RAPT CONSULTING

Acoustic Assessment – Mt Penang Gardens

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Acoustic Assessment – Mt Penang Gardens

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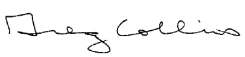
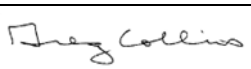
2222383_220406	0	06 April 2022	Gregory Collins - MAAS	
2222383_220406_1	1	05 May 2022	Gregory Collins - MAAS	

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1. Introduction

1.1 Background

RAPT Consulting has been engaged to undertake a noise and vibration Impact Assessment (NVIA) for GYDE Consulting to inform a Review of Environmental Factors (REF) for the road and infrastructure works at Mt Penang Gardens.

It is understood Hunter and Central Coast Development Corporation (HCCDC) wish to upgrade the road network and services within Mt Penang Gardens to facilitate future development of the commercial areas of the site.

The upgrades to upgrade water, sewer and road infrastructure to improve the functionality and accessibility of Mt Penang include:

- Widening and addition of car parking and shared pathways to Parklands Road south.
- The construction of Parklands Road North, creating a connection with Baxter Track
- Widening and realignment of McCabe Street
- Realignment of the Avenue and new shared pathways.

The extent of works is shown in Figure 1-1.

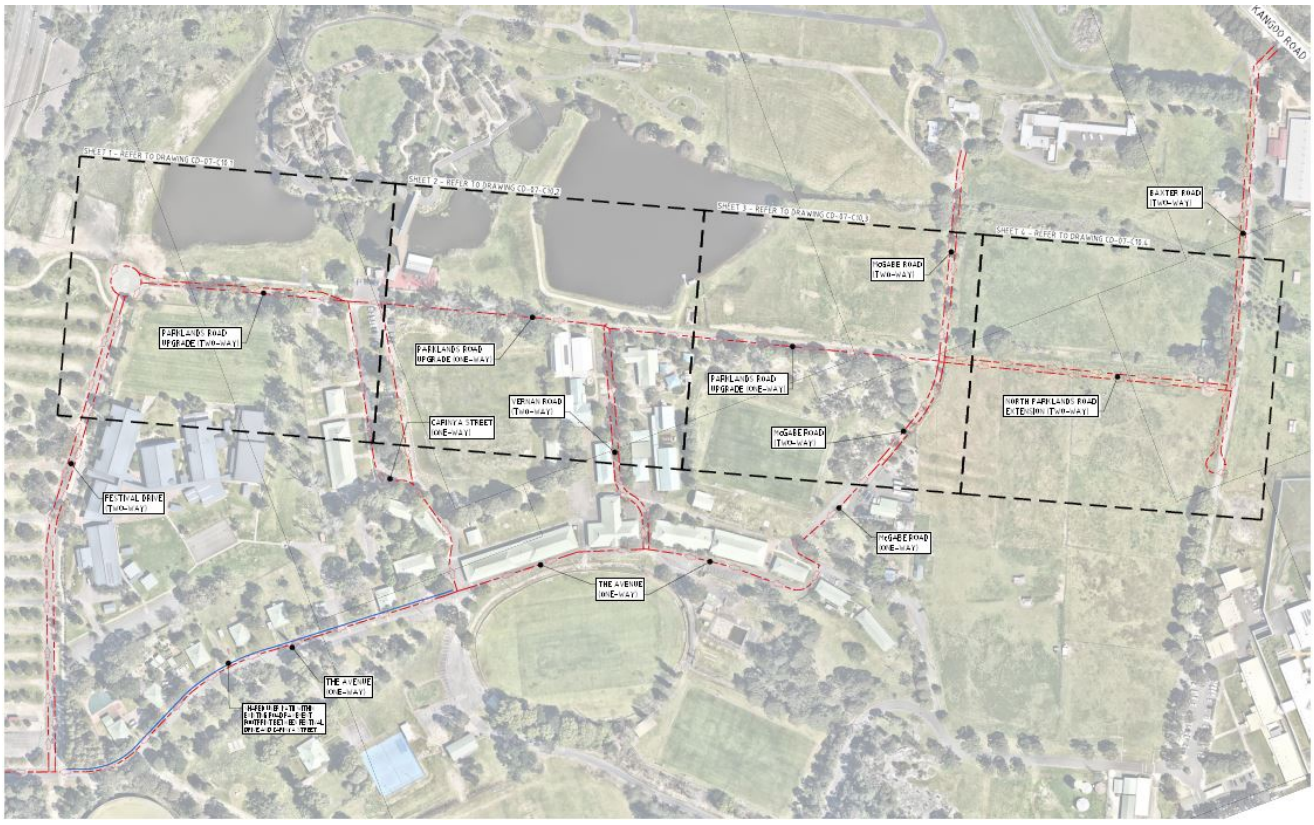


Figure 1-1 Extent of Works (Source: Northrop Engineering)

1.2 Assessment Objectives

This acoustic assessment considers the potential impacts of the construction and operation of the proposal. The purpose is to assess potential noise and vibration from the project and to recommend mitigation measures where required.

The outcomes of this assessment include recommendations for potential noise and vibration mitigation and management measures designed to achieve an acceptable noise amenity for residential (dwelling) occupants and other sensitive receivers surrounding the study area.

1.3 Scope

The acoustic assessment scope of work included:

- Initial desk top review to identify noise sensitive receptors from aerial photography
- Undertake noise measurements to determine ambient and background noise levels
- Establish project noise goals for the construction and operation of the proposal
- Identify the likely principal noise sources during construction, operation and their associated noise levels
- assessment of potential noise, vibration and sleep disturbance impacts associated with construction and operation aspects of the project
- provide recommendations for feasible and reasonable noise and vibration mitigation and management measures, where noise or vibration objectives may be exceeded.

1.4 Relevant Guidelines

The relevant policies and guidelines for noise and vibration assessments in NSW that have been considered during the preparation of this assessment include:

- Interim Construction Noise Guideline (ICNG), Department of Environment and Climate Change, 2009
- Assessing Vibration: A Technical Guideline, Department of Environment and Conservation (DEC), 2006
- British Standard BS7385.2 - 1993 Evaluation and Measurement for Vibration in Buildings, Part 2 - Guide to damage levels from ground borne vibration 1993
- DIN 4150: Part 3-1999 Structural vibration – Effects of vibration on structures 1999
- NSW Road Noise Policy (RNP), Department of Environment, Climate Change and Water (DECCW), 2011
- Noise Policy for Industry (NPfI), Environment Protection Authority (EPA), 2017.

1.5 Limitations

The purpose of the report is to provide an independent acoustic assessment for the proposal.

It is not the intention of the assessment to cover every element of the acoustic environment, but rather to conduct the assessment with consideration to the prescribed work scope.

The findings of the acoustic assessment represent the findings apparent at the date and time of the assessment undertaken. It is the nature of environmental assessments that all variations in environmental conditions cannot be assessed and all uncertainty concerning the conditions of the ambient environment cannot be eliminated. Professional judgement must be exercised in the investigation and interpretation of observations.

In conducting this assessment and preparing the report, current guidelines for acoustics, noise were referred to. This work has been conducted in good faith with RAPT Consulting's understanding of the client's brief and the generally accepted consulting practice.

No other warranty, expressed or implied, is made as to the information and professional advice included in this report. It is not intended for other parties or other uses.

2. Existing Environment

2.1 Receptors

The area surrounding the site is zoned IN1 General Industrial, RE1 Public Recreation, SP1 Special Activities and SP2 Infrastructure. A map showing the land use zonings in the vicinity of the proposal are shown in Figure 2-1.

