.

Noise limits are not specified for other noise-sensitive premises, such as residences built on land zoned rural (eg, the Whittle property).

The permit conditions specify that compliance measurements must be undertaken within three months of the permit taking effect, and then in response to complaints.

Comment

The permit conditions provide an example of how noise emission from a major motor sports complex might be managed. The lack of restrictions on minor events and the exclusion of nearby rural properties from the noise criteria indicate that the permit is intended to simply "put a cap" on the existing noise exposure. However the 65dBA daytime criterion does have merit if it can be achieved.

The noise limits are interesting in that they take into account the effect of wind on the noise level emitted from the racetrack and allow for a 10 dB increase under these conditions. The predominant wind direction around Calder Park is a northerly wind and most of the affected dwellings are to the south. This indicates that the "downwind" criterion would be frequently invoked.

We believe this is a realistic approach to a situation where the motor sports venue has been in place for many years and where all reasonable noise control measures have been implemented.

4.5 Other Published Studies

We have undertaken a detailed literature search as part of this project. In general, there is little detailed literature on the subject of raceway noise levels and effects. Many papers look at noise levels emitted from racetracks but most fail to correlate the measured noise levels with an assessment of effects or annoyance. The following is a summary of papers we have reviewed for this study:

4.5.1 Hellweg and Nechvatal (1978) reviewed 13 oval racing tracks, 3 dragstrips, 1 sports car track and 1 motorcycle racing facility in Illinois that had generated complaints. They concluded noise levels from the racetracks were generating an adverse impact, although insufficient information on noise levels is provided. They concluded that it was a cost effective option to introduce a requirement to install effective mufflers on all classes of vehicle. In some cases noise reductions of up to 16 dB were required and achieved simply by fitting mufflers. The study notes that a nationwide survey on racetracks showed that out of 32 oval tracks where mufflers were required, 6 reported an attendance drop, 2 a temporary attendance drop 15 no effect on attendance and 9 an increase in attendance. Note this is an old study that has looked at only American manufactured cars.

4.5.2 In a separate paper, as part of the above study, Ciecka (1978) suggests that tracks would shut down if vehicle noise reductions of 36 decibels were achieved, although the starting noise level is not given. It is suggested that attendance at tracks would fall by 1% if noise reductions of 10 dB were achieved and 10% if 20 dB noise reductions were achieved (Reference given: Daniel and Wood 1971). The paper also suggests that 50% of people would be highly annoyed at noise exposures of 70 dBA (no parameter given). This annoyance level was calculated using a function developed in 1977 by the Committee on Hearing which is now likely to be outdated.

4.5.3 Close (1976) looked at the history of a stock car racing track that was being encroached on by residential dwellings, the closest of which was 400 metres away. The paper suggests "peak" noise levels of 85 dBA were measured at nearby residences (parameters are not given but it is inferred that these are either L_{max} measurements or short term L_{10} measurements, not L_{peak}). The effectiveness of two types of barriers were analysed and found to reduce noise levels only marginally, although insufficient measurements appear to have been performed. Noise limits were imposed on the track at residential dwellings by local government which varied depending on the time frame measured. The limits range between 70 dBA (no parameter given) measured over 12 seconds reducing down to 62 dBA (no parameter given) over 60 minutes. These limits were to be achieved using effective mufflers. These noise levels were achieved and found to be acceptable. The paper suggests that noise reductions of approximately 16 dB could be achieved for these cars using mufflers, however further reductions were not feasible as engine noise started to predominate.

4.5.4 Cops and Myncke (1977) suggest that differences of +/- 17 dB can be observed around a racetrack under different ground and wind conditions. The paper suggests that noise levels from cross-country races are not normally "inconvenient" to residents if less than 50 dBA L_{eq}.

4.5.5 Garinther and Klab (1995) prepared a study of a proposed raceway using the Auditory Detection Model. The study used annoyance criterion proposed by Lyon (1973) to determine annoyance. This criterion is shown below:

- Slight annoyance which will occur between a just audible level and 0 dB above background (awareness of intruding noise)
- Moderate annoyance which will occur between 0 to 10 dB above background (concern about the intruding noise)
- Excessive annoyance which will occur between 10 to 20 dB above background (organized reactions can be expected against the intruding noise)
- Severe annoyance which will occur at greater than 20 dB above background (major organised reactions and possible lawsuits can be expected against the intruding noise)

Background noise levels in the areas surrounding the racetrack were 45 – 52 dBA (no parameter given). Noise levels of 65 dBA L_{eq} were predicted under no-wind situations at a distance of one kilometre. Noise barriers were found to be less effective for the racetrack than they would be for interstate traffic noise. Distances within which noise levels would cause annoyance were predicted to be 5 times greater during downwind conditions as opposed to no-wind conditions. During downwind conditions residents in a city three kilometres away would experience moderate annoyance from raceway noise.

4.5.6 Stevenson (1999) measured noise from a speedway near Christchurch and found noise levels of 70 dBA L_{eq} at an unspecified distance. This data was used as evidence to a planning tribunal who were considering a new speedway in Blenheim. The existing night-time background noise levels of 30 dBA (no parameter given, we assume L_{95}) was used as justification for denying resource consent to the proposed Blenheim speedway. The study notes that the PA system was potentially more annoying at similar levels to the racecars. This appears to be a subjective impression based on a discussion with one resident.

4.5.7 Roberts (1999) assessed noise over a period of 19 years from a range of motorsport tracks in Australia. The study found that at distances of approximately 250 metres from an international go-kart track, noise levels of 65 dBA L_{eq} were possible. Similar noise levels were found from motorbike tracks. Car racing generated noise levels of approximately 75 dBA at similar distances. The study suggests that minimum buffer distances of 3000m should be maintained between residential areas and motor racing vehicles where downwind conditions are likely.

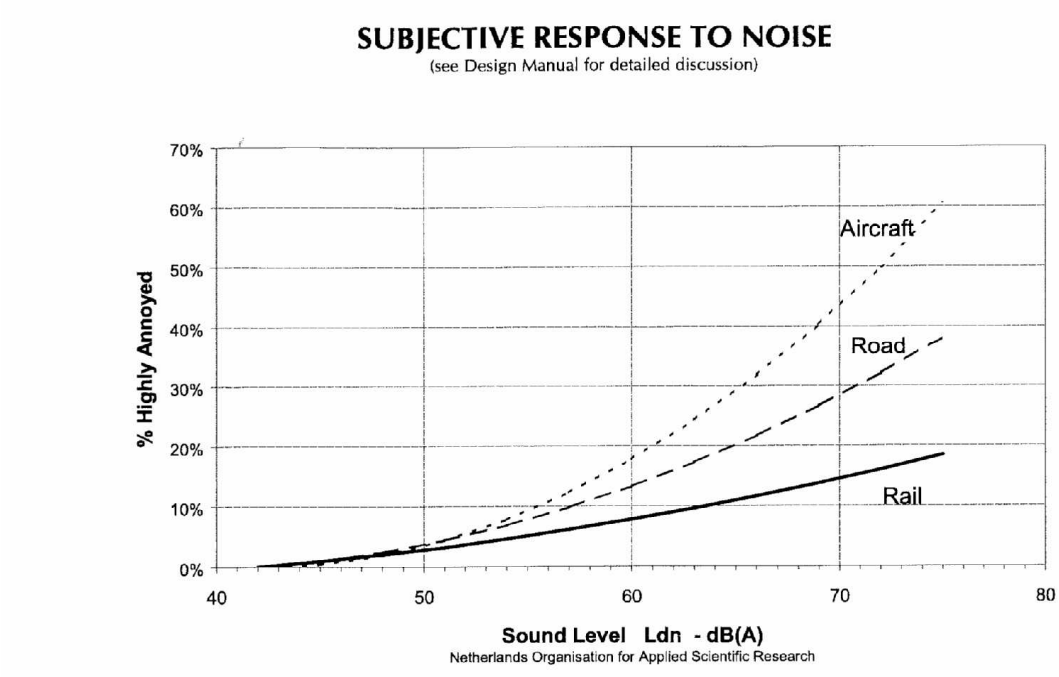
4.5.8 Maziul, Job and Vogt analysed complaint data as a measurement of annoyance in a community. The study found that generally only a small percentage of annoyed or highly annoyed people will actually lodge a complaint about noise. It is stated that when a new source of aircraft noise is introduced into a formerly quiet area, resident's complaints are often more vocal and that the expectation of a change in noise levels will affect annoyance without an objective change in level. The study claims that those who do complain tend to be of higher socio-economic status than those who don't. Serial complainers are found to often skew the number of complaints and the study cites cases of where a very small minority of individuals have been the source of the majority of complaints. A study by Luz, Raspe and Schomer also showed that "…complaints are generated by unusual rather than typical noise levels...". As a result, they concluded that "…complaints do not appear to be a good measure of the community response…".

4.5.9 Stansfeld and Matheson (2003) discuss the non-auditory effects on health. They found that habituation generally occurs to noise, however in some studies habituation does not occur. The study states that noise exposure decreases task-based performance and can increase heart rate and blood pressure. Some studies reviewed showed that noise was a minor risk factor in cardiovascular disease. Exposure to high intensity noise has been linked to raised levels of noradrenaline and adrenaline. High frequency noise was found to be more annoying than low frequency noise and loudness or perceived intensity was found to be the primary characteristics

that affected annoyance. Dr. Alice Suter, (1991), discussing long held beliefs regarding habituation to noise says "The evidence is fairly clear that so long as the stimulus remains the same, noise annoyance does not subside over time". She cites a study showing no habituation for highway noise 4 months to 2 years after the opening of new routes, and another which found that annoyance in a previously surveyed community increased by 10 percent with no change in noise levels.

4.5.10 A large number of international studies have been conducted to correlate people's response to noise with a measured noise level. Several studies have been performed on annoyance. One of the most commonly referred to is the analysis by Schultz (1978). Since this study, further data has become available and most available data has been analysed by Miedema and Vos (1998) to produce revised response curves as shown below. Note that these response curves have been used in the WA EPA assessment of annoyance around the Kwinana Motorplex. As the Midema and Vos annoyance criterion are expressed in the form of L_{dn}, using this criterion in the assessment of a short activity such as drag racing may not be valid.

Graph 2
Annoyance Vs. Noise Level (L_{dn})



4.5.11 Joncour et al (2000) found that when the combined effects of more than one noise source (traffic and rail) were studied to determine the synergistic effects of both sources that a dose response curve for the one source would adequately take into account the effect of the other source. We assume this relates to the annoyance curve for the loudest or most annoying curve.

4.6 Proposed Noise Annoyance Criteria

A summary of the criteria reviewed during our literature search is shown below. The criteria has been used to establish annoyance criteria for Ruapuna Park and the Christchurch Kart Club (Refer to Section 4.6.2 and 4.6.3)

In the following table it is very important to note the distinction between noise limits applied at the **site boundary** and noise limits applied at the **notional boundary** of nearby dwellings. For Ruapuna Park, the noise limits are applied at the **Park boundary,** and hence the noise limits may appear relatively high when compared to noise limits applied to the Kart Club which are applied at the **notional boundary** of nearby dwellings. For Ruapuna Park, when compliance with the noise limit (80 dBA L_{10}) is just achieved at the **Park boundary**, noise levels would be approximately 15 dB less at the closest nearby **notional boundary** (65 dBA L_{10}). The City Plan noise limits for Ruapuna can therefore not be directly compared with limits set at notional boundaries of dwellings.

Table 7
Noise Criteria for Various Motorsport Activities

Reference	Noise Level	Discussion
City Plan Noise Limits	Ruapuna Noise Provisions – Up to **80 dBA $L_{10\ (1\ hour)}$** **95 dBA L_{max}** for 200 days per year at **park boundaries**. For 15 of those 200 days, activities are permitted until midnight. For 5 of those 200 days, no L_{max} level shall be applied	Compliance with the 200 day limit at the Ruapuna Park boundary could result in different noise levels at the nearest dwelling, depending on the type of event generating the noise. For Ruapuna Park, noise levels of approximately **65 dBA $L_{eq.}$** are expected at notional boundaries of residential units when compliance with the 200 day noise provision at park boundary is just achieved.
	Carrs Road Kart Track – Up to **65 dBA $L_{10\ (1\ hour)}$** **85 dBA L_{max}** For official Kart Racing days at **notional boundaries** of nearby dwellings.	The 15 day noise limit allow for some events to occur further into the night period. The 5 day limit places no restrictions on single loud impulsive noise levels. Compliance with the City Plan provisions for the Carrs Road Kart Club have generally been shown to be achieved.
	Rural 2, Rural 5 and Open Space 2 zones surrounding Ruapuna Park **57 dBA L_{eq} day (critical standard)** **49 dBA L_{eq} night (critical standard)** SP Awatea/Rural 2 zones adjacent Kart Club **50 dBA L_{eq} day (development standard)** **41 dBA L_{eq} night (development standard)** **57 dBA L_{eq} day (critical standard)** **49 dBA L_{eq} night (critical Standard)**	
NZS6802	**55 dBA L_{10} day** **45 dBA L_{10} night**	Commensurate with Open Space 3 zone rules.

Reference	Noise Level	Discussion
NZS6802 (Cont.)	**"Background (L_{95}) + 10 dBA"** Acceptable limits for Ruapuna (applied at the nearest dwelling notional boundary) would be **50 – 55 dBA L_{eq}** day **40 – 50 dBA L_{eq}** night Acceptable daytime limit for Carrs Road Kart Club (applied at the nearest dwelling notional boundary) would be around: **50 dBA L_{eq}** day	Refer to Section 4.2
NZS6805	**<65 dBA L_{dn}** less than **55 dBA L_{dn}** without façade treatment	Limit applicable to aircraft noise but concept is considered to have relevance to this project.
World Health Organisation Guidelines	**50 – 55 dBA L_{eq} day** **45 dBA L_{eq} night**	Commensurate with NZS 6802 noise limits
ACT EPA Limits	Approximately **65 dBA L_{eq}** for up to 7 events per year; or **55 dBA L_{eq}** for up to 20 events per year; or **50 dBA L_{eq}** for up to 50 events per year. (on the basis of a 45 dBA Leq background)	Limits assume that the tracks are assigned 27 credits as per the Fairbairn park cluster. The limits shown are not absolute, for instance the racetracks could have approximately 5 events at 65 dBA L_{eq} and 10 events at 50 dBA (refer to Section 4.5.4)
NSW limits	**75 dBA L_{eq}** for up to 5 events per year; or **55 dBA L_{eq}** for up to 10 events per year; or **50 dBA L_{eq}** for up to 20 events per year; or **45 dBA L_{eq}** for up to 50 events per year	As above the noise limits are not absolute, the racetracks could have 5 events at 75 - 80 dBA L_{eq} and 7 events at 45 – 50 dBA L_{eq} (refer to Section 4.5.5)
Auckland Kart Club Limit	**60 dBA L_{10}** (daytime) under no/light wind conditions	Noise limit stated by commissioner as "unfavourable to nearby residents"
Pukekohe Park Noise Limits	Motorsport Rules (**95 dBA** at 30 metres) Dwellings constructed between **55 dBA L_{dn}** and **65 dBA L_{dn}** contour required to acoustically treat facades	Having no limit on noise level would be unlikely to cause an increase in noise emission from Ruapuna.
Western Springs Speedway	**65 dBA L_{eq}** suggested as "acceptable" level **80 dBA L_{eq}** for 12 events finishing before 10:00pm Note: site and notional boundaries are at the same location in this case.	65 dBA L_{eq} may represent an acceptable level for more events at Western Springs, whereas 80 dBA L_{eq} represents what can be achieved for the 12 events allowed.
Victoria – Calder Park Raceway	**65 dBA L_{eq}** no wind (9:00am – 6:00pm) **75 dBA L_{eq}** downwind (9:00am – 6:00pm) **60 dBA L_{eq}** no wind (6:00pm - 11:00pm) **70 dBA L_{eq}** downwind (6:00pm - 11:00pm)	Relevant noise limits as Calder Park situation is very similar to Ruapuna situation. The limits apply to a maximum of 24 major events per year at the Park.
Close (1978)	**62 dBA $L_{eq\ (1\ hour)}$** (parameter assumed)	Suggested as an acceptable level
Cops and Myncke (1977)	**50 dBA L_{eq}**	Level considered "not inconvenient"
Garithner and Klab (1995)	**40 – 45 dBA L_{eq} –** Slight annoyance **40 – 50 dBA L_{eq}** – Moderate annoyance **50 – 60 dBA L_{eq}** – Excessive annoyance **<60 dBA L_{eq}** – Severe annoyance	These noise limits are based on the measured background noise level in the area adjacent to Ruapuna Park
Miedema and Vos (1998)	**60 dBA L_{dn}** – approximately 5 – 20% of people highly annoyed	L_{dn} will allow higher noise levels during the day if no noise is present at night

The above table shows that the noise limits imposed on Ruapuna Park and the Christchurch Kart Club are higher than most other guidelines reviewed. Calder Park Raceway is most directly comparable to Ruapuna Park, and has more permissive noise limits than Ruapuna, however large events at this raceway are limited to 24 per year. This is fewer than would be permitted at Ruapuna.

4.6.1 *Note on Noise Descriptors Used in this Study*

The above table gives noise limits generally in the form of L_{eq} noise level, however some noise limits are also in the form of L_{max} and L_{10}. The descriptor L_{95} is used to describe the background noise level in an area and should not be used to form a noise limit for a noise source that is cyclic or fluctuating; it should only be used to describe the ambient background noise level in an area.

In this study, we have predicted noise levels in terms of the L_{eq} and L_{max} parameters. No noise predictions from motorsport noise have been made using the L_{95} parameter. Where an L_{95} noise level is mentioned, it is only to provide a description of the existing noise environment.

4.6.2 *Ruapuna Park*

We have considered the following factors when determining noise levels that would be considered to have adverse effects on Ruapuna Park:

- **The number of events that currently occur at the site**

  As has been demonstrated in the review of Australian motor racing noise policy, events which cause high noise levels at a receiver location are considered acceptable if they occur very seldom. Conversely, noise events that exceed the ambient background noise level at a dwelling only marginally are considered acceptable even if they occur regularly.

- **The permanence of the site**

  Ruapuna is a permanent motor racing complex. Noise limits which may be accepted for temporary noisy events may not be applicable to this site.

- **The history of the site**

  Ruapuna is an existing motor racing complex that has been on the site for many years. Most residents in close proximity to the complex will have moved into the area surrounding the racetrack, rather than the racetrack moving into a well established area. As noted in the above table, Calder Park Raceway in Victoria is an example of a similar situation in which local government responded by "placing a cap" on existing noise emissions.

- **The existing level of noise in the surrounding area**

  The area surrounding Ruapuna Park already receives considerable noise from aircraft operations at Christchurch International Airport Limited (CIAL) and the Fulton Hogan Quarries on Pound Road and Leggett Road. The area surrounding Ruapuna Park is located inside the 55 dBA L_{dn} CIAL noise contour with some land located inside the 65 dBA L_{dn} contour. These areas also receive noise from traffic on nearby local roads. Dwellings further afield may receive noise from State Highways and locomotives on the main trunk line. This suggests that the noise effects from the park may not be as significant as if it was located in an area with low background noise levels.

After a careful analysis of the noise limits contained in the preceding section and consideration of the above factors, we conclude that noise levels from Ruapuna Park are likely to have the following associated effects if measured at the notional boundary of surrounding dwellings during major events under the **predominant wind conditions** (northeast and southwest winds):

Table 8
Noise Effects Vs. Noise Level – Ruapuna Current Operation

Noise Level L_{eq} dBA at the notional boundary of nearby dwellings		Effect
Daytime (7am – 10pm)	Night-time (10pm – 7am)	
55	45	No more than minor effects
60	50	Moderate noise effects
65	55	Significant noise effects
70	60	Severe noise effects

The above noise levels relate to the noise level at the notional boundary of nearby dwellings. Whilst the exact relationship between the noise level at the **Park boundary** and nearby dwelling notional boundary will vary, in general the 80 dBA L_{10} noise limit at the **Park boundary** would correlate to a noise level of around 62-65 dBA L_{eq} at the nearest dwelling notional boundary location.

The above noise levels are based on the number of events currently being held at the Park. The Park is entitled to hold up to 200 events per year at noise levels not exceeding 80 dBA L_{10} at the site boundary and for 5 of those 200 days the Park may operate with no L_{max} noise control. If the Park was operating to its permitted capacity (Refer to Section 7.2), we predict the following noise effects:

Table 9
Noise Effects Vs. Noise Level – Ruapuna Limit of Operation

Noise Level L_{eq} dBA at the notional boundary of nearby dwellings		Effect
Daytime (7am – 10pm)	Night-time (10pm – 7am)	
50	40	No more than minor effects
55	45	Moderate noise effects
60	50	Significant noise effects
65	55	Severe noise effects

It is important to realise that the above are only given as guidance on the potential mean level of response to noise; the actual effects of the noise on each individual will vary.

4.6.3 *Carrs Road Kart Club*

Having reviewed the noise criteria in Table 7 and considered the number of events currently held per year and the existing background noise levels, we have come to the conclusion that the kart track is likely to produce the following noise effects for the following noise levels during the predominant wind conditions (northeast and southwest winds):

Table 10
Noise Effects Vs. Noise Level – Carrs Road Track

Noise Level L_{eq} dBA at the notional boundary of nearby dwellings		Effect
Daytime (7am – 10pm)	Night-time (10pm – 7am)	
55	45	No more than minor effects
60	50	Moderate noise effects
65	55	Significant noise effects
70	60	Severe noise effects

4.6.4 *What is Reasonable?*

In order to assess the level of noise from the Kart Club and Ruapuna Park it is necessary to determine what is "reasonable" under Section 16 of the Resource Management Act.

In our review of relevant literature on motorsport noise we have noted one Environment Court decision that deals with the issue of "what is a reasonable level of noise?". This was the decision on the Auckland Kart Club in 1992 (refer to Section 4.4.3), in which the presiding Judge determined that a noise level of 60 dBA L_{10} under zero meteorological conditions was "reasonable". It is important to note that this limit was set for an existing operation on every third weekend with two practice days per week. This level of usage is significantly less than what would be proposed for the Kart Club or what currently exists at Ruapuna. This level of operation also represented a significant reduction on previous levels of usage.

In coming to its decision, the Court stated that "*what is reasonable in terms of section 16(1) of [the resource management act] is clearly what is most reasonable to the receiver, set in the context of what the kart club can achieve as the best practicable option*"

If this definition is to be applied to the area surrounding Ruapuna Park, then what is reasonable to the receiver is to expect that the level of motorsport noise does not increase, whilst the current levels of noise are reduced as far as is practicable. What would be reasonable to Ruapuna Park is that they continue to be allowed to operate as they always have, whilst complying with their obligation under sections 16 and 17 of the RMA to avoid unreasonable noise and to reduce noise as far as is practicable. Furthermore, as the raceway has been in operation before the current residents were located around the site, it would be unreasonable for residents to expect that they would receive only minor effects from noise; however it would be reasonable for them to expect that noise effects were not significant. It would also be reasonable for residents to expect that Ruapuna Park comply with their obligation under Sections 16 and 17 of the RMA to avoid unreasonable noise and to reduce noise as far as is practicable. Moderate noise effects from the existing site (around 60 dBA $L_{eq\ (1\ hour)}$ for normal operation during normal wind conditions) are therefore not considered unreasonable. Accordingly we have proposed an annoyance criteria whereby it is reasonable that residents expect moderate amounts of noise (refer to Section 4.6.2 and 4.6.3).