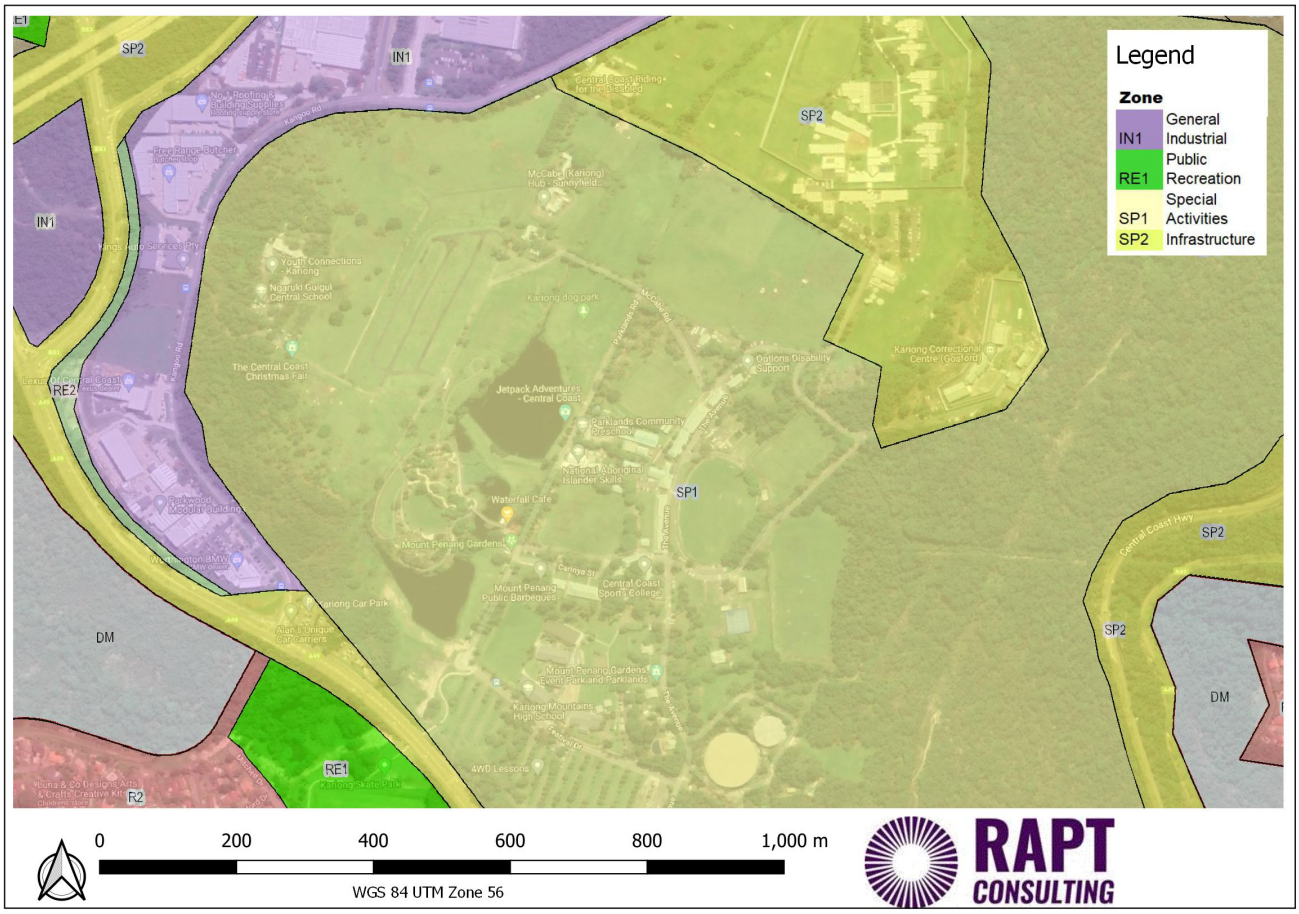


Figure 2-1 Land Use Zonings (Source: RAPT Consulting)

Closest receptors to the proposal assessed in this acoustic assessment are identified in Table 2-1 and Figure 2-2.

Table 2-1 Receptors and Distance to Study Area

Receiver ID	Address	Receptor Type	Easting	Northing
R1	Kariong Mts High School	Educational	341527	6299736
R2	Mt Penang Public Barbecue Park	Recreation	341574	6299881
R3	Mt Penang Gardens Park	Recreation	341521	6299941
R4	Waterfall café	Commercial	341523	6299964
R5	National Aboriginal Islander Skills	Educational	3415971	6300055
R6	Parkland Community Preschool	Educational	341627	6300107
R7	7 McCabe Road	Commercial	341567	6300358
R8	10 McCabe Road	Commercial	341597	6300427
R9	Central Coast Riding for the Disabled	Commercial	341676	6300586
R10	3 Central Coast Hwy	Commercial	341939	6300437
R11	50 McCabe Road	Commercial	341789	6300229
R12	45 McCabe Road	Commercial	341834	6300161
R13	40 The Avenue	Educational	341794	6300103
R14	25 The Avenue	Educational	341741	6299952
R15	6 The Avenue	Residential	341741	6299868
R16	4 The Avenue	Residential	341731	6299751
R17	1 The Avenue	Residential	341767	6299644

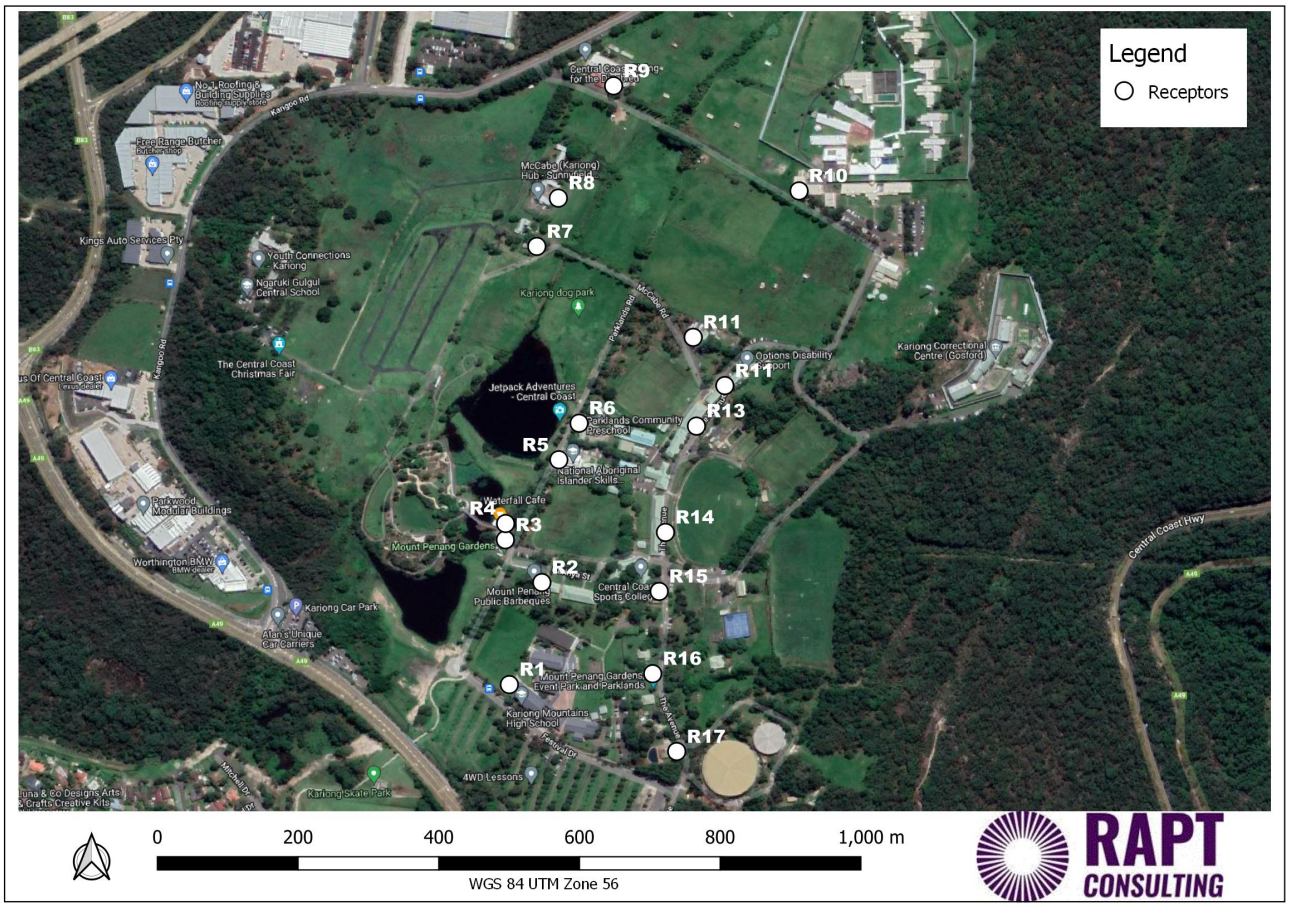


Figure 2-2 Receptors Assessed Surrounding the Proposal Site

2.2 Background and Ambient Noise

To establish background and ambient noise levels, noise monitoring was undertaken by RAPT Consulting from 11 March to 17 March 2022. The monitoring was undertaken at R5 National Aboriginal Islander Skills 32 Parklands Road and at R15 6 The Avenue. Site observations noted these locations was considered indicative of the local ambient noise environment in the vicinity of The Avenue and Parklands Road and these sites also presented as secure location whereby minimising the risk of theft or vandalism to the monitoring equipment. Additionally, they are considered as acceptable locations for determination of the background noise with consideration to the NSW Environment Protection Authority's (EPA's) – Noise Policy for Industry (NPfI). During site visits it was noted that occasional road traffic, distant road traffic and natural wildlife, primarily described the ambient noise environment and is indicative of a sub-urban noise environment.