We note that whilst the area surrounding Ruapuna Park does experience high levels of ambient noise from aircraft and quarry noise, residents surrounding the quarry could reasonably expect that once the quarries in the area are exhausted that they will be rehabilitated and the subsequent land use activity will comply with the City Plan noise standards. If Ruapuna Park and/or the Christchurch Kart Club are relocated to these quarries, it is unlikely that these activities could comply with these noise limits and would require exemptions, similar to the exemptions they currently have in the City Plan. Therefore what is "reasonable" in this case is that any **increase** in the level and effects of motorsport noise on residents is not significant.

5.0 EXISTING NOISE ENVIRONMENT

5.1 Around Ruapuna Park – Ambient Noise

The Ruapuna Park site falls just outside of the 65 dBA L_{dn} CIAL noise contour but just inside the 95 dBA SEL noise contour. Areas within 2 kilometres to the east, south and west fall inside the 55 dBA L_{dn} contour. The populated area of Templeton to the south west of the site is bisected by the 55 dBA L_{dn} contour. The site is also located close to the Fulton Hogan quarries on Pound Road and Leggett Road, which are audible in the surrounding area. The area surrounding the site also receives a noise both from local roads and from the busy State Highway 1 through Templeton. Some dwellings will also receive noise from the main trunk line that runs just north of Templeton.

We have undertaken a noise survey to gain an understanding of the existing noise environment around the site. This has involved noise measurements at representative locations throughout, to establish typical daytime noise levels around the site.

In spite of the relatively high L_{eq} noise levels in the area from the airport, quarries and surrounding roads, the background (L_{95}) noise levels are not especially high. Transient noise events from planes and traffic will set the L_{eq} noise level at most receivers, however in between these events there will be periods of relatively low ambient noise where noise from Ruapuna Park could be intrusive.

The results of our noise monitoring are summarised in Table 11 and the locations are illustrated in Photo 2. Detailed monitoring results are given in Appendix 4:

Table 11
Measured Ambient Noise Levels around Ruapuna

Site	Description	Measured Existing Noise Levels (dBA re 2 x 10^{-5}Pa) Daytime[1] L_{eq}[2]	Daytime[1] L_{95}[2]	Night-time[1] L_{eq}	Night-time[1] L_{95}
RP1	200m south of Main South Road on Marshs Road. 7m from near carriageway.	67	41	-	-
RP2	Corner of Maddisons Road and Hasketts Road. 7m from near lane	63	45	-	-
RP3	Residential area corner of Maddisons Road and Kirk Road	56	42	52	25
RP4	Residence on western side of Barters Road 350 metres south of Maddisons Road. Approximately 40 metres from near carriageway.	52	40	49	41
RP5	Council noise logging location at Templeton Golf Club near Fulton Hogan Quarry	56 week	46 week	51 week	37 week
		57 weekend	42 weekend	48 weekend	32 weekend

Note: 1. Typical measured levels within 7am – 10pm (daytime) and 10pm – 12am (night-time) periods. These periods are commensurate with the permitted operating hours of Ruapuna
2. See Appendix 2 for an explanation of acoustic terminology.

Our measurements show that;

- During the day, background noise levels (L_{95}) are generally 40 - 45 dBA, with typical average (L_{eq}) noise levels around 52 - 57 dBA at distances from roads representative of façade locations. The significant difference between the background noise level L_{95} and the average intrusive noise level L_{eq} at attended measurement locations is generally due to traffic passbys at close distance. These L_{eq} noise levels would be representative only of dwellings with facades close to road carriageways.
- At locations close to the Fulton Hogan quarry, background noise levels are around 46 dBA L_{95}, which is appreciably higher than other measurement locations.
- During the night period (10pm – 12am) the background noise level at the residential area on the corner of Maddisons Road and Kirk Road is very low (25 dBA L_{95}) however the noise level at the location of Barters Road is very high (41 dBA L_{95}). The background noise levels at Templeton Golf Course are around 32 to 37 dBA L_{95}. The cause of this variation is unknown, although it serves to illustrate that background noise levels in the area can vary considerably.

5.2 Ruapuna – Measured noise emissions

Christchurch City Council have undertaken a very significant and comprehensive project involving over 176 hours of attended noise monitoring of events at Ruapuna Raceway, Speedway and Drag Strip. This project has been peer reviewed by Marshall Day Acoustics.

The report concludes that there were no occasions in which the "up to 5 days no L_{max} limit" (refer to Section 4.1.1) exception rule was invoked. There were only 15 occasions when the "200 day" exception rule was invoked at the raceway and 2 occasions at the speedway. On all other occasions the base limits were complied with. Ruapuna Park is therefore deemed to be in compliance with the Christchurch City Plan Rules.

On some occasions during this study, Council performed noise measurements at locations near the south-eastern boundary of Ruapuna Park, and also at the location of the nearest dwelling (Lot 1 DP 23834 – Refer Photo 1) on occasion. Where a measurement was performed on the Ruapuna Park site, an estimate can be made of the corresponding noise level at the nearest dwelling.

A summary of these measurements and corresponding estimates at the nearest dwelling are shown in the following table.

Table 12
Ruapuna Noise Emissions at Nearest Dwelling (Lot 1 DP 23834)

Source	Description	Duration (minutes)	Noise Level L_{eq} dBA
Raceway	V8 Event	35	57
	V8 Event	60	56 – 63
	Circuit Sprint	60	54
	Club Day	60	55
	Motorcycling Champs	60	54 – 56
	Lady Wigram Trophy	60	55 - 66
	Skope Classic	60	56 – 59
	BEARS	60	59 – 61
	Street Car Pursuit*	1.5	61
Speedway	Sprint Cars	15	53
	Midgets and Sprints	60	58
	Midgets, TQ's and Sprints	60	59
	Midgets, ¾ midgets	60	57
	Sprint Cars, Solos	60	57 – 64
	U21 Solos	60	56 – 58

The above table shows that noise levels at the nearest dwellings are generally around 55 – 63 dBA $L_{eq\ (1\ hour)}$. However, noise levels of up to 66 dBA $L_{eq\ (1hour)}$ are possible at the dwelling (this was during a strong north-westerly). The noise levels from the raceway were all recorded during the day period. Noise levels from the speedway were all recorded during the late evening to night period.

5.3 Around the Carrs Road Site

The background noise level in the area surrounding the Carrs Road raceway is predominantly due to traffic noise on Halswell Junction Road. We have performed attended monitoring in the suburban area to the southeast of the kart track (Westlake). This monitoring was performed during a weekend during a time period when the Kart track could be operating (but was not). A summary of our results follows:

Table 13
Ambient Noise Measurements near Carrs Road Track

Measured Existing Noise Levels (dBA re 2 x 10^{-5}Pa)			
Site	Description	Daytime	
		L_{eq}	L_{95}
CR1	Westlake Suburb, Corner of The Stables Cul-De-Sac	53	40
CR2	Westlake Suburb, Westlake Reserve	43	37

The results indicates the background noise level in the area is around 37 – 40 dBA L_{95}.

5.4 Kart Track at Carrs Road – Measured Noise Emissions

Christchurch City Council have performed environmental noise monitoring of Kart Club Racing at the existing Carrs Road racetrack. We have reviewed the noise data that has been made available to us. This data is summarised as follows.

Table 14
CCC Noise Measurements of Carrs Road Track

Representative of:	Event Description	Duration (minutes)	Noise Level L_{eq} dBA
Notional boundary of Lot 2 DP 20875	Unknown number of Karts	60	54
	Unknown number of Karts	60	51 – 55
	Club Day	60	58
Notional boundary of Lot 1 DP 23622 Industrial area	Unknown number of Karts	60	52
	Enduro Racing – Various Classes	1 – 36	54 – 57
Notional Boundary of Lot 3 DP 20264	Garden City Championships	60	55 – 56
	Meeting Various Classes	Unknown	57 – 59

The above table shows that noise levels are generally up to around 60 dBA L_{eq} at all nearby dwelling locations. The Christchurch City Plan noise limit of 65 dBA L_{10} would be complied with in all cases.

6.0 NOISE MODELLING

In order to predict noise levels from the Christchurch Kart Club and Ruapuna Park at all surrounding dwellings we have modelled the existing racetracks using measured data and SoundPLAN computer software. In modelling the noise level from the racetrack, we have considered the following:

6.1 General Noise Propagation

6.1.1 *Meteorology*

Weather conditions play an important part in noise propagation, particularly over distances above about 300 metres. The two most important effects are;

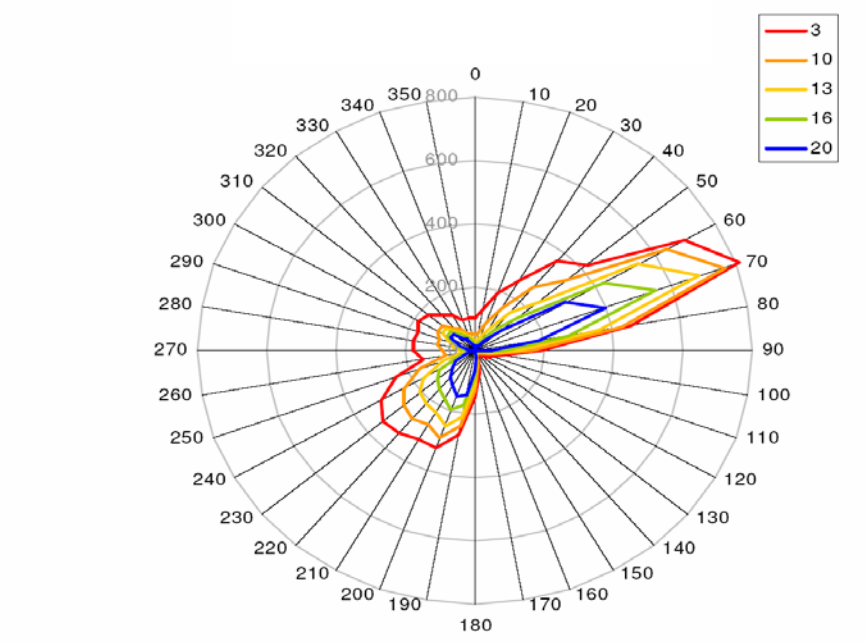
Wind

Sound travelling downwind gets "bent" downwards in much the same way as a temperature inversion. Conversely, sound travelling upwind is "bent" upwards. Hence, noise levels tend to be higher downwind and lower upwind than would be expected in calm conditions (Beranek, Ver, 1992). Wind effects are normally only noticeable in light to moderate wind conditions, as during times of strong winds, noise in trees and general wind related noise tends to mask out intrusive noise to some degree. Wind noise will significantly reduce the effect of acoustic barriers or screening where receivers are a large distance from the source (see Section 6.1.2).

Data provided by CCC[1] from long-term wind monitoring at the site shows that a north-easterly wind is by far the most common wind direction. The wind rose for the site is shown in Graph 3. The data has been procured from the nearby Christchurch International Airport and is considered a good representation of wind conditions at Ruapuna Park.

[1] Data originally gathered by NIWA

Graph 3
Wind Rose for North-West Christchurch



The predominance of north-easterly winds is well known in Christchurch; however we understand that most complaints regarding noise from the Park occur during north-westerly conditions. This is most likely due to the location of the closest neighbours and other residential areas to the south-east of the Park. Noise monitoring data has shown that noise levels are highest at this location during north-westerly winds.

Research shows (Beranek, Ver, 1992) that wind effects on noise are relatively constant within a ± 45° angle of the actual wind direction.

Temperature Inversion

During periods of strong temperature inversions, the influence of a distant noise source will be more noticeable because the warm air above the ground "bends" sound waves downward. Temperature inversions when combined with downwind effects typically result in increases in noise of about 3 dBA, even when an intervening noise barrier is in place (Beranek, Ver, 1992). Without a noise barrier, the increase in noise level due to temperature inversions will depend on the distance from the source; the further from the source the greater the increase in noise level will be.

Christchurch experiences a number of temperature inversions, particularly during winter months. These inversions generally occur during the night period, but may also persist into the day.

Given that winter is outside the main racing season for Ruapuna Park, and that inversions generally occur during the night, noisy activities are less likely to occur

frequently during temperature inversion conditions. Our calculations therefore do not consider conditions where temperature inversions are likely. In any event, temperature inversions do not normally occur when there is wind and hence it would be overly conservative to assume both downwind propagation and temperature inversion effects occurring at the same time. The downwind effects are considered an adequate representation of the effects of temperature inversions, should these persist into the daytime when there is racing.

6.1.2 *Noise Barriers*

A barrier is any large object that blocks the line-of-sight between any source and receiver, including the ground or terrain if it protrudes upward through the line of sight. The effectiveness of a barrier is a function of its height and location in relation to the noise source; taller barriers will generally perform better than shorter barriers and barriers close to the source perform better than barriers midway between source and receiver. A common misconception is that trees produce a barrier effect. Trees can only appreciably reduce noise levels if sound passes through a large expanse of heavily wooded area; a thin line of trees along a boundary will have a negligible effect on noise.

The barrier effect can be significantly reduced by wind. This is especially true for barriers located midway between source and receiver. The effectiveness of a barrier can also be significantly reduced if a parallel barrier is located on the far side of the sound source. In this situation multiple sound reflections between the two barriers can produce reverberation and the reverberation will reduce the effectiveness of the barrier. This situation is worst when the receiver can see the far side barrier over the top of the near barrier. This situation has relevance for Ruapuna Park in the possible relocation site of the Pound Road quarry; reverberation or reflection off quarry walls may significantly reduce the effectiveness of the quarry walls as noise barriers. Given the width of the quarry, it would not be possible to locate the racetracks in an area such that reflection and/or reverberation did not occur. Nor would it be possible to treat the quarry walls such that reflections were significantly reduced.

As a guide to the effectiveness of the quarry walls as noise barriers, we have assessed the noise reduction that would be achieved for various receiver conditions around the quarry. We have compared two conditions;

a) When a racetrack is on the quarry floor (at 8m below ground level); and

b) At an equivalent distance, when a racetrack is located at existing ground level (not on the quarry floor).

The results show that where a racetrack is located very close to the near wall of the quarry that noise reductions of between 8 to 10 dB are likely at receivers located greater than 500 metres from the quarry. However where the track, or parts of the track, are not located very close to the pit wall (as would be the case for Ruapuna Park if relocated into the middle of the quarry) or there are reflecting surfaces behind the track (such as the far wall of the quarry) the attenuation provided by the pit walls has

been found to be significantly reduced. In this situation, noise reductions of only 1 – 2 dB are expected. As will be shown later in the report, this is commensurate with our findings for noise barriers beside Ruapuna Park and the Christchurch Kart Club.

6.2 Track Operational Noise

6.2.1 *Kart Noise Levels*

We have performed detailed measurements of one Rotax Kart in operation at the track. Other measurements have been performed for other classes of karts by Council. A summary of the measured sound pressure levels for each class of Kart is contained in the following table:

Table 15
Kart Measurement Summary

Kart Type	Number of Karts	Distance from track	L_{eq} dBA	L_{max} dBA
100cc Junior Stock Yamaha	20 (approx)	15m (inside)	85 - 88	97
125cc Rotax	20 (approx)	15m (inside)	84	95
	1	13m braking into corner	74	80
	1	16m tight corner	75	80
	1	9 m acceleration out of corner	82	90
	1	22m wide sweeping corner	75	81
	1	30m wide sweeping corner	81	87
	1	27m accelerating out of tight bend	71	75
		10m tight bend	85	94
	1	7m straight	79	88
	1	26m tight bend	67	74
	1	13m bend at end of long straight	84	89
	1	19 m small straight between 2 bends	82	89
	1	22m tight bend	83	89
	1	11m start of straight	93	93
	1	6m middle of straight	93	97
	1	3m end of straight	85	100
	1	5m middle of short straight	-	94
	1	11m tight bend	-	84
80cc Cadet	20 (approx)	15m (inside)	82	93
100cc Senior A and C	20 (approx)	15m (inside)	87	98
100cc Junior Restricted	20 (approx)	15m (inside)	82 - 83	93
125cc Rotax Masters	20 (approx)	15m (inside)	81 - 82	93
100cc Yamaha Masters	20 (approx)	15m (inside)	83 – 84	97

Generally the loudest class of Kart is the 100cc Yamaha. The quietest class of Kart is the 80cc Cadet class, however noise level from all of the classes of Karts are generally within 5 dB of each other.

6.2.2 *Ruapuna Car Club Noise Levels*

We have performed detailed measurements of two types of race car in operation at Ruapuna Park. A summary of the measured sound pressure levels for each class of car is contained in the following table:

Table 16
Race Car Measurement Summary

Car Type	Number of Cars	Distance from track (metres)	L_{eq} dBA	L_{max} dBA
V6 Holden Commodore	1	32m from fast bend	76	79
		60m from start of short straight	71	76
		20m braking into corner	77	83
		66m accelerating out of corner	72	76
		40m braking into corner	75	83
		40m accelerating out of corner	78	85
		20m braking into corner	74	92
		53m start of straight	74	81
		8m middle of long straight	92	102
		6m start of straight	92	103
		20m end of long straight	82	83
		46 braking into corner	64	67
RX7	1-2	32m from fast bend	78	81
		20m braking into corner	75	88
		40m braking into corner	83	90
		50m hairpin corner	75	94
		8m middle of long straight	93	100
		20m braking into corner	94	92

In addition to the above data we have also performed detailed monitoring of racing car noise at Pukekohe Racetrack. This data is summarised in the following tables. Note the data in the following table is expressed as Sound Power Level (L_{max}), not Sound Pressure Level as shown in the above table.

Table 17
Race Car Sound Power Level Summary

			Octave Band Sound Power Level dB L_{max} re 10-12 Watts							
		Average L_w, max (dBA)	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
V8 Supercars	Straight	141	129	135	135	143	134	129	124	117
	Braking	132	130	133	128	125	122	117	115	118
NZ V8	Straight	137	122	125	133	141	130	124	117	109
	Braking	128	123	123	125	123	117	112	108	110
Super GTs	Straight	145	133	137	143	144	138	137	131	128
	Braking	136	134	135	135	126	126	125	122	129
Porsche GT3s	Straight	141	129	142	141	140	137	133	124	117
	Braking	132	130	140	133	122	125	120	116	118
F5000s	Straight	136	126	137	140	139	135	135	132	130
	Braking	127	127	135	132	121	122	123	123	131
Formula Ford	Straight	135	125	140	138	134	129	121	116	107
	Braking	126	126	138	130	116	116	109	107	108

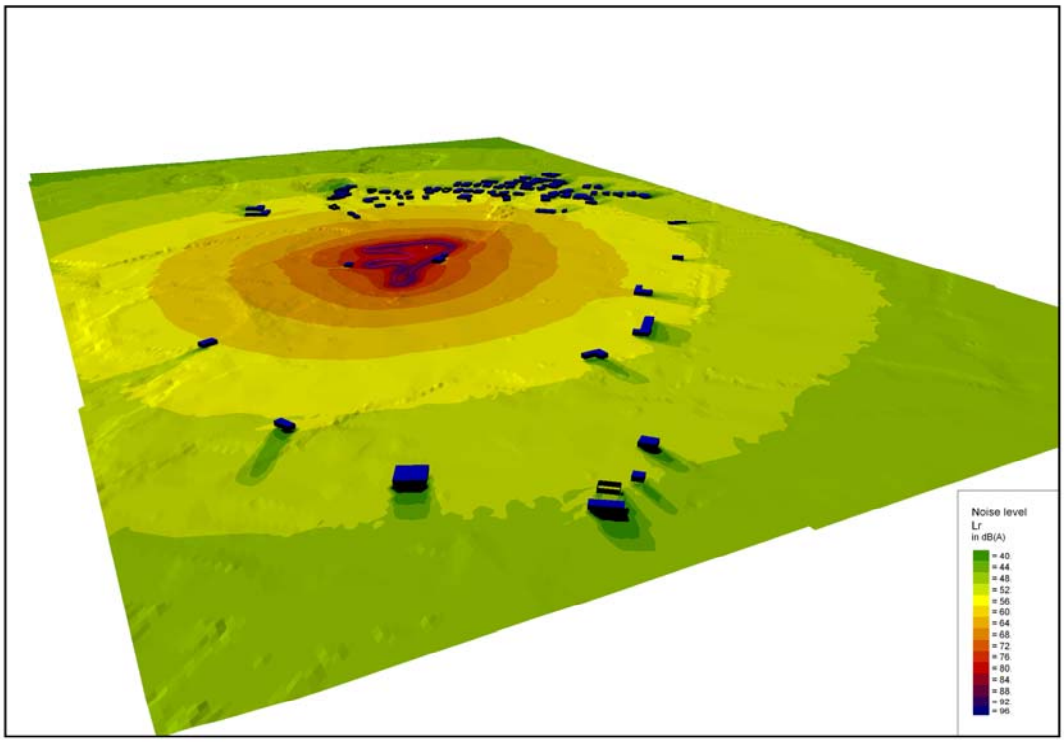
6.3 SoundPLAN

MDA have used a sophisticated proprietary noise calculation programme called *SoundPLAN* to predict noise levels from the racetrack operational activities associated with this project. This programme requires a detailed input of the surrounding topography, buildings, roads, and noise source locations. Overall noise contours around any part of the site can then be calculated, with *SoundPLAN* taking into account a large range of factors affecting the propagation of sound, including:

- the magnitude of each noise source. In most cases, this has been calculated from our measurements either at the existing racetracks or from data gathered at other racetracks around New Zealand. Our company has extensive measurements performed at Pukekohe Raceway during numerous different types of races (Refer to Section 6.2.2).
- the distance between the source and receiver
- the presence of obstacles such as screens or barriers in the propagation path.
- the presence of reflecting surfaces – including surrounding cliffs and large buildings.
- the "acoustical hardness" of the ground between the source and receiver.
- attenuation due to atmospheric absorption.
- meteorological effects such as wind gradient, temperature gradient and humidity (these have significant impact at distances greater than approximately 400m) as discussed in Section 6.1.1).

Our experience on other large projects suggests that the accuracy of a *SoundPLAN* model is about ±2 dBA. Whilst this is very good, we acknowledge that it is still only a prediction, and therefore must be treated with a certain amount of caution.

Graph 4: SoundPLAN calculation Example



6.4 Calculation Method

Because noise from Ruapuna Park received at surrounding dwellings is highly dependent on meteorological effects, it is necessary to use a noise prediction standard that deals explicitly with these factors. Given that the scope of our study is to determine the effect of two raceways in operation at different locations, it is necessary to use a standard that considers wind direction when determining sound propagation.

The most commonly used algorithm in New Zealand for environmental noise modelling is *ISO9613-2:1996 "Acoustics – Attenuation of Sound during Propagation Outdoors "*. This standard produces reliable results in many applications, however it considers all receivers are downwind from all sources at all times; the effect of wind strength and direction is not considered. If this algorithm was used in the Ruapuna Study it may give misleading results, as the Pound Road Quarry and existing Ruapuna Park are in quite different locations and could not ever physically be both upwind from many dwellings.

The *Concawe (CONCAWE, 1981)* method of sound calculation is the most widely used algorithm dealing explicitly with the influence of wind and the stability of the atmosphere. The *Concawe* method is widely used throughout the world on all types of

noise prediction projects. While we accept that this algorithm may have limitations in certain situations we believe the advantages in using it on this project outweigh any potential disadvantages.