The monitoring locations are shown in Figure 2-3 – 2-5.

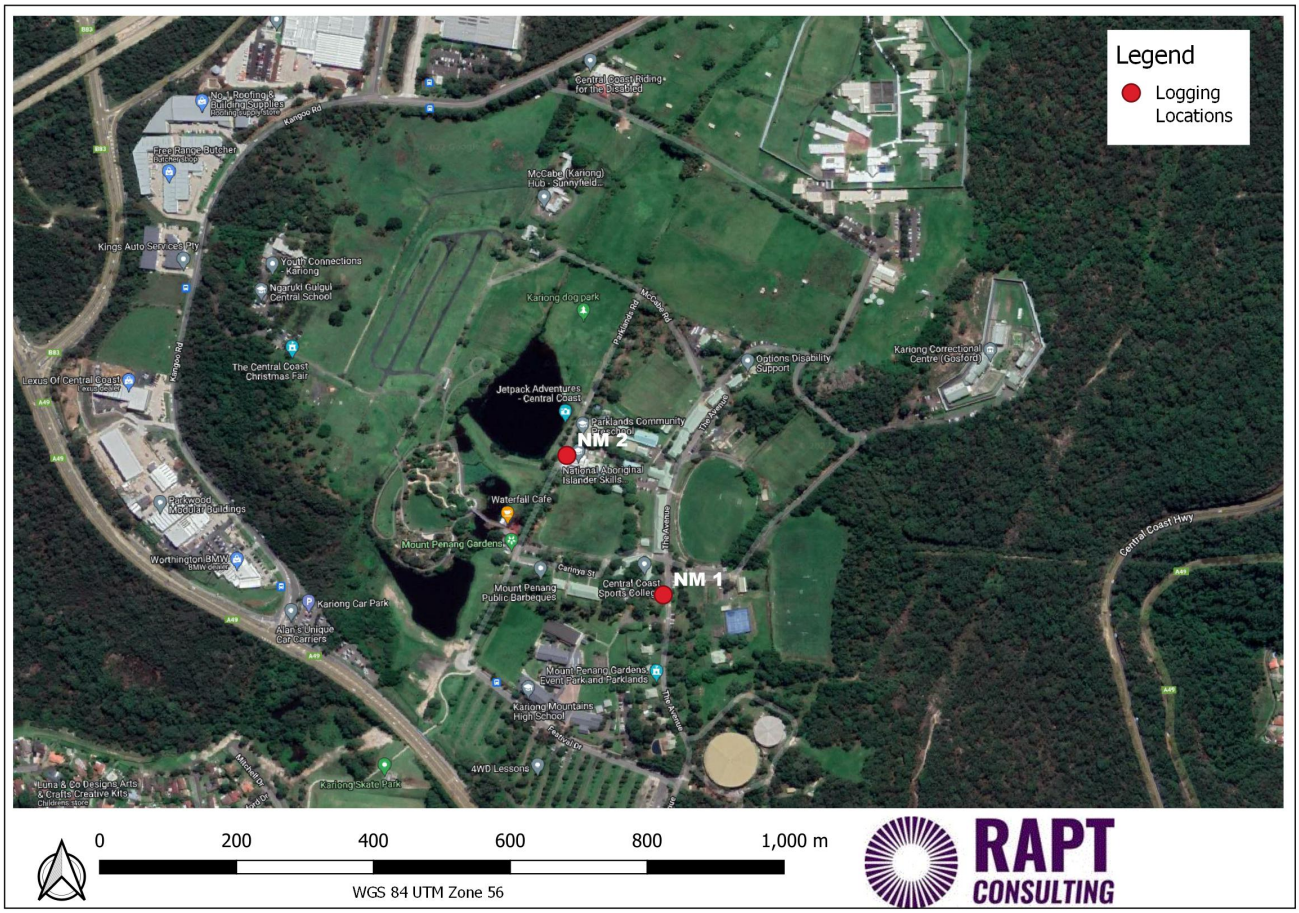


Figure 2-3 Monitoring Locations.

Figure 2-4 NM1 6 The Avenue Noise Monitoring Location

Figure 2-5 NM2 National Aboriginal Islander Skills

Monitoring was undertaken using Acoustic Research Laboratories EL-315 noise loggers with Type 2 Precision. These loggers are capable of measuring continuous sound pressure levels and are able to record L_{Amin}, L_{A90}, L_{A10}, L_{Amax} and L_{Aeq} noise descriptors. The instrument was programmed to accumulate environmental noise data continuously over sampling periods of 15 minutes for the entire monitoring period.

The noise surveys were conducted with consideration to the procedures described in Australian Standard AS 1055:2018, "Acoustics – Description and Measurement of Environmental Noise" and the NSW Noise Policy for Industry (NPfI). Calibration was checked before and after each measurement and no significant drift occurred. The acoustic instrumentation used carries current NATA calibration and complies with AS/NZS IEC 61672.1-2019-Electroacoustics – Sound level meters – Specifications.

The L_{A90} descriptor is used to measure the background noise level. This descriptor represents the noise level that is exceeded for 90 percent of the time over a relevant period of measurement. In line with the procedures described in the EPA's NPfI, the assessment background level (ABL) is established by determining the lowest tenth-percentile level of the L_{A90} noise data acquired over each period of interest. The background noise level or rating background level (RBL) representing the day, evening and night-time assessment periods is based on the median of individual ABL's determined over the entire monitoring duration. The

RBL is representative of the average minimum background sound level, or simply the background level.

The L_{Aeq} is the equivalent continuous noise level which would have the same total acoustic energy over the measurement period as the varying noise actually measured, so it is in effect an energy average.

Weather information for the unattended noise logging was obtained from the Bureau of Meteorology Gosford AWS for the monitoring period and any data adversely affected by rain, wind (more than 5 m/s as per NPfI) or extraneous noise were discarded. Noise data graphs are provided in Appendix B.

The RBL and ambient LAeq levels are provided in Table 2-2 below.

Table 2-2 Summary of Measured Results dB(A)

Descriptor	NM1 6 The Avenue	NM2 32 Parklands Road	Time Interval
$L_{A90\ Day}$	41	61	7:00am - 6:00pm
$L_{A90\ Evening}$	41[1] (42)	59	6:00pm - 10:00pm
$L_{A90\ Night}$	38	58	10:00pm - 7:00am
$L_{Aeq(15hr)}$	61	65	7:00am - 10:00pm
$L_{Aeq(9hr)}$	51	62	10:00pm – 7:00am
$L_{A10(18hr)}$	54	64	6:00am – 12:00am

Note 1 As outlined in the NPfI, the evening and night criteria or management levels are set no louder than that daytime levels. Number in brackets (XX) represents actual measured RBL determined for assessment period.

As NM1 was located at a residential receiver, the data from NM1 will be utilised for derivation of Construction Noise Management Levels for residneces for this assessment.