6.5 Terrain

The terrain data used for the computer model has been taken from the GIS database held by Christchurch City Council. This database contains detailed topographical information procured using LIDAR (Light Detection and Ranging). We have used 0.5 metre contours in our SoundPLAN model

Given the majority of the site surrounding the existing and possible racetracks is grassed or vegetative we have assumed soft ground propagation in our model over all of the surrounding area.

In order to determine the barrier effect of the Pound Road Quarry Pit walls on the racetracks, it has been necessary to alter the ground topography around the quarry in our model. This is because the quarry is currently deeper, and the quarry walls are steeper, than the quarry would be if the racetracks are relocated into it. For our modelling of scenarios in the quarry, we have raised the quarry floor to a height of 8 metres below the surrounding existing ground level and assumed that the quarry walls will be battered with a 1:3 slope.

6.6 SoundPLAN Calculation Methodology

To ensure a high level of accuracy in our models we have constructed and tested them in the following manner:

Testing of racetracks has been performed at both the existing Kart Club track at Carrs Road Reserve and at Ruapuna Raceway. On both testing days, a specific race car or kart was used to do multiple laps of the racetrack and the noise emission during passby of the vehicle measured at specific locations. Noise emissions were also measured at distances further from the track. This noise level was used to construct a noise model of the existing racetrack.

The L_{max} octave band sound power level was calculated from the measured sound pressure levels of each race car or kart on every segment of racetrack (Refer to Section 6.2.2). This sound power level was then corrected for the percentage of each segment of track in terms of the overall length of the racetrack. The sound power level was also corrected to reflect the number of vehicles operating on the track.

The noise model was then used to predict noise levels at measurement locations further from the track and the predicted result compared with the measured noise level.

The noise level from the track was then adjusted to account for a number of vehicles using the racetrack simultaneously. Predictions were then performed to locations around the track where measurements had been performed during race days. The

predicted level of noise was compared with the measured and the accuracy of the model assessed.

A summary of our predicted noise levels and a comparison with measured noise levels follows:

6.6.1 *Christchurch Kart Club SoundPLAN Calibration*

The following is a summary of our SoundPLAN computer predictions in comparison to measured noise levels:

Table 18
SoundPLAN Calibrations Summary

Description of Event	SoundPLAN predictions	Measured Noise Level	Comments
15 metres from main straight inside track	81 dBA L_{eq}	84 dBA L_{eq}	-
100cc Senior A and C Class Karts @ 50m to South of Track	73 dBA L_{eq}	69 dBA L_{eq}	-
100cc Senior A and C Class Karts @ 100m to South of Track	68 dBA L_{eq}	66 dBA L_{eq}	-
100cc Senior A and C Class Karts @ 200m to South of Track	61 dBA L_{eq}	61 dBA L_{eq}	-
Kart Event – 5 minute races over half an hour (some pauses between races)	60 dBA L_{eq}	56 dBA L_{eq}	Prediction for continuous racing and downwind conditions Measurement not of continuous racing. Measurement Kart Class unknown
Kart Event – monitoring at approximately 220 metres from track	56 dBA L_{eq}	58 dBA L_{eq}	Measurement kart class unknown some wind direction unknown

It can be seen that a good correlation between measured and predicted noise levels is achieved. The Concawe algorithm is not recommended for accurate predictions within 100 metres of the noise source. It is expected that a significant difference between measured and predicted noise levels at distances of less than 100 metres. From the above table it can be seen that measured noise levels correlate better with predictions at reasonably large distances from the track.

6.6.2 *Ruapuna Raceway SoundPLAN calibration*

The following is a summary of our SoundPLAN computer predictions in comparison to measured noise levels:

Table 19
SoundPLAN Calibration Summary

Description of Event	SoundPLAN predictions	Measured Noise Level	Comments
Single V6 Race car	55 dBA L_{eq}	54 dBA L_{eq}	Measured noise level during track testing (at positions north and south of track)
	60 dBA L_{eq}	60 dBA L_{eq}	
V8 Race	66 dBA L_{eq}	61 - 68 dBA L_{eq}	1 hour measured noise levels from a variety of V8 races (at positions north and south of track)
	74 dBA L_{eq}	64 - 73 dBA L_{eq}	

It can be seen that a good correlation between measured and predicted noise levels is achieved.

7.0 ASSESSMENT OF NOISE LEVELS

We have considered the noise effects from the following situations:

1. The existing level of noise from Ruapuna Park;
2. The potential noise from Ruapuna Park when operating at the maximum permitted capacity defined by the City Plan provisions
3. The existing level of noise from the Kart Club;
4. Relocating the Kart Club to a possible site in the Pound Road Quarry while Ruapuna Park remains in the current location;
5. Relocating Ruapuna Park to the possible site in the Pound Road quarry. The Kart Club is not relocated to the Pound Road Quarry;
6. Relocating both the Kart Club and Ruapuna Park to the Pound Road Quarry Site; and
7. Leaving Ruapuna Park in current position and considering noise mitigation strategies that could be used.

In considering the effects of situations 4 - 6, we have considered the decrease or increase in noise levels that will occur at dwellings close to the existing and possible racetracks. In order to do this, we have considered the change in noise level that will occur when the above scenarios are compared against the existing situations under various wind conditions.

It is important to realise that the results relate only to the change in the existing level of Ruapuna raceway noise. Hence, for a receiver that currently receives only low levels of raceway noise, a moderate increase in noise levels may not necessarily correlate to moderate noise effects. Furthermore the change in noise level relates only to when both the raceway and kart track are operating. We have considered the overall level of noise from the scenarios separately.

We have considered the following situations:

Table 20: Change in noise levels considered

SCENARIO	Wind Direction NE	Wind Direction NW	Wind Direction SW
EXISTING			
Ruapuna typical weekday operation	✓	✓	✓
Ruapuna Race	✓	✓	✓
As above but at maximum permitted capacity	✓	✓	✓
KART IN QUARRY & RUAPUNA EXISTING – WEEKDAY			
Ruapuna & Kart typical weekday operation	✓	✓	✓
KART IN QUARRY AND RUAPUNA EXISTING – WEEKEND			
Ruapuna Race & Kart Race	✓	✓	✓
KART AND RUAPUNA IN QUARRY - WEEKDAY			
Ruapuna & Kart typical weekday operation	✓	✓	✓
KART AND RUAPUNA IN QUARRY - WEEKEND			
Ruapuna Race & Kart Race	✓	✓	✓

A comparison has been made between each possible situation and the corresponding existing situation. For instance, the situation with the Kart track and Ruapuna raceway located in the Pound Road Quarry has been compared with noise levels that would be experienced around Ruapuna raceway in its existing location. This allows the effectiveness of relocation as a noise control measure to be considered.

We have presented our results in tabulated form as well as in graphical form.
The scenarios have been considered using the following assumptions:

- **Typical kart operation during weekdays and possible weekends:** 4 go-karts operating on the track at any one time;
- **Weekend kart events**: races of up to 32 karts;
- **Typical Ruapuna raceway operation during weekdays and possible weekends:** 2 V8 race cars practicing on the track;
- **Weekend Ruapuna raceway operation during weekends:** Full NZV8 event day.
- **Speedway:** International Sprint cars

We have assumed the following in our modelling:

- The kart track will be as shown in Appendix 3. One metre high crash barriers will be located around the track.
- Ruapuna Raceway will have the same track design as the existing track, if relocated to the quarry floor.
- "Slight breeze" (2m/s) wind conditions for southwest (230°), northeast (70°) and northwest (300°) conditions.
- The quarry floor will be 8 metres below existing ground level. We have assumed the quarry walls will have a 1:3 grading as shown in the kart concept plan.

Because of the number of existing dwellings around the Raceway and Quarry, it is not practical to list the change in noise level at each dwelling. We have therefore assigned a receiver location to groups of dwellings. In general, these receiver positions represent four dwellings; however some locations represent slightly fewer or greater numbers of dwellings. A summary of the receiver locations and the property descriptions of the dwellings they represent are summarised in Appendix 6. The approximate locations of these receivers are illustrated in the following photo:

Photo 2: Receiver Locations

7.1 Noise from Existing Ruapuna Park

In order to assess the "reasonableness" of noise from Ruapuna Park it is necessary to consider the following:

- The level of noise emitted during "normal" weekday operation at the Raceway;
- The level of noise emitted during racing at the Raceway; and
- The level of noise emitted during speedway racing.

Given that the track is used for a large variety of activities on any given weekday, from race driver training to manufacturer test days, it is not possible in the scope of this study to predict the level of noise for every given scenario of racing at the track. We have assumed the following best describe the scenarios given above:

Raceway – Normal Weekday

We have defined a typical day using two V8 racing cars operating 75% of the time between 0900 – 1700 hours. Whilst this will not reflect all possible scenarios from the track it gives an indication of baseline noise emissions during a relatively noisy "practice" day. The output from this scenario could also be considered a good representation of practice involving Rotary RX7s, F5000s or Formula Fords.

Raceway – Race

We have reviewed noise monitoring from a number of large events held at Ruapuna Raceway. Scenarios such as NZV8 racing, Skope Classic, BEARS motorcycling, Circuit Pursuits and Lady Wigram Trophy have been shown to produce noise levels throughout the event that are of similar magnitude. The following NZV8 scenario has been used as the basis of our assessment of noise from large events at the racetrack and is considered to be a good representation of $L_{eq\ (1\ hour)}$ noise levels that might be produced for any large event at the site. This scenario is summarised as follows:

1000 - 1100	NZV8 races, Formula Ford races, NZ production Cars
1100 – 1200	Toyota Racing, NZV8 Racing, OSCARS racing
1200 – 1300	GT3 Racing, Drifters
1300 – 1400	NZ production cars racing, Formula Ford racing
1500 -1600	NZV8 Racing, Toyota Racing
1600 – 1700	GT3 racing
1700 – 1800	OSCARS

Speedway Racing

We have taken speedway racing as involving constant racing and assumed international sprint cars as the basis of our noise assessment. Note that noise from this event is approximately 4 dB louder than other events measured at the speedway and hence is considered a conservative assessment.

Noise Levels from the Above Scenarios

The noise levels around the site for the above three scenarios are summarised in the following tables.

Table 21

Predicted Noise Levels around Ruapuna Park

Receiver	$L_{Aeq\ (1\ hour)}$ noise levels from Raceway during Weekday operation			$L_{Aeq,\ (1\ hour)}$ noise levels from Raceway V8 Racing			$L_{Aeq,\ (1\ hour)}$ noise levels from Speedway operation		
Wind	NE	NW	SE	NE	NW	SE	NE	NW	SE
FHR1	57	61	53	62	65	58	58	63	58
FHR2	56	57	50	61	61	54	60	62	55
FHR3	51	52	44	55	56	48	52	54	47
FHR4	53	51	45	57	55	49	55	53	48
FHR5	48	50	41	53	54	45	50	53	45
FHR6	46	51	43	51	55	47	47	52	45
FHR7	45	54	53	50	58	58	41	48	49
FHR8	40	47	50	44	51	55	41	45	49
FHR9	39	47	50	44	51	54	40	45	48
FHR10	37	43	48	41	47	52	38	42	48
FHR11	37	42	48	41	46	53	38	41	47
FHR12	38	42	49	42	46	53	38	40	47

These noise levels have been plotted graphically in Appendix 1, Figures 1a – 1f for "race operation" for the raceway and the speedway. The wind condition assumed in the figures is the predominant wind directions (north-east and south-west). The north-west wind condition has also been included, although it is important to realise that this wind condition occurs less than 10% of the time (Refer Graph 3).

The highest noise levels around Ruapuna Park are experienced by the receivers to the south-east of the racetrack on Hasketts Road during a north-westerly wind. Under this wind condition, noise levels of up to 65 dBA $L_{eq\ (1\ hour)}$ are predicted at the nearest dwellings. Under the most frequent north-easterly wind conditions, noise levels of up to 62 dBA $L_{eq\ (1\ hour)}$ are predicted at the same properties. During weekday practice conditions, noise levels of 60 dBA $L_{eq\ (1\ hour)}$ are predicted during north-westerly conditions and up to 57 dBA $L_{eq\ (1\ hour)}$ for north-easterly conditions.

Noise levels from the speedway are predicted to be marginally lower than the raceway during race conditions, but very similar at most locations.

With reference to Table 9, Section 4.6.2, we consider the raceway and speedway would have the following long-term noise effects on the 45 dwellings considered. We have only considered noise levels during either the predominant north-easterly or south-westerly wind conditions.

Table 22
Noise Effects on Number of Dwellings (Summarised in Appendix 1, Figures 7a and 7c)

Effect	Raceway	Speedway	
	Day	Day	Night
Minor effects	25	34	-
Minor to moderate effects	13	8	24
Moderate to significant effects	7	3	10
Significant to severe effects	0	0	8
Severe effects	0	0	3

It can be seen in the above table that noise from the raceway if occurring during the day will have more than minor effects on 20 dwellings. It should be noted that NZV8 racing does not normally occur into the night period and hence the noise effects during this time period have not been considered. We understand that on infrequent occasions that drifting has continued past 10pm, however we understand this no longer occurs due to safety considerations. Noise levels associated with drifting are generally lower than V8 racing. Anecdotal evidence suggests that drifting is considerably more annoying for equivalent noise levels than normal racing events.

The speedway is expected to have more than minor effects on 11 dwellings during daytime operation as shown in Table 22. Noise levels during the night period will have more than minor effects on all 45 dwellings considered.

In our proposed annoyance criteria, we considered that it would be reasonable for residents to expect moderate noise effects, however that it would not be reasonable for residents to expect significant noise effects. There are seven dwellings that are exposed to raceway noise levels between 61 – 62 dBA $L_{eq\ (1\ hour)}$ during predominant

winds. These dwellings are considered to be moderately to significantly affected by noise. At these dwellings it would be reasonable for the residents to expect that noise levels were reduced to below 60 dBA $L_{eq\ (1\ hour)}$ at the notional boundary, or the number of raceway events reduced.

The speedway currently generates unreasonable levels of noise during night operation, as, according to our criteria, it has more than moderate noise effects on 21 dwellings. During daytime operation, noise levels at three dwellings are around 60 dBA L_{eq}, a level considered to have more than moderate effects (note that the predicted level is right on the limit and the exceedence is therefore marginal). It would be reasonable for these three residents to expect that the level of noise from the speedway was reduced to below 60 dBA L_{eq} at the notional boundary, or that the number of daytime events were reduced.

In summary, the noise levels from the existing operation of Ruapuna Raceway are considered unreasonable at seven dwellings. Noise levels from the speedway are unreasonable at three dwellings during daytime operation and twenty-one dwellings during night-time operation.

7.2 Noise from Existing Ruapuna Park operating at the Maximum Permitted Capacity

Christchurch City Council have requested that the noise effects from Ruapuna Park be assessed as if it was operating at maximum permitted capacity.

The maximum operating capacity of Ruapuna is defined by the City Plan noise rules for the site. These are described in Section 4.1.1 and are summarised below.

- Normal permitted operation with noise levels of 65 dBA $L_{10\ (1\ hour)}$ and 90 dBA L_{max}
- Up to 200 events per year with noise levels of 80 dA $L_{10\ (1\ hour)}$ and 95 dBA L_{max}
- Up to 15 days per year with operation up to 2400 hours;
- Up to 5 days per year with the noise levels of 80 dBA $L_{10\ (1\ hour)}$ and no L_{max} limit.

It is important to note that the above limits are all applied at the **site boundary.**

As previously discussed, we understand from Council monitoring that in 2006 Ruapuna Park held 43 "large events" in the racing calendar at the raceway and 14 "large events" at the speedway. During monitoring, the Raceway invoked the "200-day 80 dBA L_{10}" noise rule on 15 occasions and Speedway invoked the "200-day 80 dBA L_{10}" noise rule on only two occasions. On two occasions the 15 day rule was invoked by the Speedway, allowing motor-sport activities to continue until midnight. The "5-day no L_{max}" rule was not invoked at any point during monitoring.

In our analysis of noise at maximum permitted capacity, we have assumed that the park will operate with 200 large events per year. Whilst it would be theoretically possible for the park to operate with 365 large events per year and still achieve their noise limits, the park does not perform noise monitoring of events and hence the only way to ensure compliance with the "200 day" limit would be to limit large events to below 200 per year. This would still be a significant increase in usage and, with smaller events, would likely represent almost constant activity at the Ruapuna Site.

Given that the park required the 200 day rule to be invoked on 17 days when approximately 60 large events held on site, we have assumed that 200 large events would invoke the rule 60 times.

Even at the maximum permitted level of operation, $L_{eq\ (1\ hour)}$ noise levels emitted from the site would not increase. This is because the site already holds very large events and the type of event currently held is not restricted by the noise limits. It is therefore only the increased number and/or duration of events that could cause an increase in annoyance in the surrounding area.

The park is also entitled to operate up to 2400 hours on 15 occasions per year. The site held 2 events in 2006 that occurred until 2400 hours and invoked this rule. If the park was operating at maximum permitted capacity, the number of events later in the night period would increase from 2 to 15. This is a significant increase.

The L_{max} noise rule limits noise from short duration loud events, such as a car backfiring. An increased number of events is therefore unlikely to result in higher maximum noise emissions from the site – only an increase in the number of single "loud" noises. This is because the increased number of events does not increase the L_{max} noise level emitted from the racetrack. As the "5-day, no L_{max} rule" does not currently need to be invoked, an increased number of events would not necessarily mean that the rule would need to be invoked.

Based on an established relationship between number of events and noise level (refer Table 10, Section 4.6.2) we consider the raceway and speedway would have the following long-term noise effects on the 45 dwellings considered if operating to full capacity. We have only considered noise levels during either the predominant north-easterly or south-westerly wind conditions:

Table 23
Noise Effects on Number of Dwellings (Summarised in Appendix 1, Figure 7b)

Effect	Raceway	Speedway	
	Day	Day	Night
Minor effects	-	24	-
Minor to moderate effects	25	10	-
Moderate to significant effects	13	8	24
Significant to severe effects	7	3	10
Severe effects	0	0	11

In our proposed annoyance criteria, we considered that it would be reasonable for residents to expect moderate noise effects, however that it would not be reasonable for residents to expect significant noise effects. For the daytime operation at the Raceway and Speedway, the noise levels are considered to have significant to severe effects for 10 dwellings. For the night-time operation at the Speedway, the noise levels are considered to have a significant to severe effects for 21 dwellings. Therefore, we consider that it is unreasonable for Ruapuna Park to operate at its maximum permitted

capacity of 200 large events per year, with 15 events occurring until 2400 hours and 5 events with no L_{max} limit.

7.3 Noise from Carrs Road Kart Club

As part of this report we have considered the noise effects from the existing Kart Club at Carrs Road on the surrounding residents. Note that in this assessment we have considered the existing level of operation, i.e weekday practices with semi-regular race meeting during the weekend.

We have reviewed the "Environmental Health Considerations for the Awatea Variation Report" prepared by Russell Malthus, Environmental Health Consultant. A summary of the main points in this report and our comments follow:

The report suggests that the Group 1 Zone noise standards are exceeded at distances of 400 metres. We have reviewed noise monitoring performed by Christchurch City Council at the Kart Club that has been performed for a variety of events. This data shows that the Group One development Standards are exceeded at these distances, and may in fact be exceeded at even further distances at times. We note that the Kart Club is not required to comply with the Group One values; it has a specific noise limit in the City Plan.

The report states that complaints have been received as far afield as Halswell, and that the distinctive character of the karts may contribute to the complaints as the noise level from the karts would be below the Development Standards at this location. We agree that the noise level in Halswell would likely be below the development standard noise limit (50 dBA L_{eq}) during almost all conditions. Such a level would comply with most environmental noise standards and complaints here may be more likely due to the character of the noise source rather than the level. However at these locations the background noise level is around 37 – 40 dBA L_{95}, and this relatively low daytime background noise level may contribute to the perceived intensity of the sound.

The report suggests that noise barriers may be useful at reducing the noise level at receivers close to the site however the confines of the track preclude these barriers from being constructed. It should be noted that the track crash barrier and bunding is currently providing a reasonable degree of acoustic screening and increasing the height of the bunding around the track would have only limited effectiveness in further reducing noise levels at a distance from the track.

The report states that reduction of noise at the receiver would be impractical and not provide protection outdoors. We agree with this statement. Given the amount of nearby dwellings, fitting retrospective noise control treatment at the receiver would be very expensive. Furthermore, treating dwellings will only reduce noise levels inside dwellings with windows shut and will not reduce noise levels outside, or inside when windows are open. Given that kart events occur during the day, we consider that treating dwelling facades would have only limited effectiveness at reducing annoyance.

The report concludes that the kart track is adversely affecting residents in the area and that it may also impact on existing or future businesses.

Appendix 1, Figures 2a – 2c shows noise levels that we predict will occur around the existing Kart Club track at Carrs Road during a large race involving Yamaha 100cc class karts for north-east and south-west wind conditions respectively. The noise level at the nearest dwellings is around 61 dBA L_{eq} during downwind propagation. During zero-met conditions we would expect this noise level to reduce by approximately 5 dB.

Comparing these noise emissions with Table 10 in Section 4.6.3, the noise emissions from the Kart Track are considered to have the following noise effects on the 45 nearby residents considered.

Table 24
Noise Effects on Dwellings (Summarised in Appendix 1, Figure 7g)

Effect	Number of Dwellings Affected by Carrs Road Kart Club
Minor effects	40
Minor to moderate effects	4
Moderate to significant effects	1
Significant to severe effects	0
Severe noise effects	0

Again, in our proposed annoyance criteria, we considered that it would be reasonable for residents to expect moderate noise effects, however that it would not be reasonable for residents to expect significant noise effects.

A small number of dwellings are expected to be moderately affected; however only one dwelling is expected to be significantly affected. We note that the majority of dwellings around the track are expected to receive less than minor effects. If the usage of the track were to increase from its current usage, there would likely be a commensurate increase in annoyance.

We disagree with the assessment made in the Environmental Health Considerations for the Awatea Variation Report that the noise levels would affect businesses, given the short period of operation at the site during the week (Wednesday afternoon) and the fact that the number of karts on the track is fewer than during a large race during these times. Although some businesses operate during weekends and effects on these businesses need to be considered, these businesses are unlikely to be private offices. Given that noise levels of up to 60 dBA L_{eq} are expected at existing business facades, this would give a noise level of approximately 45 dBA L_{eq} inside with a partially open window. This is below the maximum recommended level noise for most commercial and industrial operations as contained in AS/NZS2107:2000 *Acoustics—Recommended design sound levels and reverberation times for building interiors.* We would therefore consider the effects of noise on businesses to be less than minor.

Based on the current level of use, we consider that at the majority of dwellings surrounding the Kart Club, noise levels are reasonable. However at one dwelling it

could be reasonably expected that the Kart Club decrease noise levels to below 60 dBA L_{eq}.

It should also be noted that this area is likely to experience significant growth in the future. The number of moderately affected dwellings could therefore increase. We therefore recommend that relocation of the Kart Club is considered if the surrounding land is going to be rezoned as residential under the Awatea Plan Change.

7.4 Relocating Kart Club to Quarry. Ruapuna Park Stays in Current Location.

The following table shows the change in noise level at each receiver location over the existing level of noise from Ruapuna Park if the kart track was relocated into the Pound Road Quarry. In this situation noise levels in the area cannot decrease unless mitigation measures are implemented at the existing Ruapuna racetrack.