3. Noise and Vibration Objectives

3.1 Construction Noise

Construction noise is assessed with consideration to DECCW Interim Construction Noise Guidelines (ICNG) (July 2009). The ICNG is a non-mandatory guideline that is usually referred to by local councils and other NSW government entities when construction / demolition works require development approval. The ICNG recommend standard hours for construction activity as detailed in Table 3-1.

Table 3-1 ICNG Recommended Construction Hours

Work type	Recommended standard hours of work
Normal construction	Monday to Friday: 7 am to 6 pm. Saturday: 8 am to 1 pm. No work on Sundays or Public Holidays.
Blasting	Monday to Friday: 9 am to 5 pm. Saturday: 9 am to 1 pm. No work on Sundays or Public Holidays.

The ICNG provides noise management levels for construction noise at residential and other potentially sensitive receivers. These management levels are to be calculated based on the adopted rating background level (RBL) at nearby locations, as shown in Table 3-2.

Table 3-2 ICNG Noise Guidelines at Receivers

Period	Management Level $L_{Aeq(15\ min)}$
Residential Recommended standard hours	Noise affected level: RBL + 10 Highly noise affected level: 75 dB(A)
Residential Outside recommended standard hours	Noise affected level: RBL + 5
Classrooms at schools and other educational institutions	Internal Noise Level 45 dB(A) (applies when properties are being used, Outdoor Noise Level 55 dB(A) assumes 10 dB(A) loss through an open window)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	65 dB(A)
Offices, retail outlets (external)	70 dB(A)
industrial premises (external)	75 dB(A)

The above levels apply at the boundary of the most affected residences / offices or within 30 m from the residence where the property boundary is more than 30 m from the residence.

The *noise affected level* represents the point above which there may be some community reaction to noise. Where the *noise affected level* is exceeded all feasible and reasonable work practices to minimise noise should be applied and all potentially impacted residents should be informed of the nature of the works, expected noise levels, duration of works and a method of contact. The *noise affected level* is the background noise level plus 10 dB(A) during recommended standard hours and the background noise level plus 5 dB(A) outside of recommended standard hours.

The *highly noise affected level* represents the point above which there may be strong community reaction to noise and is set at 75 dB(A). Where noise is above this level, the relevant authority may require respite periods by restricting the hours when the subject noisy activities can occur, considering:

- Times identified by the community when they are less sensitive to noise (such as mid-morning or mid-afternoon for works near residences).
- If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Based on the above and the RBL's determined from site monitoring, construction noise management levels (NML's) have been derived for residential receptors, as shown in Table 3-3.

Table 3-3 ICNG NML's for residential receivers Leq(15min) dB(A)

Period	RBL L_{A90}, dB(A)	Standard hours noise management levels, $L_{Aeq,15min}$, dB(A)	Out-of-hours noise management levels, $L_{Aeq,15min}$, dB(A)
Day[5]	41	51	46
Evening[5]	41	-	46
Night[5]	38	-	43

3.2 Construction Sleep Disturbance

The ICNG requires a sleep disturbance assessment to be undertaken where construction works are planned to extend over more than two consecutive nights. The ICNG makes reference to the EPA's NSW Environment Criteria for Road Traffic Noise (ECRTN), now superseded by the NSW Road Noise Policy (RNP), for the assessment of sleep disturbance. The RNP references the recommendations in the ECRTN as providing the most appropriate assessment guidance.

The guidance provided in the RNP for assessing the potential for sleep disturbance recommends that to minimise the risk of sleep disturbance during the night-time period (10pm to 7am), the $L_{A1(1\ min)}$ noise level outside a bedroom window should not exceed the $L_{A90(15\ min)}$ background noise level by more than 15 dB(A). The EPA considers it appropriate to use this metric as a screening criterion to assess the likelihood of sleep disturbance. If this screening criterion is found to be exceeded, then a more detailed analysis must be undertaken that

should include the extent that the maximum noise level exceeds the background noise level and the number of times this is likely to happen during the night-time period.

The RNP contains a review of research into sleep disturbance which represents NSW EPA advice on the subject of sleep disturbance due to noise events. It concludes that having considered the results of research to date that, 'Maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions. Therefore, given that an open window provides around 10 dB(A) in noise attenuation from outside to inside, external noise levels of 60-65 dB(A) are unlikely to result in awakening reactions.

Construction is generally expected to take place during standard hours, and therefore sleep disturbance is not expected to be an issue. However, out of hours work and extended construction hours may be required on limited occasions such as for special deliveries or in the case of emergencies. As such an assessment of sleep disturbance has been undertaken and construction sleep disturbance assessment levels are presented in Table 3-4.

Table 3-4 Construction Noise Sleep Disturbance Assessment Levels

Night-time rating background level, dB(A)	Sleep disturbance screening $L_{A1(1min)}$ criteria, dB(A)	Sleep disturbance awakening reaction $L_{A1(1min)}$ criteria, dB(A)
38	53	65

3.3 Construction Road Traffic Noise

Noise from construction traffic on public roads is not covered by the ICNG. However, the ICNG does refer to the ECRTN, which is now superseded by the RNP, for the assessment of noise relating to construction traffic on public roads.

To assess noise impacts from construction traffic, an initial screening test is undertaken by evaluating whether existing road traffic noise levels would increase by more than 2 dB(A). Where the predicted noise increase is 2 dB(A) or less, then no further assessment is required. However, where the predicted noise level increase is greater than 2 dB(A), and the predicted road traffic noise level exceeds the road category specific criterion then noise mitigation should be considered for those receivers affected. The RNP does not require assessment of noise impact to commercial or industrial receivers. In order to increase noise levels by 2 dB(A) an increase in traffic volume of 60% would be required, which based on the nature of works associated with the project is not expected to occur and therefore compliance is expected. It is anticipated an average of 10 -20 construction vehicles will access the site per day. This is not expected to impact existing road network noise conditions.

3.4 Vibration Guidelines

3.4.1 Human Exposure

Vibration goals the were sourced from the DECCW's *Assessing Vibration: a technical guideline*, which is based on guidelines contained in British Standard (BS) 6472–1992, *Evaluation of human exposure to vibration in buildings (1–80 Hz)*.

Vibration, at levels high enough, has the potential to cause damage to structures and disrupt human comfort. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent as follows:

- continuous vibration continues uninterrupted for a defined period and includes sources such as machinery and continuous construction activities

- impulsive vibration is a rapid build up to a peak followed by a damped decay. It may consist of several cycles at around the same amplitude, with durations of typically less than two seconds and no more than three occurrences in an assessment period. This may include occasional dropping of heavy equipment or loading activities

- intermittent vibration occurs where there are interrupted periods of continuous vibration, repeated periods of impulsive vibration or continuous vibration that varies significantly in magnitude. This may include intermittent construction activity, impact pile driving, jack hammers.

The preferred and maximum values for continuous and impulsive vibration are defined in Table 2.2 of the guideline and are reproduced in Table 3-5 for the applicable receivers.

Table 3-5 Preferred and Maximum Levels for Human Comfort

Location	Assessment Period[2]	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Impulsive vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14

Note 2 Daytime is 7:00am to 10:00pm and Night-time is 10:00pm to 7:00am

The acceptable vibration dose values (VDV) for intermittent vibration are defined in Table 2.4 of the guideline and are reproduced in Table 3-6 for the applicable receiver type.

Table 3-6 Acceptable Vibration Dose Values for Intermittent Vibration (m/s1.75)

Location	Daytime [3]		Night-time [3]	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas[4]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Note 3 Daytime is 7:00 to 22:00 and night-time is 22:00 to 7:00: and
Note 4 Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be needed to assess intermittent values against the continuous or impulsive criteria for critical areas.

3.4.2 Building Damage

Currently, there is no Australian Standard that sets the criteria for the assessment of building damage caused by vibration. Guidance of limiting vibration values is attained from reference to the following International Standards and Guidelines:

- British Standard BS7385.2 - 1993 *Evaluation and Measurement for Vibration in Buildings*, Part 2 - Guide to damage levels from ground borne vibration
- German Standard DIN 4150-3: 1999-02 Structural Vibration – Part 3: *Effects of vibration on structures*.