Table 25
Change in Noise Levels at Receiver Locations

Receiver	Kart in Quarry & Ruapuna Existing Location - Change in L_{eq} Noise Level (dB)							
	Ruapuna Existing Reference Level (Weekday)	Weekday Operation At Ruapuna and Kart Club			Ruapuna Existing Reference Level (Race)	Race Operation At Ruapuna and Kart Club		
Wind	All	NE	NW	SW	All	NE	NW	SW
FHR1	0	+1	0	0	0	+2	0	+1
FHR2	0	0	0	0	0	+1	0	0
FHR3	0	0	0	0	0	+1	0	+1
FHR4	0	0	0	0	0	+1	0	0
FHR5	0	0	0	0	0	+1	0	+1
FHR6	0	+1	0	0	0	+2	+1	+1
FHR7	0	+5	+4	+5	0	+8	+8	+8
FHR8	0	+2	+1	+2	0	+5	+3	+5
FHR9	0	+1	+1	+1	0	+3	+2	+4
FHR10	0	+2	+1	+1	0	+4	+2	+4
FHR11	0	+1	+1	+1	0	+3	+2	+3
FHR12	0	+1	+1	+1	0	+3	+2	+2

The following table gives a guide to the significance of the change in noise level at each receiver location. Note that an increase in raceway noise level will only have the commensurate effect where raceway noise is already the predominant noise in an area.

Table 26
Change in Sound Level Vs. Subjective Response

Change in L_{eq} Sound Level (dB)	Subjective Reaction
>12	More than a doubling of Loudness
9 – 11	Doubling of Loudness
5 – 7	Appreciable Change
3 – 4	Just Perceptible Change
0 - 2	Imperceptible Change

An imperceptible increase in noise levels is predicted for the majority of receivers during normal "weekday" operation. The only exception to this is the two dwellings at receiver location FHR7. At this location we would predict a perceptible increase in noise levels.

During raceday operation at both racetracks, an imperceptible increase in noise level is still predicted for many receivers; however a just perceptible to appreciable increase would generally be experienced at receivers to the north and east of the quarry.

The overall noise levels from this scenario are summarised for the north-east, north-west and south-west wind conditions in the following table:

Table 27
Raceway Noise Levels at Receiver Locations

Receiver	Kart in Quarry & Ruapuna Existing Location – $L_{Aeq\ (1\ hour)}$ noise levels					
	Weekday Operation At Ruapuna and Kart Club			Race Operation At Ruapuna and Kart Club		
Wind	NE	NW	SW	NE	NW	SW
FHR1	58	61	53	64	65	58
FHR2	57	57	50	62	61	54
FHR3	51	52	44	56	57	48
FHR4	53	51	45	57	55	49
FHR5	49	50	42	54	55	46
FHR6	47	51	43	53	56	48
FHR7	50	58	58	58	66	66
FHR8	42	48	53	49	54	59
FHR9	41	47	51	47	53	57
FHR10	39	44	50	45	50	56
FHR11	38	43	50	45	48	55
FHR12	39	43	50	45	48	56

The above results are summarised in Appendix 1, Figures 3a – 3c. Comparing these noise emissions with Table 10 in Section 4.6.3, the noise emissions from the Kart Track are considered to have the following noise effects on the 45 dwellings in the Pound Road area considered in this study (refer to Photo 1 and Appendix 6). In considering effects, we have only considered noise levels during the predominant north-east or south-west wind conditions.

Table 28
Noise Effects on Dwellings (Summarised in Appendix 1, Figure 7e)

Effect	Number of Dwellings Affected Kart in Quarry Ruapuna Existing
Minor effects	10
Minor to moderate effects	26
Moderate to significant effects	7
Significant to severe effects	2
Severe effects	0

In our proposed annoyance criteria, we considered that it would be reasonable for residents to not expect any perceptible increase in noise. As previously discussed, a just perceptible to appreciable increase in noise level is expected to the north and east of the quarry. This increase in noise level is expected to result in two dwellings being exposed to motorsport noise levels that are considered to have significant to severe effects where previously they were exposed to noise levels that are considered to have no more than minor effects. Sixteen dwellings would receive minor to moderate effects whereas previously they received no more than minor effects.

Note that in considering the above we have assessed possible mitigation measures around the quarry that could be used to decrease noise emissions. These include bunding around the top of the quarry and recontouring of the quarry pit edges to increase the barrier effect. None of these measures were effective enough to influence our conclusions.

We therefore do not consider that the noise environment resulting from relocating the Kart Club to the Pound Road quarry would be reasonable.

7.5 Relocating Ruapuna Park to Quarry. Kart Club is Located Elsewhere

The following table shows the change in noise level at each receiver location if Ruapuna Park was relocated into the Pound Road Quarry. In this situation, noise levels may increase for some receivers and decrease for others.

Table 29
Change in Noise Levels at Receiver Locations

Receiver	Ruapuna Relocated to Pound Road Quarry Change in L_{eq} Noise Level (dB)			
	Existing Scenario	Operation in Pound Road Quarry		
Wind	All	NE	NW	SW
FHR1	0	-4	-12	-10
FHR2	0	-5	-11	-10
FHR3	0	-2	-7	-6
FHR4	0	-5	-9	-8
FHR5	0	-1	-6	-4
FHR6	0	+2	-4	-4
FHR7	0	+11	+8	+3
FHR8	0	+10	+9	+8
FHR9	0	+9	+9	+7
FHR10	0	+9	+7	+7
FHR11	0	+9	+6	+6
FHR12	0	+7	+4	+5

The table and the figures show that receivers to the south of the existing racetrack (FHR1 – FHR5) show an appreciable decrease in noise levels. In some cases the noise levels will halve in loudness.

At receivers to the east, northeast and north of the Pound Road Quarry (FHR7 – FHR12) a doubling of loudness would be expected during northeast conditions. During other conditions, an appreciable increase in noise levels is expected.

Relocating Ruapuna Park into the quarry would result in significant reductions in noise at some receiver locations. However at a similar number of receiver locations a significant increase is expected.

The overall noise levels from this scenario are summarised for the north-east, north-west and south-west wind conditions in the following table:

Table 30
Raceway Noise Levels at Receiver Locations

Receiver	Ruapuna Raceway in Quarry - $L_{Aeq\ (1\ hour)}$ noise levels					
	Weekday Operation At Ruapuna			Race Operation At Ruapuna		
Wind	NE	NW	SW	NE	NW	SW
FHR1	54	48	43	59	54	48
FHR2	51	45	40	56	50	45
FHR3	48	44	37	53	49	42
FHR4	47	41	36	52	46	41
FHR5	47	43	36	52	48	41
FHR6	47	46	38	52	51	43
FHR7	56	61	56	61	66	61
FHR8	49	55	57	54	60	63
FHR9	47	54	56	53	60	61
FHR10	46	49	54	50	54	59
FHR11	45	47	54	50	52	59
FHR12	44	45	53	49	50	58

The above results are summarised in Appendix 1, Figures 4a – 4c. Comparing these noise emissions with Table 9 in Section 4.6.2, the noise emissions from the Park are considered to have the following noise effects on the 45 nearby residents considered. In considering effects, we have only considered noise levels during north-east or south-west conditions as these are the predominant wind directions.

Table 31
Number of dwellings affected (Summarised in Appendix 1, Figure 7d)

Effect	Number of Dwellings Affected Ruapuna Relocated to Quarry
Minor Effects	18
Minor to moderate effects	18
Moderate to significant effects	9
Significant to severe effects	0
Severe effects	0

In our proposed annoyance criteria, we considered that it would be reasonable for residents to not expect any perceptible increase in noise. As previously discussed, whilst relocating Ruapuna to the Pound Road Quarry will result in noise reductions at some receivers, a commensurately larger increase in noise level is expected at some dwellings. Furthermore, dwellings in the area surrounding the quarry will experience increased effects from noise.

We therefore do not consider that the noise effects, in relocating Ruapuna Park into the Pound Road quarry, are reasonable.

7.6 Relocating both the Kart Club and Ruapuna Park to the Quarry

The following table shows the change in noise level at each receiver location with this scenario if both the kart track and the raceway were relocated into the Pound Road Quarry. In this situation noise levels in the area can increase or decrease depending on proximity to the quarry and existing Ruapuna Park.

Table 32
Noise Levels at Receiver Locations

Receiver	Kart & Ruapuna Raceway both in Quarry Change in L_{eq} Noise Level (dB)							
	Ruapuna Existing Reference Level (Weekday)	Weekday Operation At Ruapuna and Kart Club			Ruapuna Existing Reference Level (Race)	Race Operation At Ruapuna and Kart Club		
Wind	All	NE	NW	SE	All	NE	NW	SE
FHR1	0	-2	-11	-9	0	0	-9	-6
FHR2	0	-5	-11	-9	0	-3	-9	-7
FHR3	0	-2	-7	-6	0	0	-5	-4
FHR4	0	-5	-10	-8	0	-3	-8	-6
FHR5	0	-1	-6	-5	0	0	-4	-3
FHR6	0	+2	-3	-4	0	+3	-1	-2
FHR7	0	+11	+8	+6	0	+13	+11	+9
FHR8	0	+10	+8	+7	0	+11	+10	+9
FHR9	0	+8	+8	+7	0	+10	+9	+8
FHR10	0	+9	+6	+6	0	+10	+7	+8
FHR11	0	+8	+5	+6	0	+10	+6	+7
FHR12	0	+7	+3	+4	0	+8	+5	+6

At receivers FHR1 – FHR5 there would generally be a reduction in noise levels under this scenario, however under north-east conditions the reduction would be imperceptible to just perceptible. For dwellings to the north and east of the quarry (FHR7 – FHR12) more than a doubling of loudness would be predicted. Under all wind conditions an appreciable to very significant increase in noise levels is predicted at receiver locations FHR7 – FHR12.

The overall noise levels from this scenario are summarised for the north-east, north-west or south-east wind conditions in the following table:

Table 33
Raceway Noise Levels at Receiver Locations

Receiver	Kart Club & Ruapuna in Quarry – $L_{Aeq\ (1\ hour)}$ noise levels					
	Weekday Operation At Ruapuna and Kart Club			Race Operation At Ruapuna and Kart Club		
Wind	NE	NW	SW	NE	NW	SW
FHR1	55	50	44	62	56	51
FHR2	52	46	41	58	52	47
FHR3	49	45	38	55	51	44
FHR4	48	41	36	54	47	42
FHR5	47	44	37	53	50	43
FHR6	48	47	39	54	53	45
FHR7	57	62	59	62	69	67
FHR8	49	55	58	55	61	64
FHR9	47	54	56	53	60	62
FHR10	46	49	55	51	55	60
FHR11	45	47	54	51	52	60
FHR12	45	45	53	50	51	59

The above results are summarised in Appendix 1, Figures 5a – 5c. Comparing these noise emissions with Table 9 in Section 4.6.2, the noise emissions from the relocation of the tracks are considered to have the following noise effects on the 45 nearby residents considered. In considering effects, we have only considered noise levels during north-east or south-west conditions as these are the predominant wind directions.

Table 34
Number of dwellings affected (Summarised in Appendix 1, Figure 7f)

Effect	Number of Dwellings Affected Ruapuna and Kart Club Relocated to Quarry
No more than minor effects	14
Minor to moderate effects	10
Moderate to significant effects	19
Significant to severe effects	2
Severe noise effects	0

In our proposed annoyance criteria, we considered that it would be reasonable for residents to not expect any perceptible increase in noise. As previously discussed, whilst relocating Ruapuna Park and the Kart Club to the Pound Road Quarry will result in noise reductions at some receivers, a commensurately larger increase in noise level is expected at some dwellings. Furthermore, dwellings in the area surrounding the quarry will experience increased effects from noise, and two receivers will be significantly to severely affected by noise.

We therefore do not consider that the noise effects, in relocating both Ruapuna Park and the Kart Club into the Pound Road quarry, are reasonable.

7.7 Potential Mitigation Measures at Ruapuna Park

To reduce the noise effects from any source, the following measures are normally considered:

- **Reduce noise emissions from the source**

  For Ruapuna Motorsport Complex, reduction of noise emissions at the source would involve testing of vehicles to ensure they met a specific noise performance standard. In order for vehicles to comply with this standard the fitting of performance mufflers would be required.

  The current MotorSport New Zealand noise rule is that no vehicle shall exceed a noise level of 95 dB during a pass-by when measured at 30 metres and 90° from the point of the track at which the vehicle is at its maximum rpm. We understand that Speedway New Zealand imposes a similar noise limit on speedways, however the distance is 25m (reference: Speedway New Zealand Inc. Rule T5).

  The reduction of noise by reducing exhaust noise is often presented as a trade-off between the excitement of racing fans during races and the annoyance caused to nearby residents (Ciecka, Close, Snellgrove). It is suggested that reduction in vehicle noise levels will reduce visitor numbers to racetracks, however the opposite effect has been found to be true in some studies (Hellweg).

  The practicality of exhaust noise control has been disputed for various car types. Exhaust noise control from single-seater cars is considered less practical than for saloon cars. A study by Close suggested that noise from stock car engines, differentials and fans will become dominant once exhaust noise levels have been reduced by approximately 15 dB.

  A similar conclusion was made by Growcott in his evidence on Western Springs Speedway, where he stated that the limit of improvement using mufflers on speedway cars would be achieved using a relatively modest sized muffler (approximately 10 dB). Marshall Day Acoustics has performed some preliminary work at this speedway which suggests that reduction in noise using mufflers may have a limit of 5 dB.

- **Enclose the source**

  Enclosing a noise source is often a very effective noise mitigation measure. Fully enclosing the raceway and speedway would present obvious problems and we do not consider this to be a practical solution.

- **Construct noise barriers around the source.**

  Constructing noise barriers around a source is often a cost effective way to reduce noise emissions. However, noise barriers can often have limited effectiveness at large distances, as meteorological effects such as wind and temperature inversions can reduce their effectiveness. This is particularly true

for situations where noise barriers are located halfway between source and receiver.

Noise barriers can also reduce the amount of noise absorbed as sound passes over soft ground. Noise barriers are more effective when introduced to a situation where noise is propagating over hard ground.

There is already an existing bund around the southern side of Ruapuna Raceway which is providing line-of-sight screening to most residences and is likely to have some effectiveness as a noise barrier. There is a full sheet steel wall that encircles the speedway. The ground cover surrounding the complex is acoustically soft.

We have considered the effect of constructing an 8 metre high noise barrier or bund to the south of the raceway and speedway in the location of the existing bund.

In order to show these results, we have produced a noise difference map showing the noise level difference with the barrier in place, compared with the existing situation. This plot is shown in Appendix 1, Figure 6.

From the figure it can be seen that while the barrier produces a significant reduction in noise levels close to the barrier, at the location of most surrounding dwellings the noise reduction is not significant (less than 2 dB). At these dwelling locations, the barrier would reduce noise levels from the near side of the track significantly; however the noise from the main straight on the far side of the track would not be significantly reduced. We do not consider that increasing the height of the existing bund to be an effective noise control option as it would not provide an appreciable decrease in noise levels.

- **Acoustically treat the receiver**

  Generally, acoustically treating the receivers is viewed as a last resort when all other noise control measures have been exhausted. Only indoor areas are normally treated; outdoor recreational areas will still receive the same amount of noise.

  Acoustically treating receivers usually involves:

  - The installation of heavy glass panes or double glazing if appropriate;
  - Increasing the mass of internal wall and ceiling linings;
  - Installing ventilation systems so that windows can remain shut; and
  - Treating external doors where appropriate

  It should be noted that new dwellings constructed in this area are required to comply with City Plan noise limits to control aircraft noise from CIAL internally. Many of the above measures will therefore have already been included in new or recently constructed dwellings around Ruapuna Park.

7.8 Summary of Possible Relocation Scenarios

We have considered all of the possible relocation scenarios currently being considered by Council.

Relocating the Kart Track to the Pound Road quarry whilst Ruapuna Park stays in its current location will result in an insignificant increase in noise level for many receivers; however a just perceptible to appreciable increase would generally be experienced at receivers to the north and east of the quarry (Refer to Section 7.4). At receivers close to the quarry an appreciable increase in noise would be experienced.

Relocating Ruapuna Raceway into the quarry would result in significant reductions in noise at some receiver locations. However at a similar number of receiver locations a significant increase is expected. Under the predominant northeast wind directions, the increase in noise levels at some dwellings will be more significant than the decrease in noise levels at others under the same conditions.

Relocating both the Kart Track and Ruapuna Park to the Pound Road quarry will in general result in a reduction in noise levels at receivers to the south and west, however the reduction would be only just perceptible under predominant north-east conditions. For dwellings to the north and east of the quarry more than a doubling of loudness is predicted.

The expected levels of annoyance in each situation are summarised in the following table:

Table 35: Summary of Noise Effects (Summarised in Appendix 1, Figures 7)

Effect	Number of dwellings affected				
	Currently affected	Affected if Ruapuna at Limit of Operation	Ruapuna Relocated to Quarry	Kart Club in Quarry Ruapuna Existing	Both Ruapuna and Kart Club Relocated to Quarry
Minor effects	25	-	18	10	14
Minor to moderate effects	13	25	18	26	10
Moderate to significant effects	7	13	9	7	19
Significant to severe effects	0	7	0	2	2
Severe effects	0	0	0	0	0

No relocation options to the Pound Road Quarry are considered reasonable in terms of noise effects. If relocation of these racetracks is considered to be required, alternative sites should be considered.

As discussed in Section 4.0, the City Plan currently contains a 400 metre exclusion zone around the boundary of the site within which it is a non-complying activity to build. There are currently six dwellings within this buffer zone, with a seventh located just outside the zone. These dwellings are moderately to significantly affected by noise. The current buffer distance is therefore generally sufficient for preventing

significant noise effects on new dwellings; however dwellings built just outside this zone may still be moderately affected by noise. In order to prevent minor to moderate noise effects, the buffer zone would need to be extended to approximately 1300 metres from the existing Ruapuna site. The 1300 metre buffer would represent a contour outside of which noise levels were generally below 55 dBA $L_{eq\ (1\ hour)}$.

We have summarised the approximate buffer distances around each of the above scenarios that would be required to prevent moderate and significant noise effects:

Table 36: Buffer Distances

Effect	Buffer Distances (Metres)			
	Ruapuna at Limit of operation	Ruapuna Relocated to Quarry (normal operation)	Kart Club in Quarry Ruapuna Existing (normal operation)	Both Ruapuna and Kart Club Relocated to Quarry (normal operation)
Distance to Prevent Significant effects	1300m	250 – 450 m	500 – 1000 m	400 – 900m
Distance to Prevent Moderate Effects	2600m	1000m	1600 – 2000m	2000m

We recommend that the current exclusion zone around Ruapuna Park should be strongly defended by Council. Any attempt to develop or subdivide property inside this zone should be discouraged. Consideration should be given to increasing the buffer distance to approximately 1300 metres.

8.0 CONCLUSIONS

Marshall Day Acoustics have examined the existing and potential noise environments of the areas surrounding Ruapuna Park and the existing noise environment of the Kart Club.

We have proposed criteria for assessing the "reasonableness" of noise when applied to the existing Ruapuna Park and Kart Club operations. In the rural residential areas surrounding Ruapuna Park, daytime noise levels are generally considered to be reasonable, however seven houses are exposed to raceway noise levels that are marginally above our reasonableness criteria. Three houses are exposed to speedway noise levels that are marginally above the reasonableness criteria during the daytime. This is consistent with the small number of complainants. Night operations at the speedway are currently considered unreasonable at twenty one dwellings based on our criteria.

With Ruapuna Park operating to maximum permitted capacity the noise levels from dayime operation of the raceway are considered to have significant to severe effects for 10 dwellings. For the night-time operation at the Speedway, the noise levels are considered to have a significant to severe effects for 21 dwellings. Therefore, we consider that it is unreasonable for Ruapuna Park to operate at its maximum permitted capacity of 200 large events per year.

The current buffer distance around Ruapuna Park is generally sufficient to prevent significant noise effects on existing dwellings. A buffer distance of approximately 1300 metres would be required to prevent moderate noise effects. The construction of an 8 metre high noise barrier to the south of the existing raceway would not result in a significant decrease in noise levels for the majority of receivers.

Additionally, Marshall Day Acoustics have performed acoustic modelling of a number of scenarios for the possible relocation of the Christchurch Kart Club and Ruapuna Park. Given the predominance of the north-easterly wind at the site location, the possible relocation of the Christchurch Kart Club into the Pound Road quarry would, in general, cause noise effects to increase at the majority of nearby dwellings. Similarly, the possible relocation of Ruapuna Park into the Pound Road quarry would, in general, cause noise effects to increase at the majority of nearby dwellings.

Given the increasing pressure on land surrounding the Christchurch Kart Club we recommend that consideration is given to relocation, however relocation of either the Kart Club or Ruapuna Raceway to the Pound Road quarry is not considered reasonable in terms of noise effects on the surrounding area.

We consider that the current location of Ruapuna currently represents the best practicable option in terms of noise effects on existing dwellings. We do not consider the Pound Road Quarry as the best relocation site for the Kart Club in terms of noise effects on existing dwellings.