The recommended Peak Particle Velocity (PPV) guidelines for the possibility of vibration induced building damage are derived from the minimum vibration levels above which any damage may occur are presented in Table 3-7 for DIN 4150-3: 1999-02 and Table 3-8 for BS7385.2 – 1993.

Table 3-7 DIN 4150-3 Guideline values for vibration velocity to be used when evaluating the effects of short-term vibration on structures

Type of Structure	Peak Component Particle Velocity, mm/s			
	Vibration at the foundation at a frequency of			Vibration of horizontal plane of highest floor at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz*	
Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20-40	40-50	40
Dwellings and buildings of similar design and/or occupancy	5	5-15	15-20	15
Structures that, because of their sensitivity to vibration, do not correspond to those listed in lines 1 and 2 of table 5-7 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

Note 5 At frequencies above 100Hz, the values given in this column may be used as minimum values

Table 3-8 BS7385.2 Transient Vibration Guideline Values for Potential building - Cosmetic Damage

Building Type[7]	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz[6]	15 Hz and above[6]
Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
Unreinforced or light framed structures. Residential or light commercial type buildings.	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Note 6 Values referred to are at the base of the building: and
Note 7 For transient vibration effecting unreinforced or light framed structures at frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded.

Unlike noise which travels through air, the transmission of vibration is highly dependent on substratum conditions between the source/s and receiver. Also dissimilar to noise travelling through air, vibration levels diminish quickly over distance, thus an adverse impact from vibration on the broader community is not typically expected. Vibration during works is considered an intermittent source associated with two main types of impact: disturbance at receivers and potential architectural/structural damage to buildings. Generally, if disturbance issues are controlled, there is limited potential for structural damage to buildings.

Ground Vibration – Minimum Working Distances from Sensitive Receivers

The Transport for NSW Construction Noise and Vibration Strategy (CNVS) provides guidance for minimum working distances. As a guide, minimum working distances from sensitive receivers for typical items of vibration intensive plant are listed in Table 3-9. The minimum distances are quoted for both "cosmetic" damage (refer BS 7385) and human comfort (refer OH&E's Assessing Vibration - a technical guideline). DIN 4150 has criteria of particular reference for heritage structures. Table 3-9 provides the recommended minimum safe working distances for vibration intensive plant from sensitive receivers.

Table 3-9 Recommended Minimum Safe Working Distances for Vibration Intensive Plant from Sensitive Receiver

Plant Item	Rating / Description	Minimum Distance Cosmetic Damage		Minimum Distance Human Response (NSW EPA Guideline)
		Residential and Light Commercial (BS 7385)	Heritage Items (DIN 4150, Group 3)	
Vibratory Roller	<50 kN (1-2 tonne)	5m	11m	15m to 20m
	<100 kN (2-4 tonne)	6m	13m	20m
	<200 kN (4-6 tonne)	12m	15m	40m
	<300kN (7-13 tonne)	15m	31m	100m
	>300kN (13-18 tonne)	20m	40m	100m
	>300kN (>18 tonne)	25m	50m	100m
Small Hydraulic Hammer	300kg (5 to 12 t excavator)	2m	5m	7m
Medium Hydraulic Hammer	900kg (12 to 18 t excavator)	7m	15m	23m
Large Hydraulic Hammer	1600kg (18 to 34 t excavator)	22m	44m	73m

Plant Item	Rating / Description	Minimum Distance Cosmetic Damage		Minimum Distance Human Response (NSW EPA Guideline)
		Residential and Light Commercial (BS 7385)	Heritage Items (DIN 4150, Group 3)	
Vibratory Pile Driver	Sheet Piles	2m to 20m	5m to 40m	20m
Pile Boring	≤ 800mm	2m (nominal)	5m	4m
Jack Hammer	Hand Held	1m (nominal)	3m	2m

While significant vibration generating activities are not expected as part of the proposal, during construction it is recommend if any of the above activities are planned, they be limited to vibratory roller <100 kN (2-4 tonne), and small hydraulic hammer 300kg (5 to 12 t excavator).

3.5 Operational Noise Criteria

RMS released the Noise Criteria Guideline (NCG) which states the following in relation to minor works:

- Minor works are works that primarily improve safety, including minor straightening of curves, installing traffic control devices, intersection widening, turning bay extensions or making minor road realignments.
- These (minor) works are not considered 'redeveloped' or 'new' (in the context of the Road Noise Policy definitions) as they are not intended to increase the traffic carrying capacity of the overall road or accommodate a significant increase in heavy vehicle traffic.
- TFNSW applies existing road criteria (as set out in Table 8 of the NSW Road Noise Policy (RNP)) where the minor works increase noise levels by more than 2 dB relative to the existing noise levels at the worst affected receiver. Table 3-10 sets out the applicable road traffic noise target levels recommended by the NCG.

Table 3-10 Road Traffic Noise Criteria

Road Category	Day	Night
Freeway/ arterial/ sub-arterial roads: Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments.	60 $L_{Aeq(15hr)}$ (External)	55 $L_{Aeq(9hr)}$ (External)
Local roads: Existing residences affected by additional traffic on existing local roads generated by land use developments	55 $L_{Aeq(1\ hour)}$ (External)	50 $L_{Aeq(1\ hour)}$ (External)

Table 3-11 provides road traffic noise criteria for other non-residential land uses taken from Table 4 of the RNP.

Table 3-11 Road Traffic Noise Assessment Criteria for Non-Residential Land Uses affected by Proposed Road Projects and Traffic Generating Developments

Existing Sensitive Land Use	Assessment Criteria – dB(A)		Additional Considerations
	Day (7am-10pm)	Night (10pm-7am)	
1. School Classrooms	LAeq, (1 hour) 40 (internal) when in use	-	In the case of buildings used for education or healthcare, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard 2107:2016 (Standards Australia 2016).
2. Hospital Wards	LAeq, (1 hour) 35 (internal)	LAeq, (1 hour) 35 (internal)	
3. Places of Worship	LAeq, (1 hour) 40 (internal)	LAeq, (1 hour) 40 (internal)	The criteria are internal, i.e. the inside of a church. Areas outside the place of worship, such as a churchyard or cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for such external areas, it should be established what in these areas may be affected by road traffic noise. For example, if there is a church car park between a church and the road, compliance with the internal criteria inside the church may be sufficient. If, however, there are areas between the church and the road where outdoor services may take place such as weddings and funerals, external criteria for these areas are appropriate. As issues such as speech intelligibility may be a consideration in these cases, the passive recreation criteria (see point 5) may be applied.
4. Open Space (Active Use)	LAeq, (15 hour) 60 (external) when in use	-	Active recreation is characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion. Passive recreation is characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, e.g. playing chess, reading. In determining whether areas are used for active or passive recreation, the type of activity that occurs in that area and its sensitivity to noise intrusion should be established. For areas where there may be a mix of passive and active recreation, e.g. school playgrounds, the more stringent

Existing Sensitive Land Use	Assessment Criteria – dB(A)		Additional Considerations
	Day (7am-10pm)	Night (10pm-7am)	
			criteria apply. Open space may also be used as a buffer zone for more sensitive land uses.
5.Open Space (Passive Use)	LAeq, (15 hour) 55 (external) when in use		
6. Isolated Residences in Commercial or Industrial Zones	-	-	For isolated residences in industrial or commercial zones, the external ambient noise levels can be higher than those in residential areas. Internal noise levels in such residences are likely to be more appropriate in assessing any road traffic noise impacts, and the proponent should determine suitable internal noise level targets, taking guidance from Australian Standard 2107:2016 (Standards Australia 2016).
7. Mixed Use Development	-	-	Each component of use in a mixed use development should be considered separately. For example, in a mixed use development containing residences and a childcare facility, the residential component should be assessed against the appropriate criteria for residences in Table 3, and the childcare component should be assessed against point 8 below.
8. Childcare Facilities	Sleeping rooms LAeq, (1 hour) 35 (internal) Indoor play areas LAeq, (1 hour) 40 internal) Outdoor play areas LAeq, (1 hour) 55 (external)	-	Multi-purpose spaces, e.g. shared indoor play/sleeping rooms should meet the lower of the respective criteria. Measurements for sleeping rooms should be taken during designated sleeping times for the facility, or if these are not known, during the highest hourly traffic noise level during the opening hours of the facility.
9. Aged Care Facilities	-	-	Residential land use noise assessment criteria should be applied to these facilities

For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no build option'.