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Appendix 1: Figures

Figures 1a – 1f

1a: Ruapuna Park Existing Raceway: NZV8 Race, NE wind

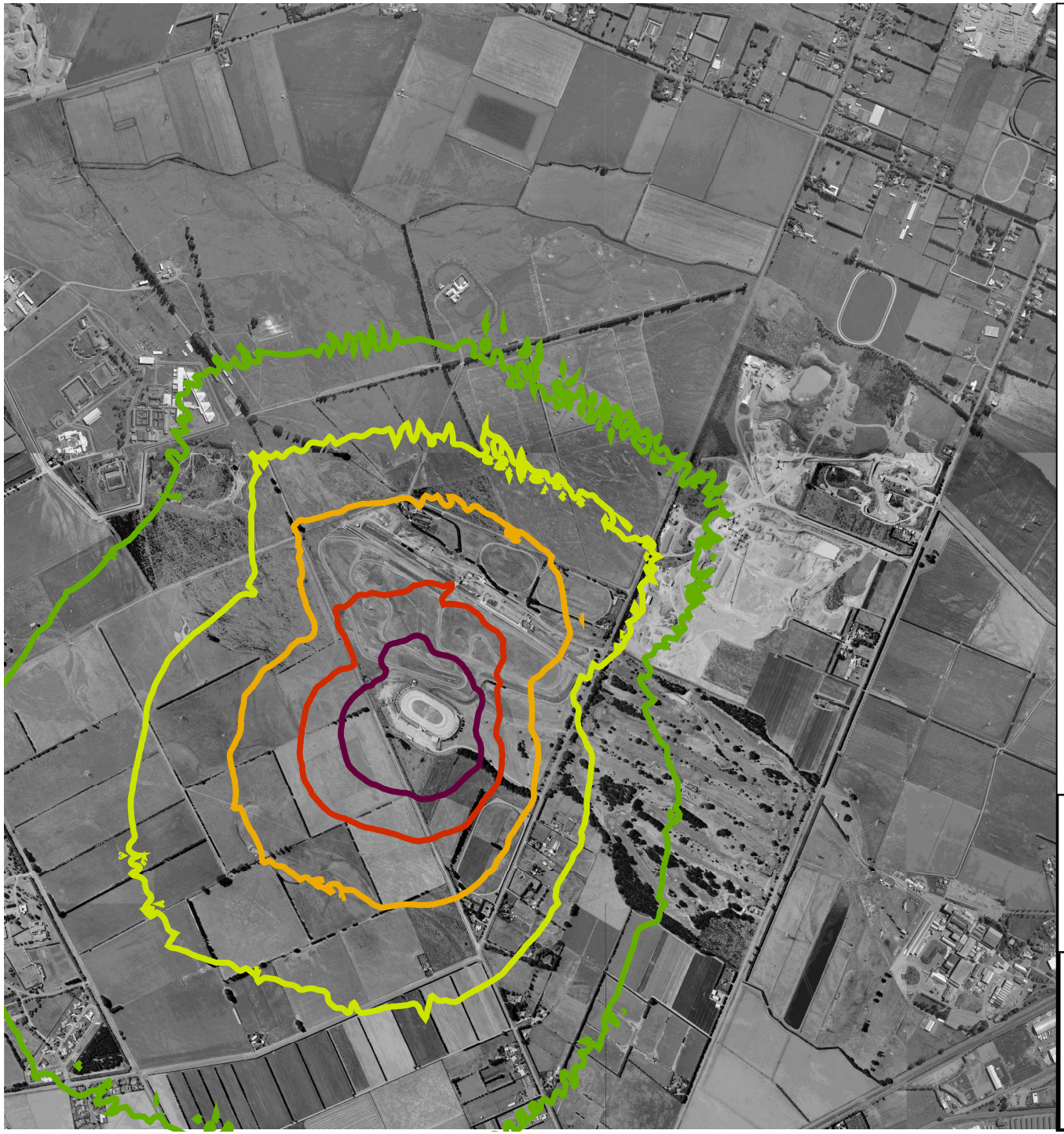
1b: Ruapuna Park Existing Raceway: NZV8 Race, SW wind

1c: Ruapuna Park Existing Raceway: NZV8 Race, NW wind

1d: Ruapuna Park Existing Speedway: International Sprint, NE wind

1e: Ruapuna Park Existing Speedway: International Sprint, SW wind

1f: Ruapuna Park Existing Speedway: International Sprint, NW wind



RACEWAY NOISE STUDY

Scenario:
Ruapuna Speedway Race

Wind Conditions:
NE

Noise level
Leq dB(A)

= 50
= 55
= 60
= 65
= 70

N

0 125 250 500 750 1000
m

MARSHALL DAY
ACOUSTICS

RACEWAY NOISE STUDY

Scenario:
Ruapuna Speedway Race

Wind Conditions:
SW

Noise level
Leq dB(A)

= 50
= 55
= 60
= 65
= 70

N

0 125 250 500 750 1000
m

MARSHALL DAY
ACOUSTICS

RACEWAY NOISE STUDY

Scenario:
Ruapuna Speedway Race

Wind Conditions:
NW

Noise level
Leq dB(A)

= 50
= 55
= 60
= 65
= 70

N

0 125 250 500 750 1000
m

MARSHALL DAY
ACOUSTICS

RACEWAY NOISE STUDY

Scenario:
Ruapuna Circuit NZV8 Race

Wind Conditions:
NE

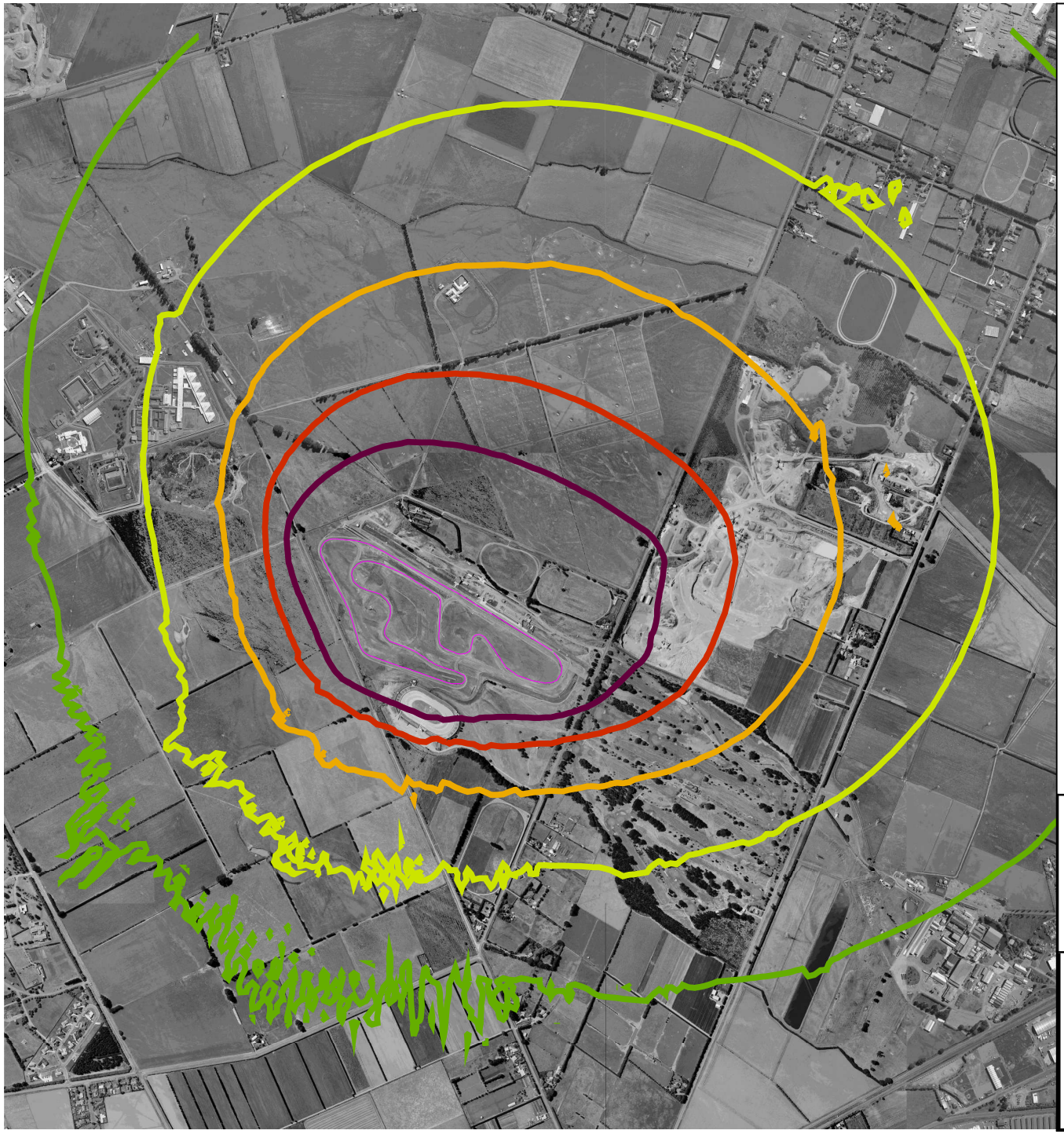
Noise level
Leq dB(A)

= 50
= 55
= 60
= 65
= 70

N

0 125 250 500 750 1000
m

MARSHALL DAY
ACOUSTICS



RACEWAY NOISE STUDY

Scenario:
Ruapuna Circuit NZV8 Race

Wind Conditions:
SW

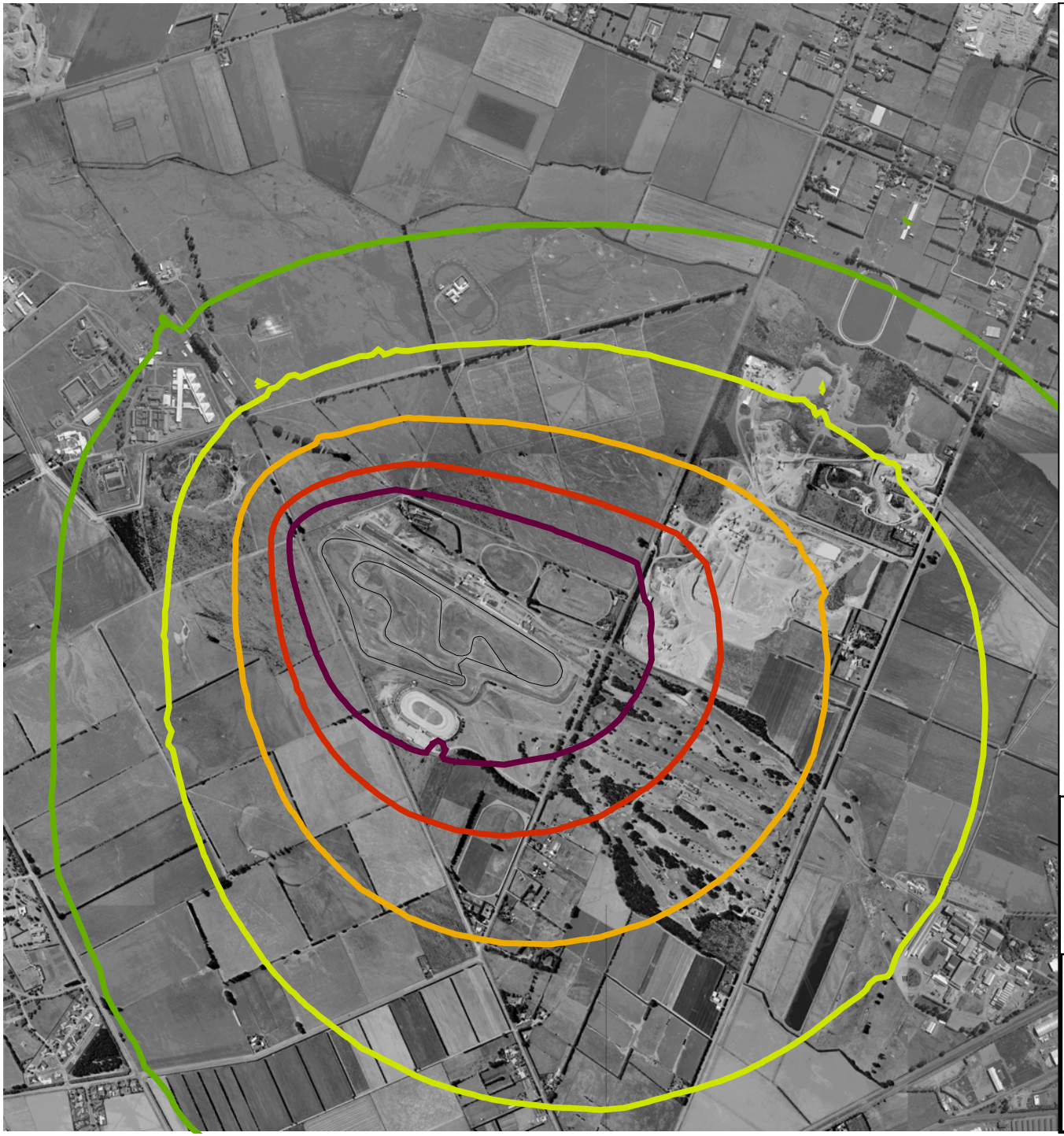
Noise level
Leq dB(A)

= 50
= 55
= 60
= 65
= 70

N

0 125 250 500 750 1000
m

MARSHALL DAY
ACOUSTICS



RACEWAY NOISE STUDY

Scenario:
Ruapuna Circuit NZV8 Race

Wind Conditions:
NW

Noise level
Leq dB(A)

= 50
= 55
= 60
= 65
= 70

N

0 125 250 500 750 1000
m

MARSHALL DAY
ACOUSTICS

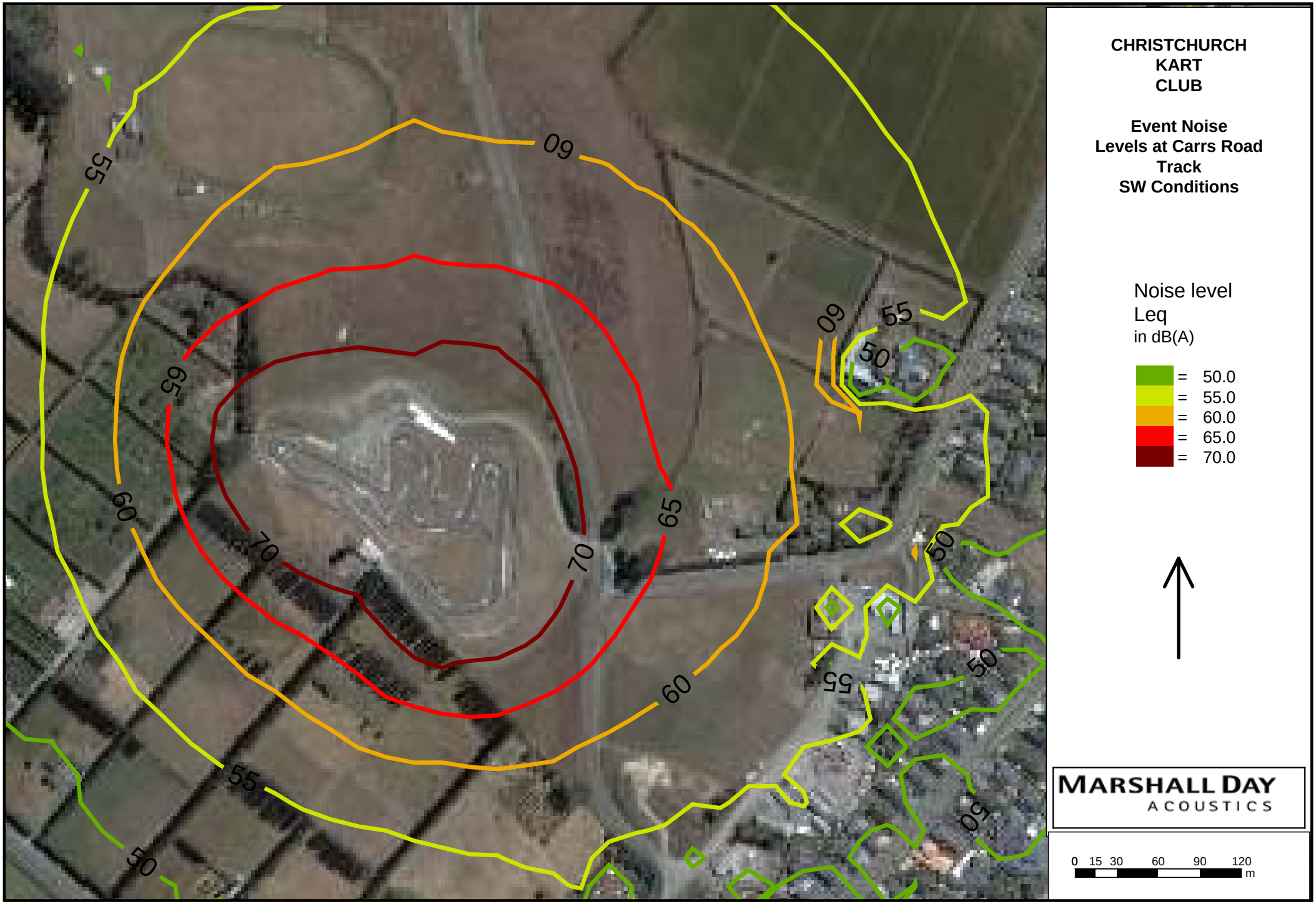
Figures 2a – 2c

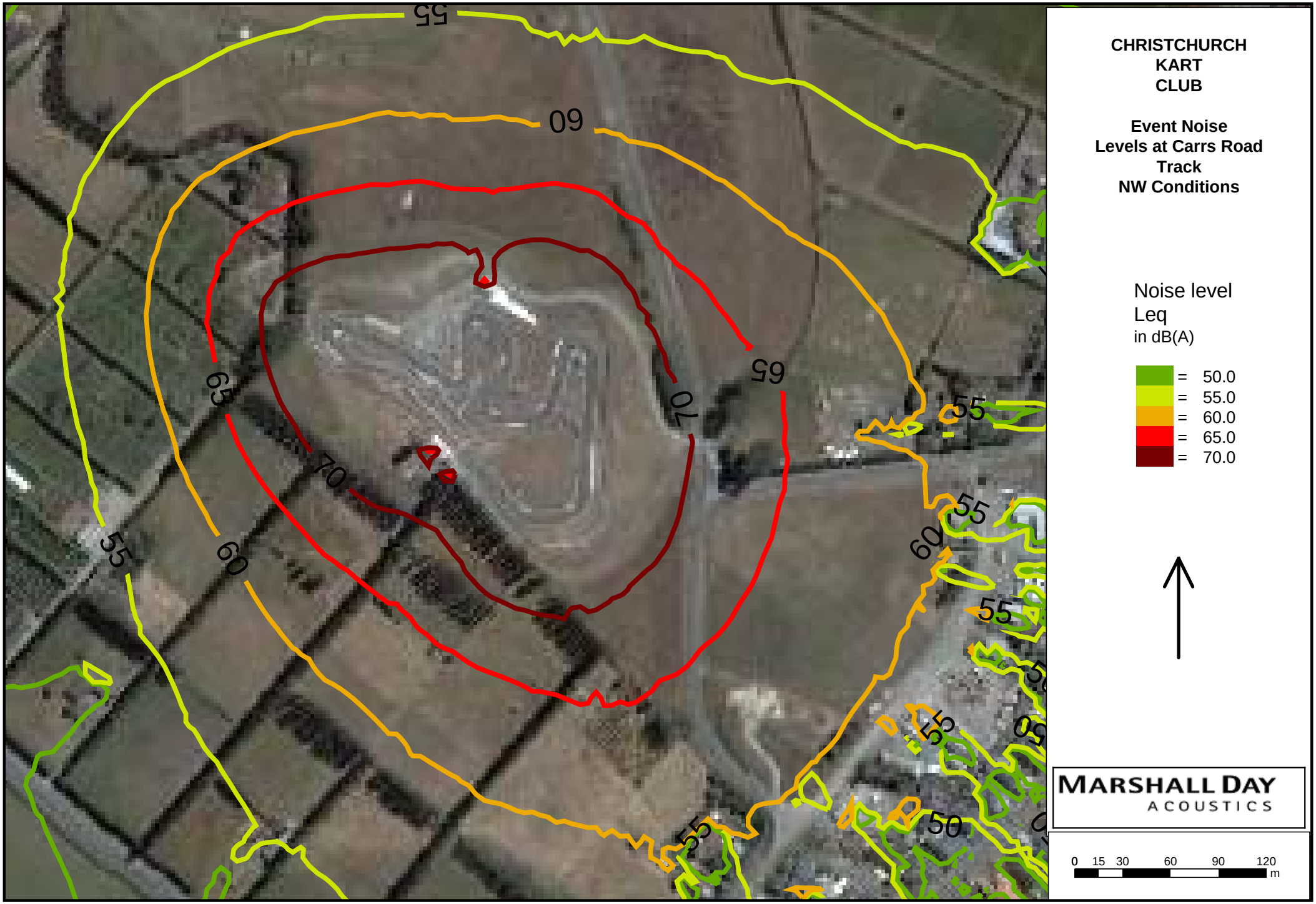
2a: Carrs Road KART track: Yamaha 100cc Race Conditions, NE wind

2b: Carrs Road KART track: Yamaha 100cc Race Conditions, SW wind

2c: Carrs Road KART track: Yamaha 100cc Race Conditions, NW wind


CHRISTCHURCH
KART
CLUB
Event Noise
Levels at Carrs Road
Track
NE Conditions
Noise level
Leq
in dB(A)
= 50.0
= 55.0
= 60.0
= 65.0
= 70.0
MARSHALL DAY
ACOUSTICS
0 15 30 60 90 120
m


CHRISTCHURCH
KART
CLUB
Event Noise
Levels at Carrs Road
Track
SW Conditions
Noise level
Leq
in dB(A)
= 50.0
= 55.0
= 60.0
= 65.0
= 70.0
MARSHALL DAY
ACOUSTICS
0 15 30 60 90 120
m

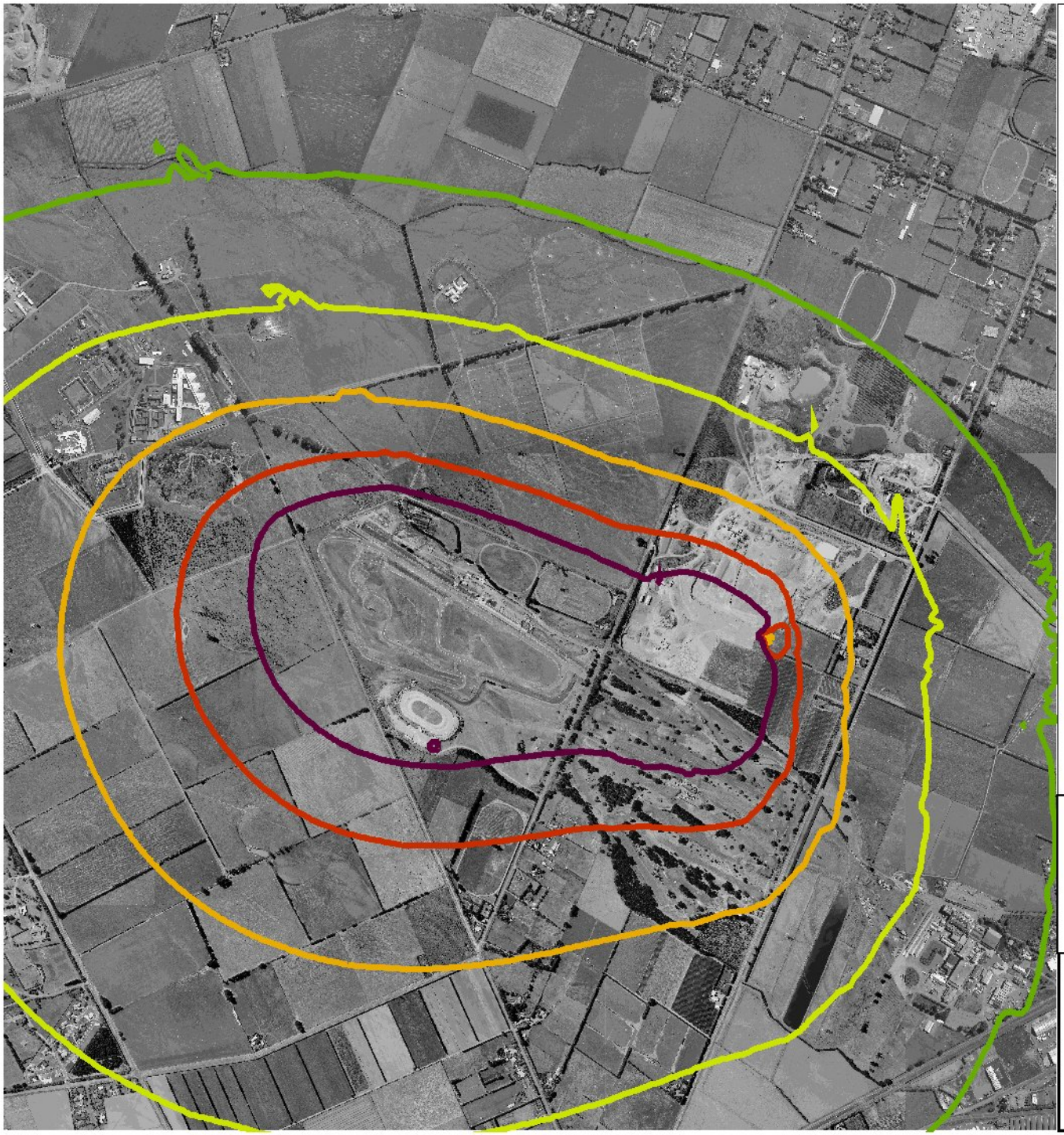

CHRISTCHURCH
KART
CLUB
Event Noise
Levels at Carrs Road
Track
NW Conditions
Noise level
Leq
in dB(A)
= 50.0
= 55.0
= 60.0
= 65.0
= 70.0
MARSHALL DAY
ACOUSTICS
0 15 30 60 90 120
m

Figures 3a – 3c

3a: Ruapuna Existing Location, Kart Track in Pound Road Quarry, Race, NE wind

3b: Ruapuna Existing Location, Kart Track in Pound Road Quarry, Race, SW wind

3c: Ruapuna Existing Location, Kart Track in Pound Road Quarry, Race, NW wind



RACEWAY NOISE STUDY

Scenario:
Ruapuna NZV8 Rac
Kart Race in quarry

Wind Conditions:
NE wind

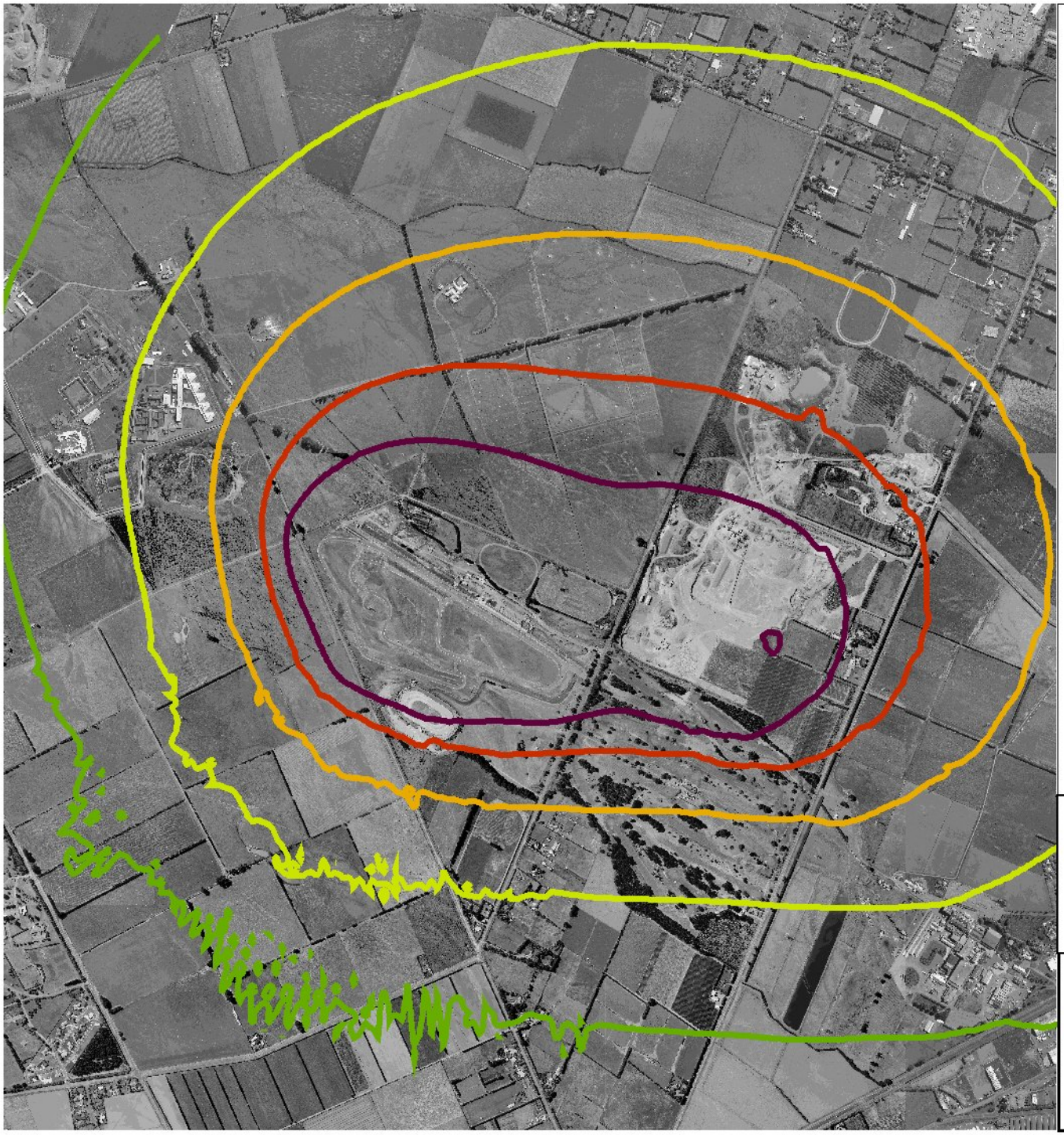
Noise level
Leq dB(A)

= 50
= 55
= 60
= 65
= 70

N

0 125 250 500 750 1000 m

MARSHALL DAY
ACOUSTICS



RACEWAY NOISE STUDY

Scenario:
Ruapuna NZV8 Race
Kart Race in quarry

Wind Conditions:
SW wind

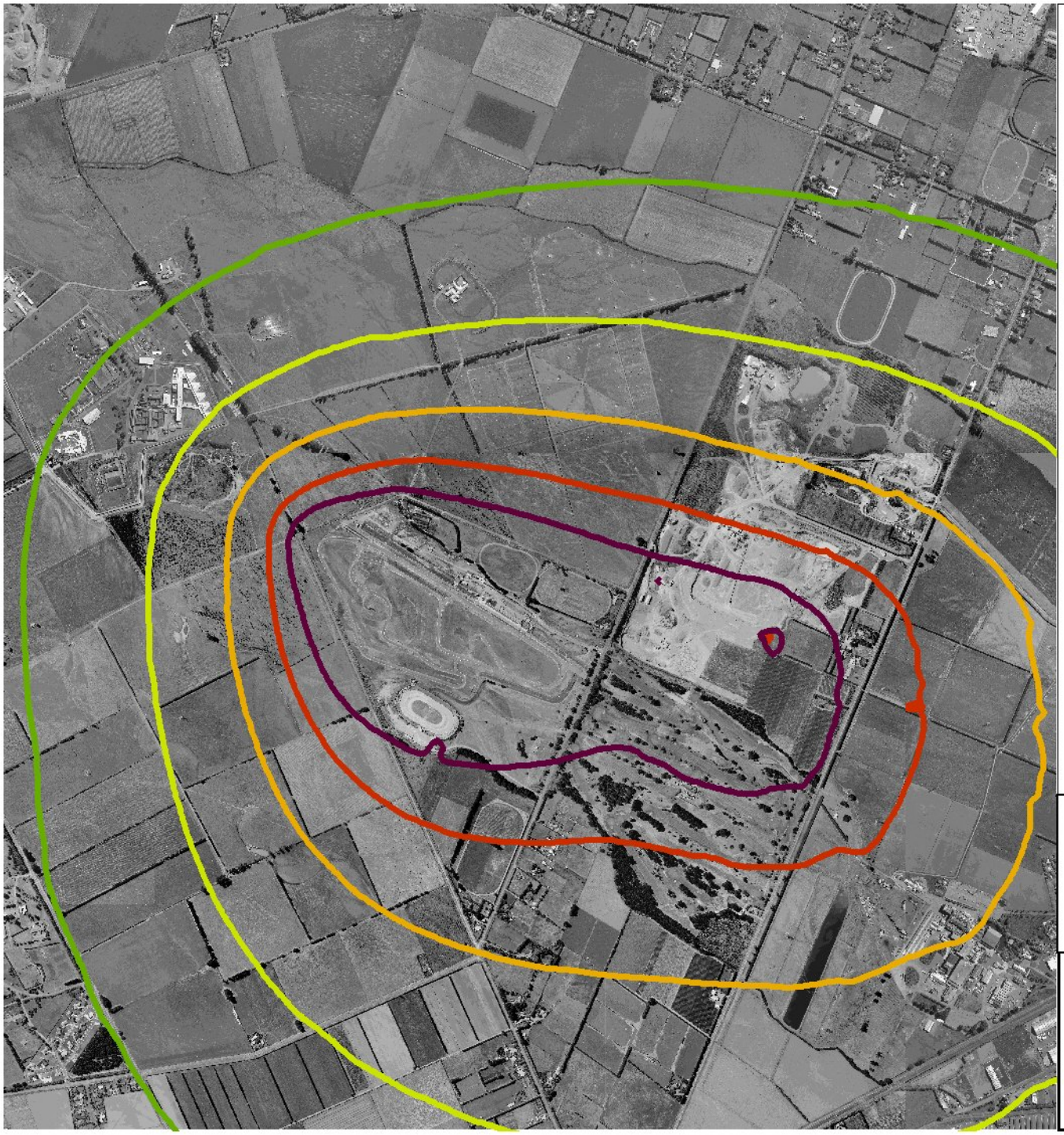
Noise level
Leq dB(A)

= 50
= 55
= 60
= 65
= 70

N

0 125 250 500 750 1000 m

MARSHALL DAY
ACOUSTICS



RACEWAY NOISE STUDY

Scenario:
Ruapuna NZV8 Race
Kart Race in quarry

Wind Conditions:
NW wind

Noise level
Leq dB(A)

= 50
= 55
= 60
= 65
= 70

N

0 125 250 500 750 1000 m

MARSHALL DAY
ACOUSTICS

Figures 4a – 4c

4a: Ruapuna Raceway in Pound Road Quarry, Race, NE wind

4b: Ruapuna Raceway in Pound Road Quarry, Race, SW wind

4c: Ruapuna Raceway in Pound Road Quarry, Race, NW wind

RACEWAY NOISE STUDY

Scenario:
NZV8 Race in quarry

Wind Conditions:
NE wind

Noise level
Leq dB(A)

= 50
= 55
= 60
= 65
= 70

N

0 125 250 500 750 1000
m

MARSHALL DAY
ACOUSTICS

RACEWAY NOISE STUDY

Scenario:
NZV8 Race in quarry

Wind Conditions:
SW wind

Noise level
Leq dB(A)

= 50
= 55
= 60
= 65
= 70

N

0 125 250 500 750 1000
m

MARSHALL DAY
ACOUSTICS

RACEWAY NOISE STUDY

Scenario:
NZV8 Race in quarry

Wind Conditions:
NW wind

Noise level
Leq dB(A)

= 50
= 55
= 60
= 65
= 70

N

0 125 250 500 750 1000 m

MARSHALL DAY
ACOUSTICS

Figures 5a – 5c

5a: Ruapuna Raceway and Kart Track in Pound Road Quarry, Race, NE wind

5b: Ruapuna Raceway and Kart Track in Pound Road Quarry, Race, SW wind

5c: Ruapuna Raceway and Kart Track in Pound Road Quarry, Race, NW wind

RACEWAY NOISE STUDY

Scenario:
NZV8 Race in quarry
Kart Race in quarry

Wind Conditions:
NE

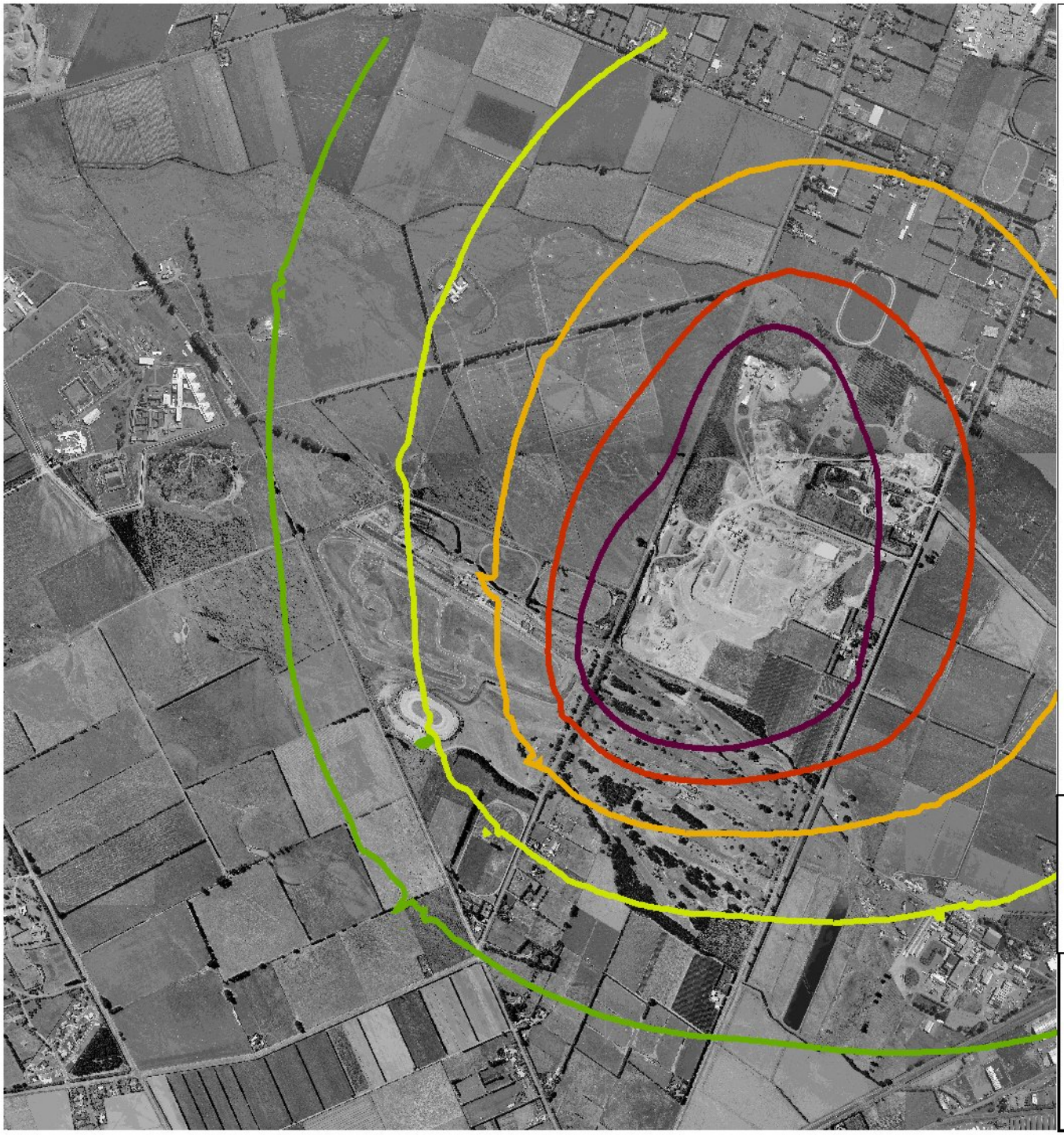
Noise level
Leq dB(A)

= 50
= 55
= 60
= 65
= 70

N

0 125 250 500 750 1000 m

MARSHALL DAY
ACOUSTICS



RACEWAY NOISE STUDY

Scenario:
NZV8 Race in quarry
Kart Race in quarry

Wind Conditions:
SW

Noise level
Leq dB(A)

= 50
= 55
= 60
= 65
= 70

N

0 125 250 500 750 1000 m

MARSHALL DAY
ACOUSTICS

RACEWAY NOISE STUDY

Scenario:
NZV8 Race in quarry
Kart Race in quarry

Wind Conditions:
NW

Noise level
Leq dB(A)

= 50
= 55
= 60
= 65
= 70

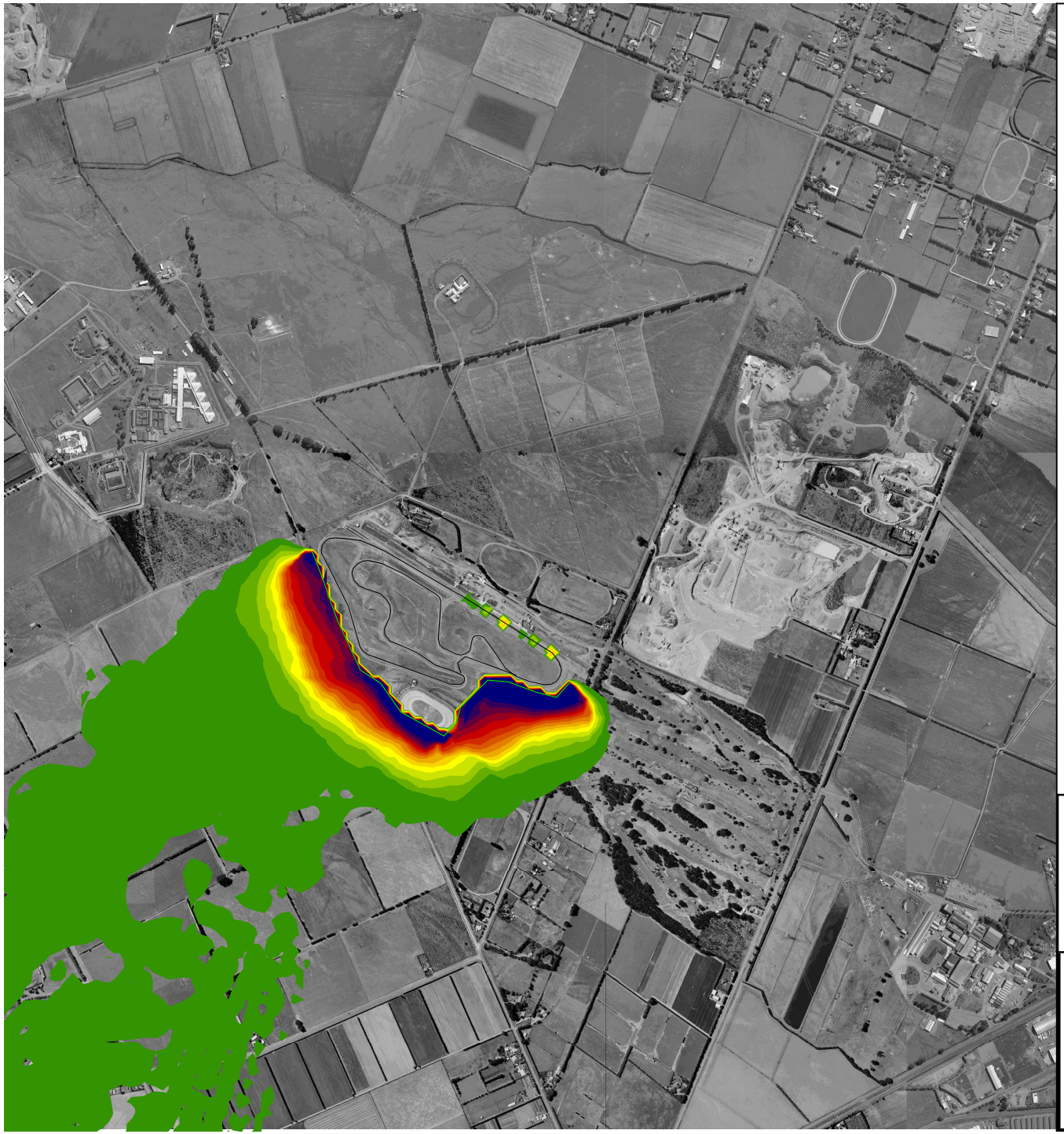
N

0 125 250 500 750 1000 m

MARSHALL DAY
ACOUSTICS

Figures 6

Figure 6: Effect of Noise Barrier



RACEWAY NOISE STUDY

Scenario:
Ruapuna Circuit NZV8 Race
Difference with 8m barrier

Wind Conditions:
No Wind

Reduction in noise level with 8m barrier

=	1.0
=	2.0
=	3.0
=	4.0
=	5.0
=	6.0
=	7.0
=	8.0
=	9.0
=	10.0
=	11.0
=	12.0
=	13.0
=	14.0
=	15.0

N

0 125 250 500 750 1000 m

MARSHALL DAY ACOUSTICS

Figures 7

Figure 7a: Affected receivers – Ruapuna Park existing location and operation

Figure 7b: Affected receivers – Ruapuna Park existing location, maximum capacity operation

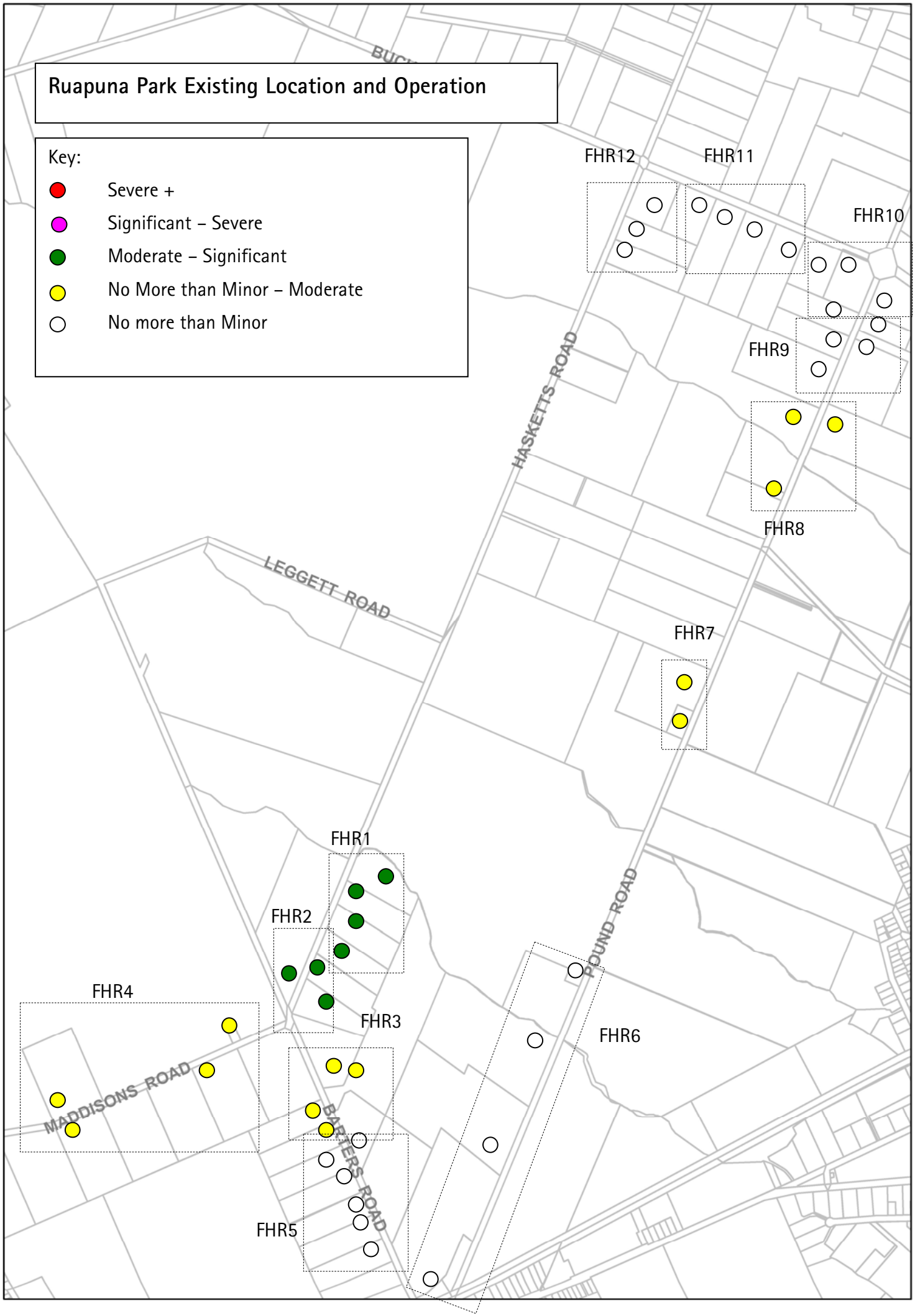
Figure 7c: Affected receivers – Speedway during night-time operation