The road network particularly Parkland Road and The Avenue are considered local roads in line with the RNP. A local Road (redeveloped) in the RNP is considered to be:

An existing local road corridor where it is proposed to increase traffic carrying capacity, increase the number of heavy vehicles by more than 50% (eg. from 10% HV to 15% HV) or change the road alignment through design or engineering changes. Redevelopment does not cover minor road works designed to improve safety, such as straightening curves, installing traffic control devices or making minor road alignments. It should be noted that this category may apply to proposals outside an existing road corridor.

4. Assessment of Potential Impacts

4.1 Construction

Location and timing of construction activities can exacerbate noise levels and their effects on sensitive land uses such as residences. Construction noise by its nature is temporary, may not be amenable to purpose-built noise control measures applied to industrial processes, and may move as construction progresses. With these constraints in mind, the ICNG was developed to focus on applying a range of work practices most suited to minimise construction noise impacts, rather than focusing only on achieving numeric noise levels. While some noise from construction sites is inevitable, the aim of the Guideline is to increase protection of residences and other sensitive land uses from noise pollution most of the time.

This section provides a summary of the likely methodology, staging, work hours, plant and equipment that would be used to complete the proposed work. For the purposes of the REF, indicative construction staging, and options are provided. Detailed methods and staging would be established by the construction contractor.

This staging is indicative, based on the current concept design and may change once the detailed design methodology is finalised. The staging is also dependent on the selected construction contractor's preferred methodology, program and sequencing of work.

4.1.1 Construction Hours and Duration

The proposed work would be undertaken during standard work hours:

- Monday to Friday, 7am to 6pm
- Saturday, 8am to 1pm
- No works on public holidays.

While not expected, out of hours work and extended construction hours may be required on limited occasions such as for special deliveries to minimise disruption or in the case of emergencies.

4.1.2 Construction Equipment Source Noise Levels

An indicative list of activities, plant and equipment that may be used for the construction of this proposal are provided in Table 4-1.

The individual sound power levels (SWL) for the anticipated type of construction plant have been referenced from RAPT Consulting's database of noise sources and the RMS Construction Noise Estimator. Other equipment and activities may be utilised and undertaken, however it is expected the emitted noise levels would be similar.

Table 4-1 Construction Plant and Equipment Sound Power Levels

Activities	Anticipated type of plant and equipment	SWL L_{Aeq} dB(A)	Estimated Usage % during 15-minute period[8]
Site Preparation	Road Truck / Light Vehicle	108	50
	Trucks medium rigid	103	50
	Power Generator	103	100
	Light Vehicles	88	50
Utilities Infrastructure	Excavator	110	50
	Dump Truck	110	50
	Franna Crane	98	50
	Backhoe	111	50
	Power Generator	103	100
Vegetation Removal and Excavation Works	Bulldozer	116	50
	Excavator	110	50
	Chipper / Mulcher	116	50
	Compactor	106	50
	Roller	109	50
	Water Cart	107	50
	Dump Truck	110	50

Activities	Anticipated type of plant and equipment	SWL L_{Aeq} dB(A)	Estimated Usage % during 15-minute period[8]
Drainage / Paving	Backhoe	111	50
	Excavator	110	50
	Concrete Truck	109	50
	Vibratory Roller	109	50
	Road Truck	108	50
Finishes	Road Truck	108	50
	Line Marking Truck	108	100

Note 8 The sound power levels for the individual plant items are worst-case levels representative of the equipment operating at maximum capacity. In practice, not all plant items would operate at maximum capacity at the same time and therefore the estimated usage has been adjusted to reflect this. This adjustment is consistent with RAPT Consulting experience on similar projects.

4.1.3 Construction Assessment

Acoustic modelling was undertaken using SoftNoise's "Predictor" to predict the effects of construction noise. Predictor is a computer program for the calculation, assessment and prognosis of noise propagation. Predictor calculates environmental noise propagation according to ISO 9613-2, "Acoustics – Attenuation of sound during propagation outdoors". Terrain topography, ground absorption, atmospheric absorption and relevant shielding objects are taken into account in the calculations.

Enhancing Weather Conditions

Fact Sheet D of the NPfI provides guidance for accounting for noise-enhancing weather conditions. Two options are available to consider meteorological effects:

1. Adopt the noise-enhancing meteorological conditions for all assessment periods for noise impact assessment purposes without an assessment of how often these conditions occur – a conservative approach that considers source-to-receiver wind vectors for all receivers and F class temperature inversions with wind speeds up to 2 m/s at night. Or

2. Determine the significance of noise-enhancing conditions. This involves assessing the significance of temperature inversions (F and G class stability categories) for the night-time period and the significance of light winds up to and including 3 m/s for all assessment periods during stability categories other than E, F or G. Significance is

based on a threshold of occurrence of 30% determined in accordance with the provisions in this policy. Where noise-enhancing meteorological conditions occur for less than 30% of the time, standard meteorological conditions may be adopted for the assessment.

As a detailed analysis of the significance of noise enhancing conditions has not been undertaken, option 1 has been utilised. Table D1 from the NPfI is reproduced in Table 4-2 and shows the noise enhancing meteorological conditions that have been adopted for this assessment

Table 4-2 Noise Enhancing Meteorological Conditions

Meteorological Conditions	Meteorological Parameters
Noise-enhancing meteorological conditions	Daytime/evening: stability category D with light winds (up to 3 m/s at 10 m AGL). Night-time: stability category F with winds up to 2 m/s at 10 m AGL.

Note 9 m/s = metres per second; m = metres; AGL = above ground level; where a range of conditions is nominated, the meteorological condition delivering the highest-predicted noise level should be adopted for assessment purposes. However, feasible and reasonable noise limits in consents and licences derived from this process would apply under the full range of meteorological conditions nominated under standard or noise-enhancing conditions as relevant. All wind speeds are referenced to 10 m AGL. Stability categories are based on the Pasquill–Gifford stability classification scheme.

Other Key assumptions in the model include:

- topographical information was obtained from NSW Government Spatial Services
- all cleared areas were modelled considering a conservative ground factor of 0.8 to account for grassed areas
- all residential receivers were modelled at 1.5 metres above the ground surface

Construction noise levels have been predicted based on the potential construction noise levels provided in Table 4-1. These noise levels represent different equipment noise levels and give an idea how noise levels may change across the proposal area with different activities being undertaken.

The magnitude of off-site noise impact associated with construction would be dependent upon several factors:

- The intensity of construction activities;
- The location of construction activities;
- The type of equipment used;
- Intervening terrain; and
- The prevailing weather conditions.

The calculated noise levels would inevitably depend on the number and type of plant items and equipment operating at any one time and their precise location relative to the receiver of interest. In practice, the noise levels would vary due to the fact that plant and equipment

would move about the worksites and would not all be operating concurrently. In some cases, reductions in noise levels would occur when plant are located behind obstacles or even other items of equipment. Predicted noise levels have been assessed from each of the work scenarios outlined above in a number of work locations. As work moves away from receivers noise levels decrease as can be seen in Figure 4-1.