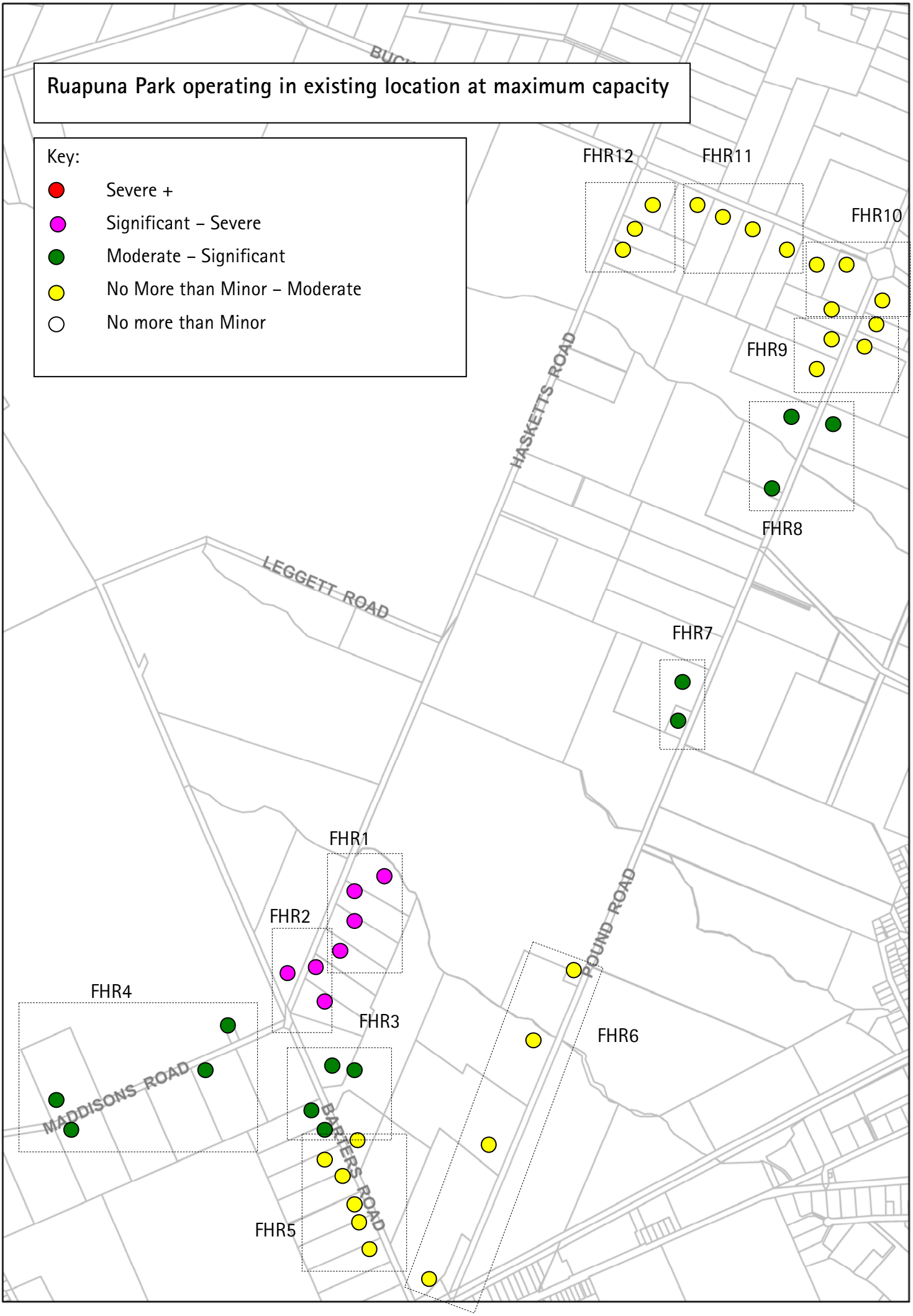
Figure 7d: Affected receivers – Ruapuna Park relocated to quarry

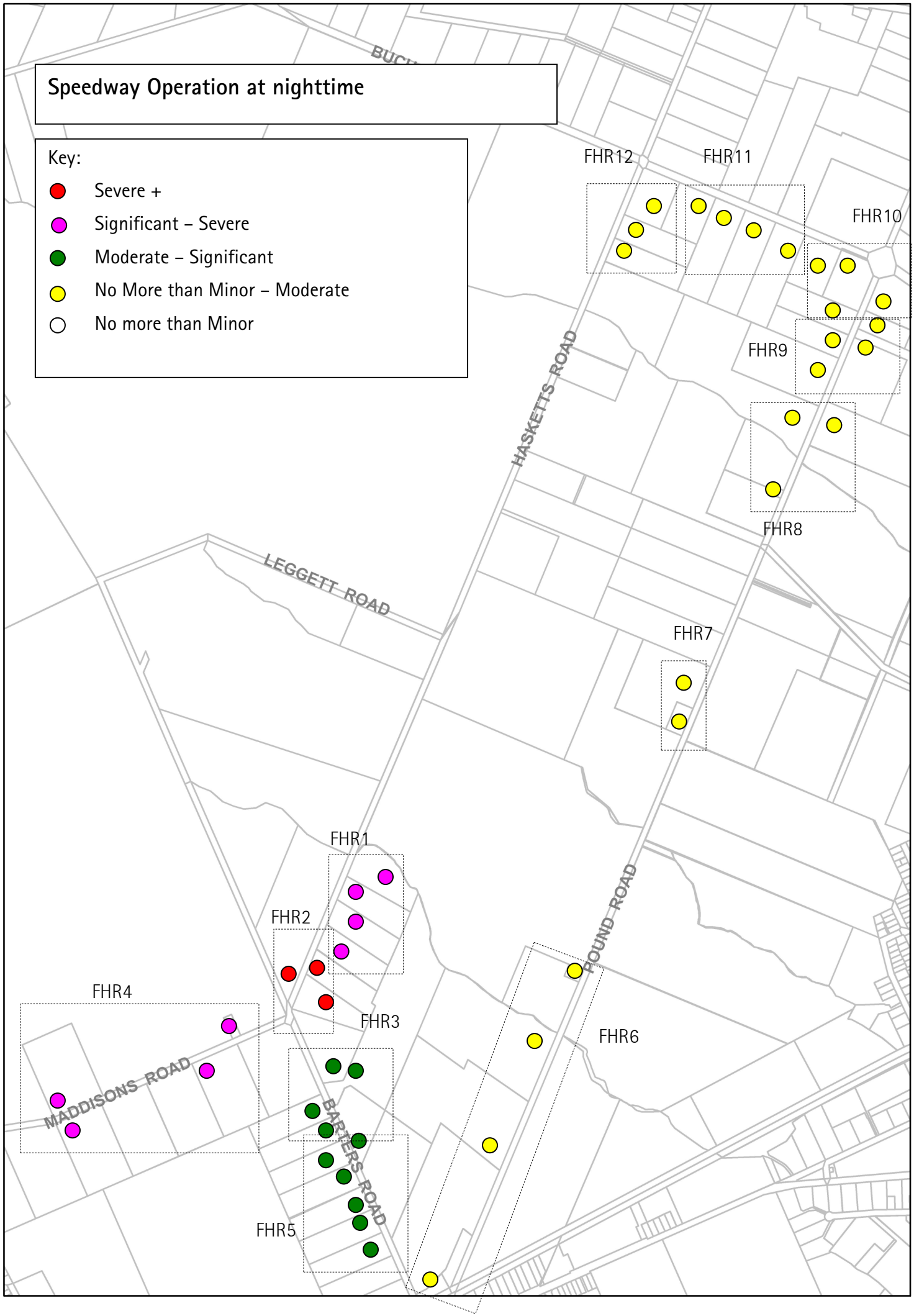
Figure 7e: Affected receivers – Ruapuna Park existing location, Kart Club in quarry

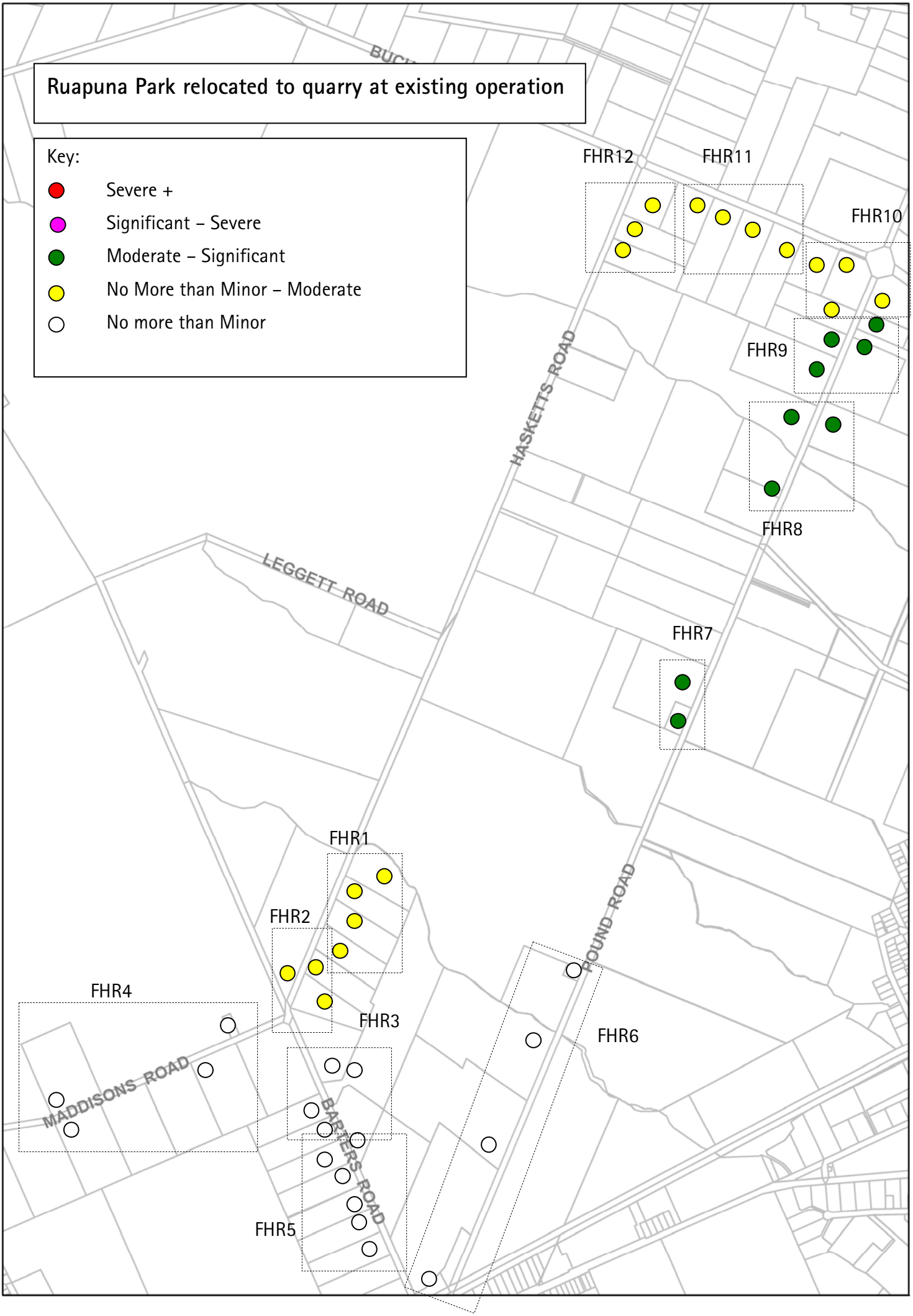
Figure 7f: Ruapuna Park and Kart Club relocated to quarry

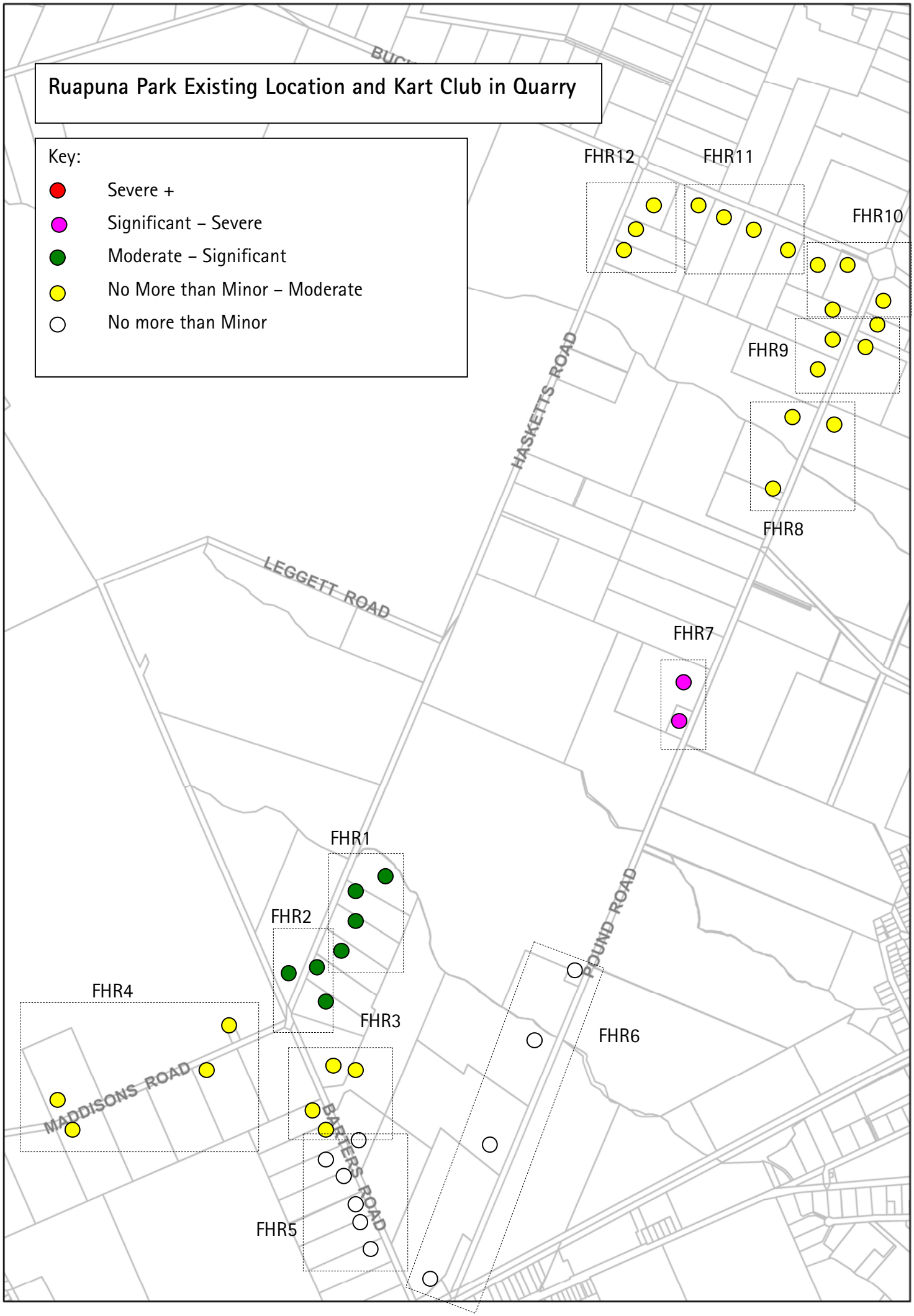
Figure 7g: Affected receivers – Carrs Road Kart Club

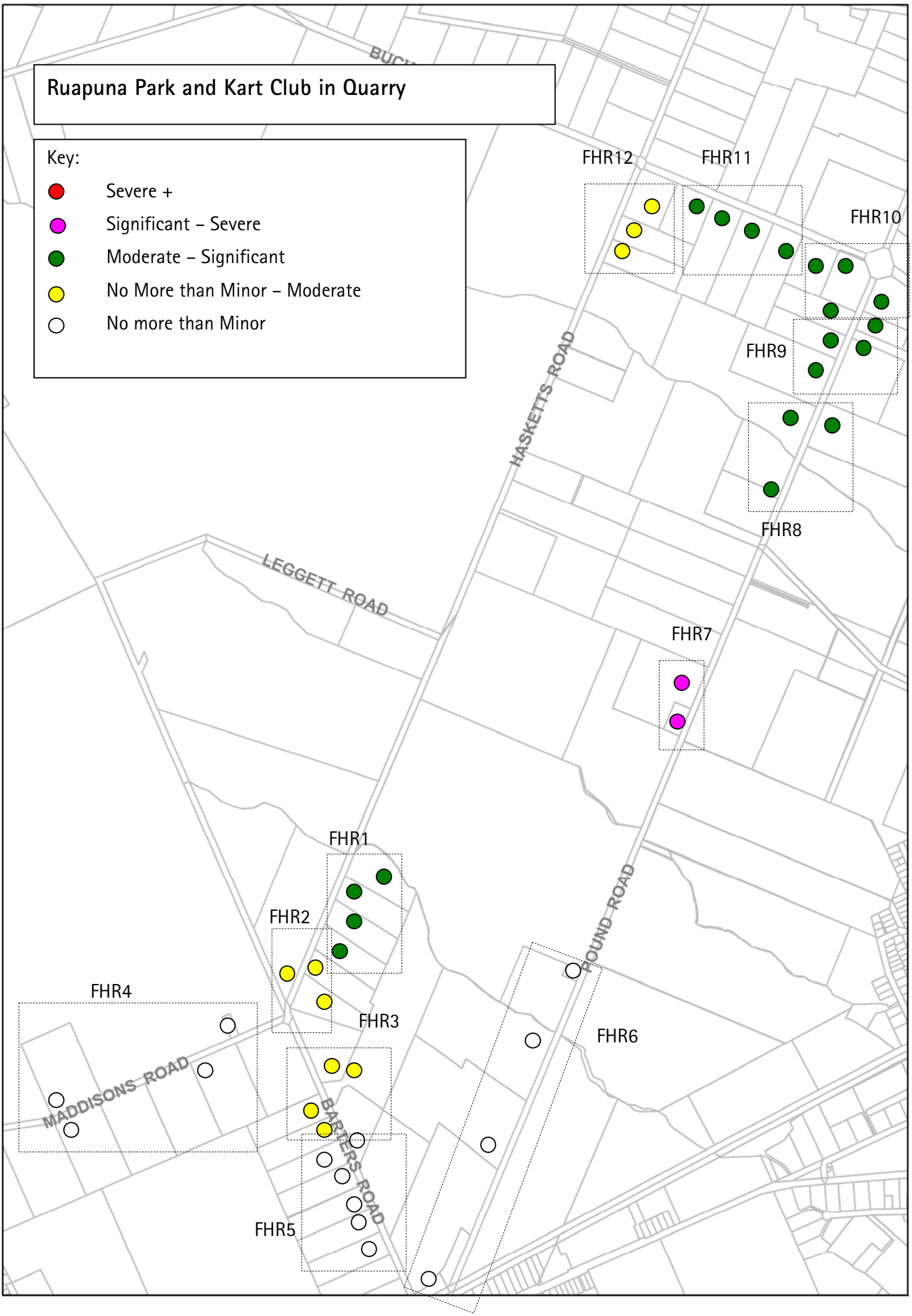

Ruapuna Park Existing Location and Operation
Key:
Severe +
Significant – Severe
Moderate – Significant
No More than Minor – Moderate
No more than Minor
FHR12
FHR11
FHR10
FHR9
FHR8
FHR7
FHR1
FHR2
FHR3
FHR4
FHR5
FHR6
HASKETTS ROAD
LEGGETT ROAD
POUND ROAD
MADDISONS ROAD
BARTERS ROAD


Ruapuna Park operating in existing location at maximum capacity
Key:
Severe +
Significant – Severe
Moderate – Significant
No More than Minor – Moderate
No more than Minor
FHR12
FHR11
FHR10
FHR9
FHR8
FHR7
FHR1
FHR2
FHR3
FHR4
FHR5
FHR6
HASKETTS ROAD
LEGGETT ROAD
POUND ROAD
MADDISONS ROAD
BARTERS ROAD


Speedway Operation at nighttime
Key:
Severe +
Significant – Severe
Moderate – Significant
No More than Minor – Moderate
No more than Minor
FHR12
FHR11
FHR10
FHR9
FHR8
FHR7
FHR6
FHR5
FHR4
FHR3
FHR2
FHR1
HASKETTS ROAD
LEGGETT ROAD
ROUND ROAD
MADDISONS ROAD
BARTIERS ROAD


Ruapuna Park relocated to quarry at existing operation
Key:
Severe +
Significant – Severe
Moderate – Significant
No More than Minor – Moderate
No more than Minor
FHR12
FHR11
FHR10
FHR9
FHR8
FHR7
FHR1
FHR2
FHR3
FHR4
FHR5
FHR6
HASKETTS ROAD
LEGGETT ROAD
ROUND ROAD
MADDISONS ROAD
BARTLERS ROAD


Ruapuna Park Existing Location and Kart Club in Quarry
Key:
Severe +
Significant – Severe
Moderate – Significant
No More than Minor – Moderate
No more than Minor
FHR12
FHR11
FHR10
FHR9
FHR8
FHR7
FHR1
FHR2
FHR3
FHR4
FHR5
FHR6
HASKETTS ROAD
LEGGETT ROAD
POUND ROAD
MADDISONS ROAD
BARTLERS ROAD


Ruapuna Park and Kart Club in Quarry
Key:
Severe +
Significant – Severe
Moderate – Significant
No More than Minor – Moderate
No more than Minor
FHR12
FHR11
FHR10
FHR9
FHR8
FHR7
FHR1
FHR2
FHR3
FHR4
FHR5
FHR6
HASKETTS ROAD
LEGGETT ROAD
ROUND ROAD
MADDISONS ROAD
BARTLERS ROAD


Existing Carrs Road Site
MCTEIGUE ROAD
CARRS ROAD
HALSWELL JUNC
ROAD
WIGRAM ROAD
Key:
Severe +
Significant – Severe
Moderate – Significant
No More than Minor – Moderate
No more than Minor
39 receivers in this area no more than minor. These receivers not shown due to number

Appendix 2: Glossary of terms

To assist readers in understanding this report, we have prepared the following brief discussion on acoustic terminology.

decibels: Sound levels are measured using a logarithmic scale known as decibels (dB). Under this scale, doubling the amount of acoustical energy results in a 3 decibel increase in level. However, subjectively, a sound which is judged as being twice as loud as another is typically 10 decibels louder. A difference of 2 dBA is the minimum which the human ear can detect.

dBA: The most common term used in relation to environmental sound. The "A" weighting applied to decibels is designed to represent the sensitivity of the ear. However, the human response to noise is such that an individual's perception to a specific noise source may well be different to that of another person.

Typical noise *levels:*

Source	Level (dBA)
Rural area away from roads	25-30
Quiet town area at night	35-45
Wind in trees (16km/h)	43
Lawnmower at 40m	62
Normal conversation at 1m	63
Dog barking at 40m	64
Car (80km/h) at 40m	65
Domestic music (background)	65
TV at 3m	74
Vacuum cleaner at 1m	81

Effect of distance: Noise is attenuated with distance from the source. For most noise sources, this attenuation is 6 dBA per doubling of distance, however at distances close to a raceway the attenuation per doubling of distance would be expected to be 3 dBA. Note that this means noise levels drop off much quicker close to a source than they do further away.

L_{10}: Because most noise sources are not constant, it is common to describe them in terms of a statistical analysis. The L_{10} noise level is the level which is exceeded for 10% of any measurement period, and is often used to represent intrusive noise.

L_{eq}: L_{eq} is an energy based average – it is the constant level which would give the same amount of acoustical energy as the time varying noise source being considered. Numerically, L_{eq} and L_{10} are often similar.

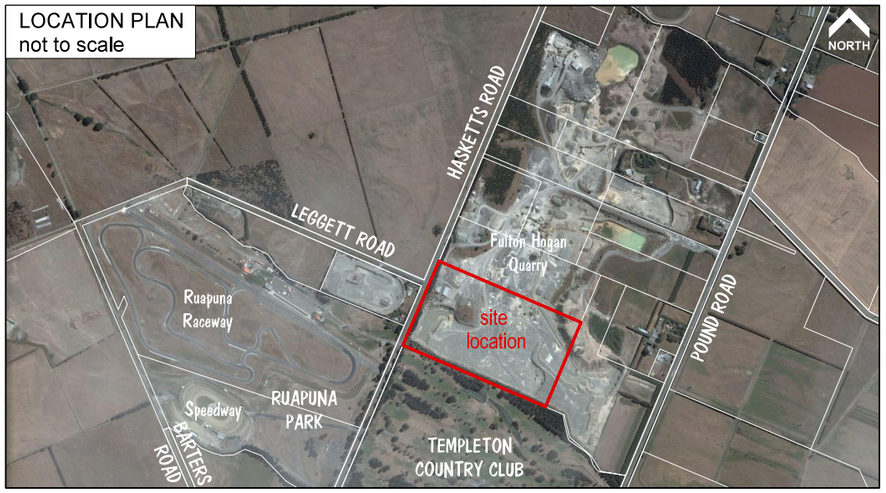
L_{95}: L_{95} is the level which is exceeded for 95% of any measurement period, and represents the "background" noise level. Many countries use L_{90} rather than L_{95}. There is very little difference between these two parameters.

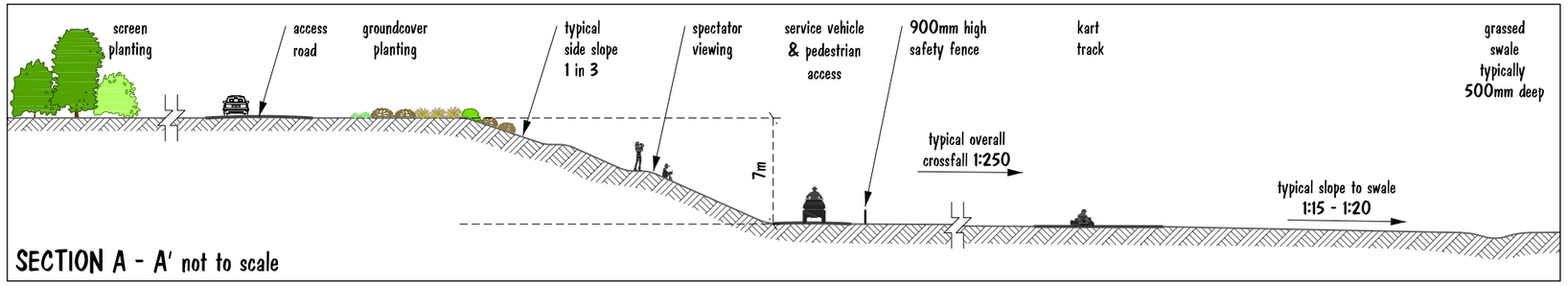
SEL: SEL is an abbreviation for "Sound Exposure Level". It represents the total amount of sound energy compressed into 1 second. SEL is extremely useful for calculating noise from a single event such as a vehicle driving past or an aircraft flying over.

Notional boundary: The notional boundary is defined as a line 20m from a rural dwelling, or the legal boundary if the dwelling is less than 20m from the boundary.

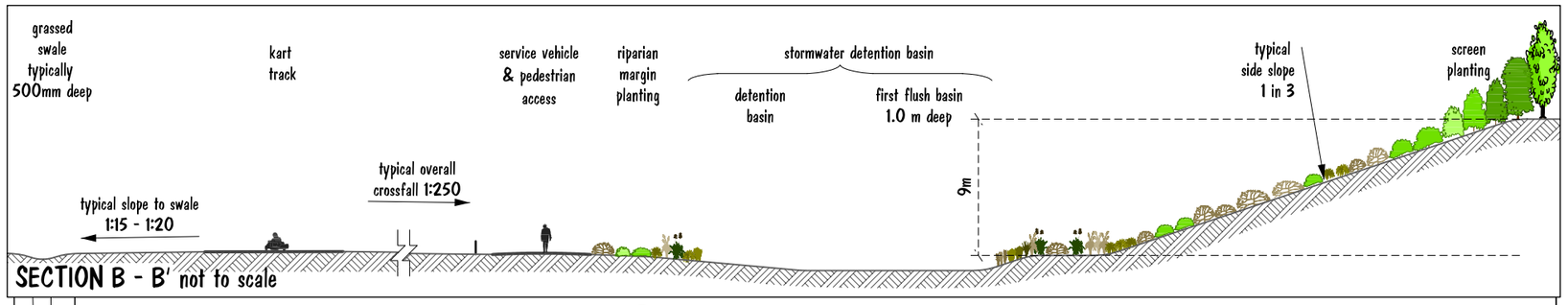
Appendix 3: Kart Club Concept Plan (Overleaf)

LOCATION PLAN
not to scale





SECTION A - A' not to scale



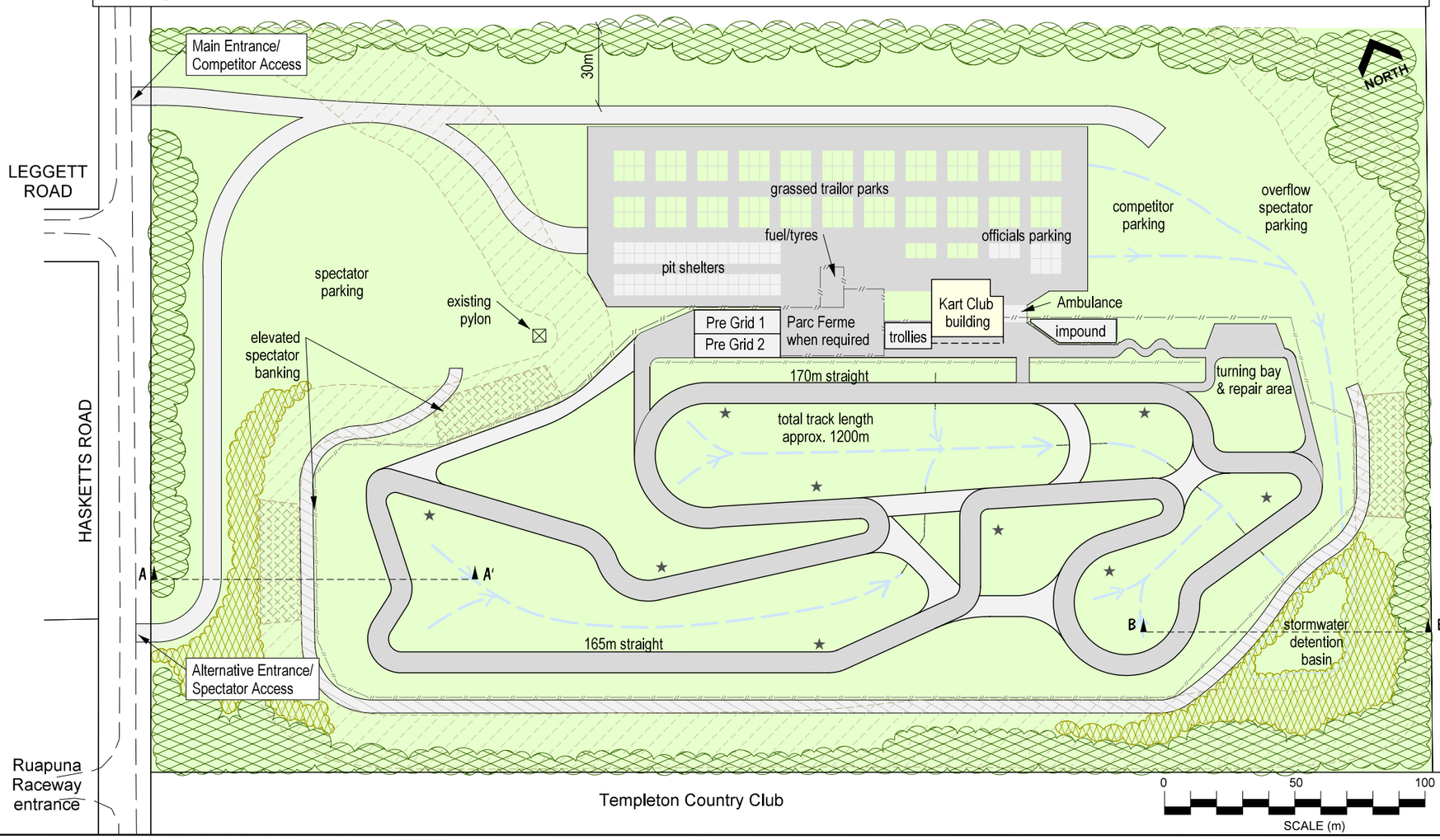
SECTION B - B' not to scale

KEY

- extent of track to be reinstated to meet International Rating Criteria
- additional track to be installed by Kart Club
- 900mm high safety fence
- 1800mm high safety fence
- ★ Flag Marshal Point
- Elevated specator banking
- Service Vehicle/Pedestrian Access
- approx. extent of sides slopes
- grassed stormwater swale
- piped section/culvert
- massed tree & shrub planting - including screen & shelter belt vegetation
- massed ground cover planting - including riparian margin plants and low growing natives

NOTES

1. Total area shown is approx. 14 hectares. Minumum land area required for this track layout is approx. 10 hectares.
2. The stormwater system consists of a one metre deep first flush basin and detention basin. These will be fed by mowable grassed swales, typically 500mm deep.
3. Along the northern boundary a 30m wide strip of land is indicated to accommodate either bunding back up to ground level or a buffer zone between activities, depending on future development.



CHRISTCHURCH
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KART TRACK RELOCATION AT POUND ROAD QUARRY

DRAFT CONCEPT

Original Plan Size: A3

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Appendix 4: Existing Noise Levels—Detailed Data

9.1 Measurement Locations

The following measurement sites have been used to determine the level of existing noise in the area surrounding the raceway.

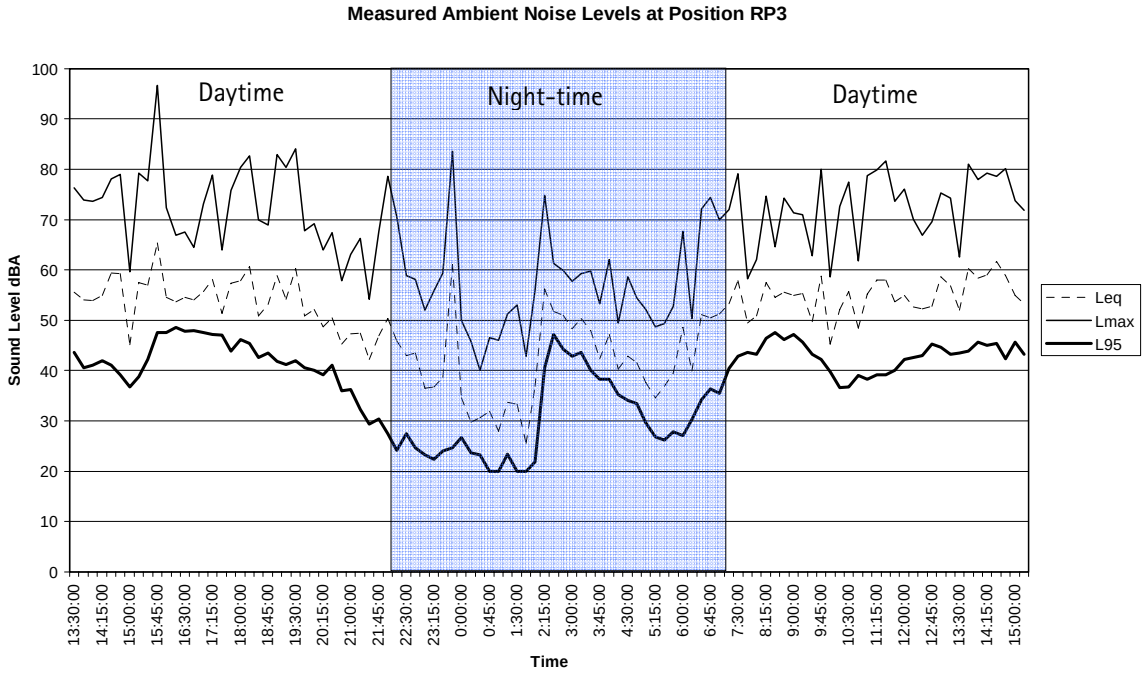
Site	Map Coordinates[1]	Description
RP1	E2468745 N5739342	200m south of Main South Road on Marshs Road. 7m from near carriageway. (attended)
RP2	E2468145 N5740485	Corner of Maddisons Road and Hasketts Road. 7m from near lane (attended)
RP3	E2466810 N5740085	Residential area corner of Maddisons Road and Kirk Road (unattended weekday)
RP4	E2468182 N5740271	Residence on Western side of Barters Road 350 metres south of Maddisons Road. Approximately 40 metres from near carriageway. (unattended weekend)
RP5		Templeton Golf Course, approximately 200 metres from Hasketts Road (Unattended).

Detailed Noise Monitoring Results

At each selected monitoring position, the existing noise environment has been investigated using either spot measurements or unattended loggers. Unattended loggers have been used to give an indication of the typical variation over 24hr periods. Results from loggers are only useful in showing general trends because there is no reliable way to know exactly what noise sources were present at any time of day, and short term weather fluctuations can give rise to unusual noise results. In the area surrounding Ruapuna, the level of ambient noise will be highly dependent on the wind direction, as plane take off and land on different runways at CIAL depending on wind direction.

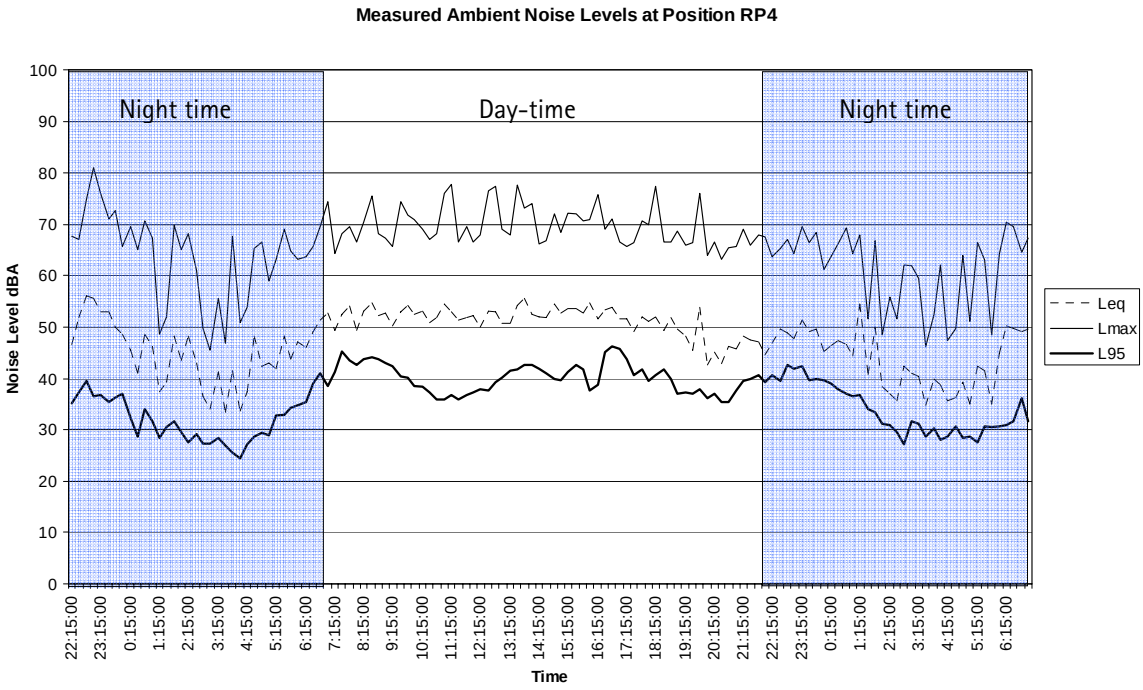
Position RP3: Residential area corner of Maddisons Road and Kirk Road

This position was chosen as it represented noise levels in the area surrounding Ruapuna but is far enough from the race track such that noise levels from track operations were not audible at the start or end of the logging period. During the early morning period, very high winds were experienced at the location which affected the results. Fortunately, this occurred outside the time period when Ruapuna is allowed to operate.



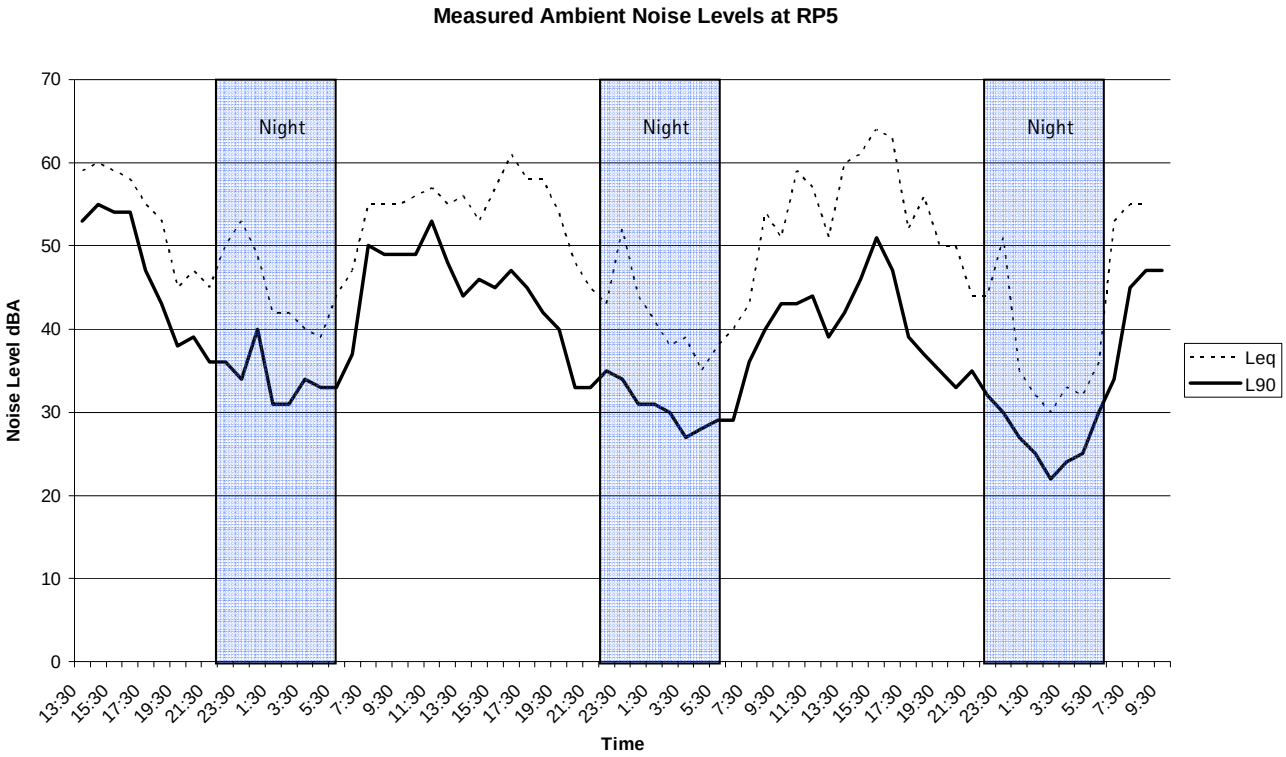
Position RP4: Residence on Western side of Barters Road, 350m south of Maddisons Road

This position was chosen as it represented noise levels in the area closest to Ruapuna. The position and time was chosen to coincide with a period when Ruapuna was not creating noise. Noise levels at this location are considered to be a fair representation of noise levels at the façade of dwellings along Barters and Hasketts Road. The wind direction during the logging period was a light southwest.



Position RP5: Templeton Golf Course beside Fulton Hogan Quarry

This was a Christchurch City Council measurement location. The measurement position was chosen to determine the background noise levels in the area surrounding the Fulton Hogan Quarry. The measurement period was Friday to Monday, 7th – 10th April 2006. The wind during the logging period was from the north-east and north-westerly direction.



Appendix 5: Octave Band Measured Noise Data

Kart Type	Number of Karts	Distance from track	Octave Band Noise Level dB L_{max}							
			63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Rotax 125cc	1	13m braking into corner	70	78	73	73	76	73	71	70
	1	16m tight corner	70	78	72	78	75	74	73	70
	1	9 m acceleration out of corner	70	87	86	90	84	79	81	81
	1	22m wide sweeping corner	75	75	77	83	73	72	69	65
	1	30m wide sweeping corner	71	79	85	85	81	78	75	72
	1	27m accelerating out of tight bend	76	77	73	76	68	64	61	58

Car Type	Number of Cars	Distance from track (metres)	Octave Band Sound Pressure Level dB L_{max}							
			63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
V6 Holden Commodore	1	40	77	84	88	77	76	76	72	62
		40	78	87	89	82	79	79	75	64
		20	90	89	89	80	76	74	69	60
		46	80	78	76	61	61	61	55	45
RX7	1-2	40	83	97	89	86	83	76	72	81
		20	83	93	92	84	87	79	76	79

Appendix 6: Receiver Locations

RECEIVER	PROPERTY DESCRIPTION	NZMG REFERENCE	
		EASTING	NORTHING
FHR1	LOT 1 DP23834 LOT 2 DP23824 LOT1 DP 24156 LOT 2 DP 24156	2468328	5741021
FHR2	LOT 1 DP 343538 LOT 5 23824 LOT 6 23824	2468052	5740794
FHR3	LOT 7 DP 22834 LOT 1 DP38418 LOT 11 DP23834 LOT 12 DP23834	2468214	5740309
FHR4	SECTION 19A DRAYTON SETT SECTION 16 DRAYTON SETT LOT 3 DP78305 LOT 6 78305	2467621	5740406
FHR5	LOT 2 38418 LOT 14 DP23834 LOT 13 DP23834 LOT 15 DP23834 LOT 16 DP23834 LOT 17 DP23834	2468265	5740074
FHR6	LOT 1 DP 33334 LOT 2 DP 33334 LOT 3 DP 33334 RS 38609	2468740	5740168
FHR7	LOT 1 DP 54768 LOT 1 DP 33515	2469351	5741577
FHR8	RS 38795 LOT 2 DP 67673 RS 2205	2469724	5742357
FHR9	LOT 1 DP 67673 LOT 1 DP 24939 LOT 1 DP 22982 LOT 2 DP 22982	2469847	5742264
FHR10	PT LOT 3 DP 22982 PT LOT 3 DP 24939 LOT 2 DP26224 LOT 4 DP 24939	2469814	5742870
FHR11	LOT 5 DP 24939 LOT 6 DP 24939 LOT 7 DP 24939 LOT 8 DP 24939	2469571	5743128
FHR12	LOT 9 DP24939 LOT10 DP 24939 LOT 11 DP 24939	2469252	5743268