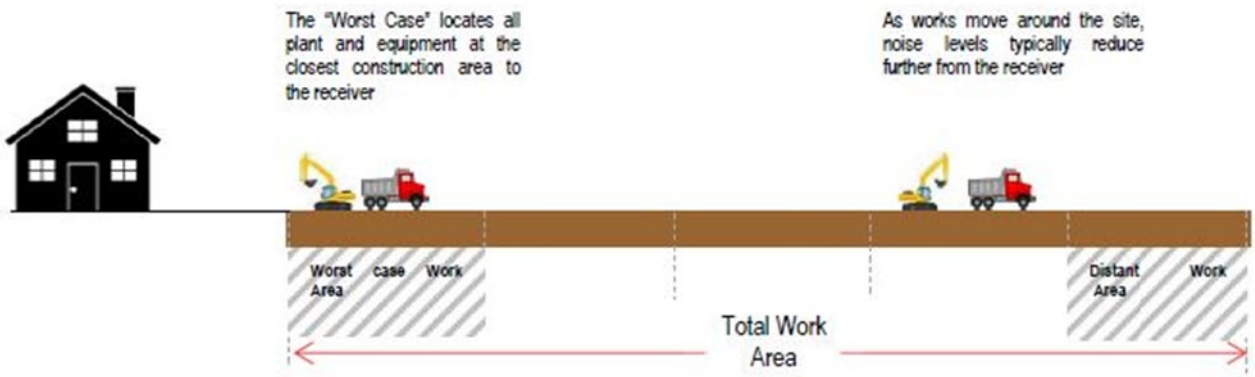


Figure 4-1 Example of Differing Work Areas

The noise levels are representative of the worst-case impact, for a given receiver type and are intended to give an indication of the possible noise levels from construction work when work is at their closest. For most construction activities, it is expected that construction noise levels would frequently be lower than predicted at the most exposed receiver. A general description of NML exceedance groups are provided below. The impact of these potential exceedances depends on the period in which they were to occur (generally night-time is more sensitive than daytime or evening for most people).

- Noise levels 1 – 10 dB(A) above NML – Impact generally marginal to minor
- Noise Levels 11 – 20 dB(A) above NML – Impact generally moderate
- Noise Levels > 20 dB(A) above NML – Impact generally high

During any given period, the machinery items to be used in the study area would operate at maximum sound power levels for only brief stages. At other times, the machinery may produce lower sound levels while carrying out activities not requiring full power. It is highly unlikely that all construction equipment would be operating at their maximum sound power levels at any one time. Finally, certain types of construction machinery would be present in the development footprint for only brief periods during construction. Therefore, the modelled construction noise results are considered to represent a worst-case scenario. Eight locations were modelling being in closest proximity to nearest receivers as shown in Figure 4-2. These scenarios also demonstrate how received noise levels can change due to location of construction activity.

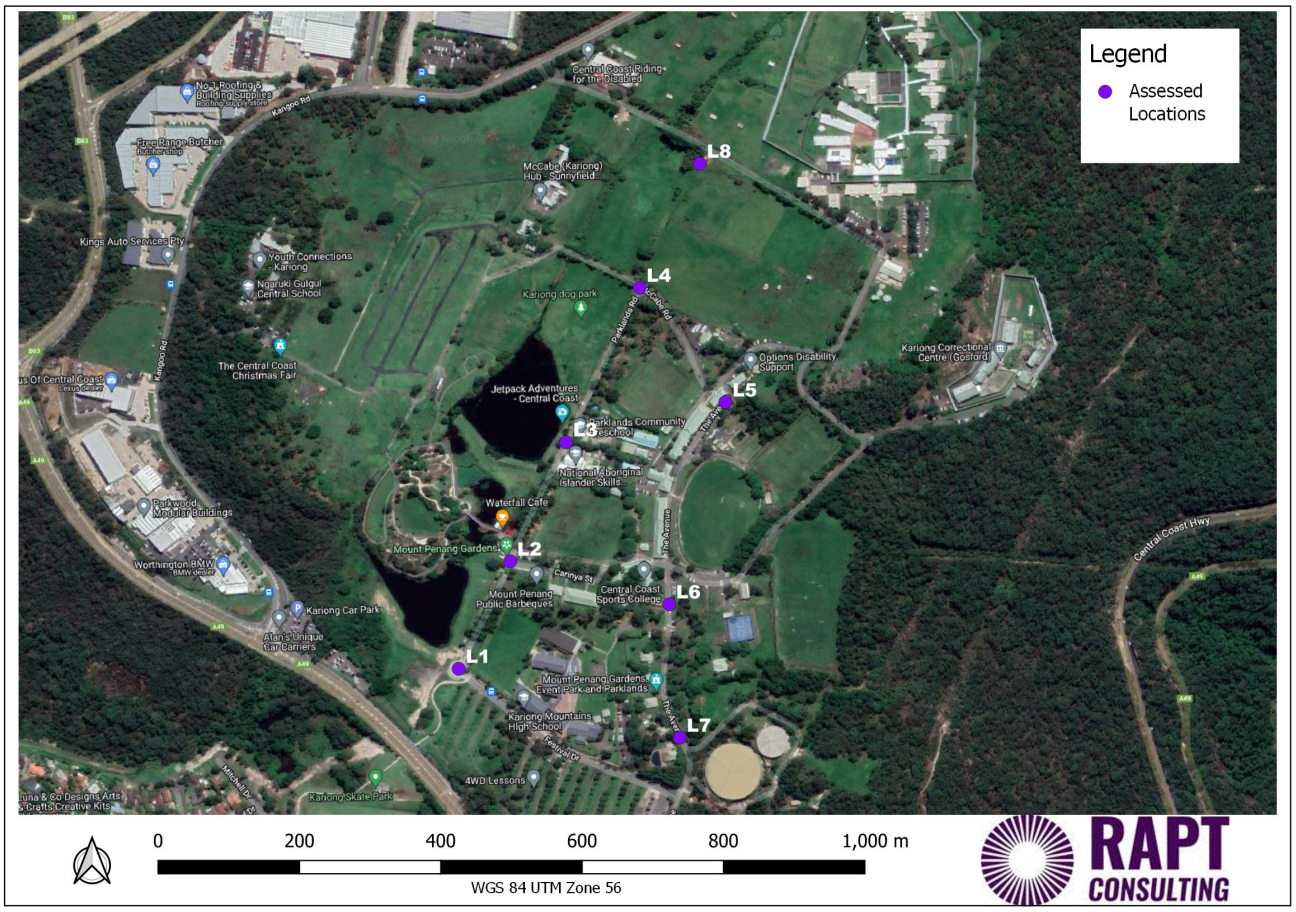


Figure 4-2 Assessed Locations

Construction noise impact assessment results

Noise levels were predicted to each assessed receptor assuming receiver heights of 1.5m above ground level for typical construction activities. Table 4-3 - 4-7 summarises the maximum predicted noise level from each of the construction scenarios at identified assessed receptors for noise enhancing climatic conditions. Predicted exceedances of NML's are highlighted in RED. Noise modelling contours are provided in Appendix C.

Table 4-3 Site Preparation Predicted Construction Noise Levels dB(A) LAeq(15min)

Site Preparation													
Receiver	L1	L2	L3	L4	L5	L6	L7	L8	Standard Hours NML	OOH Daytime NML	OOH Evening NML	OOH Night NML	Highly Affected Noise Level
R1	60	55	32	37	36	34	27	33	55	55	55	55	75
R2	51	63	35	40	38	29	28	36	65	65	65	65	75
R3	50	70	48	45	37	33	38	41	65	65	65	65	75

R4	36	63	56	48	36	33	38	44	70	70	70	70	75
R5	20	27	68	49	25	23	17	44	55	55	55	55	75
R6	36	38	69	51	29	27	24	45	55	55	55	55	75
R7	38	42	49	55	27	38	34	49	70	70	70	70	75
R8	37	40	45	52	24	33	31	51	70	70	70	70	75
R9	32	39	43	49	27	34	31	54	70	70	70	70	75
R10	32	35	39	45	41	36	33	54	70	70	70	70	75
R11	29	31	30	47	72	44	41	43	70	70	70	70	75
R12	34	38	43	58	36	38	35	52	70	70	70	70	75
R13	27	26	27	27	62	48	45	24	55	55	55	55	75
R14	22	27	28	34	51	56	46	35	55	55	55	55	75
R15	25	37	32	39	51	53	27	39	51	46	46	43	75
R16	27	29	26	37	45	56	57	34	51	46	46	43	75
R17	24	25	25	35	43	51	69	33	51	46	46	43	75

Table 4-4 Utilities Infrastructure Predicted Construction Noise Levels dB(A) LAeq,15min

Utilities Infrastructure													
Receiver	L1	L2	L3	L4	L5	L6	L7	L8	Standard Hours NML	OOH Daytime NML	OOH Evening NML	OOH Night NML	Highly Affected Noise Level
R1	64	59	36	41	40	38	31	37	55	55	55	55	75
R2	55	67	39	44	42	33	32	40	65	65	65	65	75
R3	54	74	52	49	41	37	42	45	65	65	65	65	75
R4	40	67	60	52	40	37	42	48	70	70	70	70	75
R5	24	31	72	53	29	27	21	48	55	55	55	55	75
R6	40	42	73	55	33	31	28	49	55	55	55	55	75
R7	42	46	53	59	31	42	38	53	70	70	70	70	75
R8	41	44	49	56	28	37	35	55	70	70	70	70	75
R9	36	43	47	53	31	38	35	59	70	70	70	70	75
R10	36	39	43	49	45	40	37	58	70	70	70	70	75
R11	33	35	34	51	76	48	45	47	70	70	70	70	75
R12	38	42	47	62	40	42	39	56	70	70	70	70	75
R13	31	30	31	31	66	52	49	28	55	55	55	55	75
R14	26	31	32	38	55	60	50	39	55	55	55	55	75
R15	29	41	36	43	55	57	31	43	51	46	46	43	75
R16	31	33	30	41	49	60	61	38	51	46	46	43	75
R17	28	29	29	39	47	55	73	37	51	46	46	43	75

Table 4-5 Vegetation Removal Predicted Construction Noise Levels dB(A) LAeq,15min

Vegetation Removal													
Receiver	L1	L2	L3	L4	L5	L6	L7	L8	Standard Hours NML	OOH Daytime NML	OOH Evening NML	OOH Night NML	Highly Affected Noise Level
R1	72	65	42	47	46	44	37	43	55	55	55	55	75
R2	61	73	45	50	48	39	38	46	65	65	65	65	75
R3	60	80	58	55	47	43	48	51	65	65	65	65	75
R4	46	73	66	58	46	43	48	54	70	70	70	70	75
R5	30	37	78	59	35	33	27	54	55	55	55	55	75
R6	46	48	79	61	39	37	34	55	55	55	55	55	75
R7	48	52	59	65	37	48	44	59	70	70	70	70	75
R8	47	50	55	62	34	43	41	61	70	70	70	70	75
R9	42	49	53	59	37	44	41	65	70	70	70	70	75
R10	42	45	49	55	51	46	43	64	70	70	70	70	75
R11	39	41	40	57	82	54	51	53	70	70	70	70	75
R12	44	48	53	68	46	48	45	62	70	70	70	70	75
R13	37	36	37	37	72	58	55	34	55	55	55	55	75
R14	32	37	38	44	61	66	56	45	55	55	55	55	75
R15	35	47	42	49	61	63	37	49	51	46	46	43	75
R16	37	39	36	47	55	66	67	44	51	46	46	43	75
R17	34	35	35	45	53	61	79	43	51	46	46	43	75

Table 4-6 Drainage / Paving Predicted Construction Noise Levels dB(A) LAeq,15min

Drainage / Paving													
Receiver	L1	L2	L3	L4	L5	L6	L7	L8	Standard Hours NML	OOH Daytime NML	OOH Evening NML	OOH Night NML	Highly Affected Noise Level
R1	67	60	37	42	41	39	32	38	55	55	55	55	75
R2	56	68	40	45	43	34	33	41	65	65	65	65	75
R3	55	75	53	50	42	38	43	46	65	65	65	65	75
R4	41	68	61	53	41	38	43	49	70	70	70	70	75
R5	25	32	73	54	31	28	22	49	55	55	55	55	75
R6	41	43	74	56	34	32	29	50	55	55	55	55	75
R7	43	47	54	61	32	43	39	54	70	70	70	70	75
R8	42	45	50	57	29	38	36	56	70	70	70	70	75
R9	37	44	47	54	32	39	36	60	70	70	70	70	75
R10	37	40	44	50	46	41	38	58	70	70	70	70	75

R11	34	36	35	52	77	49	46	48	70	70	70	70	75
R12	39	43	48	63	41	43	40	57	70	70	70	70	75
R13	32	31	32	32	67	53	50	29	55	55	55	55	75
R14	27	32	33	39	56	61	51	40	55	55	55	55	75
R15	30	42	37	44	56	58	32	44	51	46	46	43	75
R16	32	34	31	42	50	61	62	39	51	46	46	43	75
R17	29	30	30	40	48	56	74	38	51	46	46	43	75

Table 4-7 Finishing Works Predicted Construction Noise Levels dB(A) LAeq,15min

Finishing Works													
Receiver	L1	L2	L3	L4	L5	L6	L7	L8	Standard Hours NML	OOH Daytime NML	OOH Evening NML	OOH Night NML	Highly Affected Noise Level
R1	64	57	34	39	38	36	29	35	55	55	55	55	75
R2	53	65	37	42	40	31	30	38	65	65	65	65	75
R3	52	72	50	47	39	35	40	43	65	65	65	65	75
R4	38	65	58	50	38	35	40	46	70	70	70	70	75
R5	22	29	70	51	28	25	19	46	55	55	55	55	75
R6	38	40	71	53	31	29	26	47	55	55	55	55	75
R7	40	44	51	58	29	40	36	51	70	70	70	70	75
R8	39	42	47	54	26	35	33	53	70	70	70	70	75
R9	34	41	44	51	29	36	33	57	70	70	70	70	75
R10	34	37	41	47	43	38	35	55	70	70	70	70	75
R11	31	33	32	49	74	46	43	45	70	70	70	70	75
R12	36	40	45	60	38	40	37	54	70	70	70	70	75
R13	29	28	29	29	64	50	47	26	55	55	55	55	75
R14	24	29	30	36	53	58	48	37	55	55	55	55	75
R15	27	39	34	41	53	55	29	41	51	46	46	43	75
R16	29	31	28	39	47	58	59	36	51	46	46	43	75
R17	26	27	27	37	45	53	71	35	51	46	46	43	75

While in many instances the construction NML's are anticipated to be complied with, the results of the construction assessment indicate exceedances of NML's may occur depending on work location, work activity and proximity to receivers. The highly affected noise levels has the potential to be exceeded in certain situations at R11 and R17 during vegetation removal and paving and drainage situations. These potential exceedances are based on worst case scenarios and would be expected to be short term as the project progresses away from receptors. However there is a risk for NML's to be exceeded depending on work activities and locations. Additionally, if out of hours night time work is proposed, there is also a risk of sleep disturbance occurring at residences located on The Avenue. With this in mind it is recommended a construction noise and vibration management plan be implemented as part of the proposal to minimise the risk of adverse noise emanating upon the community.

4.2 Construction Noise and Vibration Mitigation Measures

4.2.1 Noise Mitigation Measures

The TFNSW Construction Noise and Vibration Guideline (CNVG) provides guidance for additional mitigation measures and may be used to minimise the impacts on the community from noise and vibration. The range of additional measures are described below.

Appendix B of the CNVG provides guidance for standard mitigation measures and is reproduced as Table4-8.

Table 4-8 Standard Mitigation Measures

Action required	Applies to	Details
Management measures		
Implementation of any project specific mitigation measures required.	Airborne noise	Implementation of any project specific mitigation measures required.
Implement community consultation or notification measures (refer to Appendix C for further details of each measure).	Airborne noise. Ground-borne noise & vibration.	Notification detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule over the night time period, any operational noise benefits from the works (where applicable) and contact telephone number. Notification should be a minimum of 7 calendar days prior to the start of works. For projects other than maintenance works more advanced consultation or notification may be required. Please contact Roads and Maritime Communication and Stakeholder Engagement for guidance. Website (If required) Contact telephone number for community Email distribution list (if required) Community drop in session (if required by approval conditions).

Action required	Applies to	Details
Site inductions	Airborne noise. Ground-borne noise & vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • all project specific and relevant standard noise and vibration mitigation measures • relevant licence and approval conditions • permissible hours of work • any limitations on high noise generating activities • location of nearest sensitive receivers • construction employee parking areas • designated loading/unloading areas and procedures • site opening/closing times (including deliveries) • environmental incident procedures.
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Verification	Airborne noise Ground-borne noise & vibration	Where specified under Appendix C a noise verification program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Attended vibration measurements	Ground-borne vibration	Where required attended vibration measurements should be undertaken at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Update Construction Environmental Management Plans	Airborne noise. Ground-borne noise & vibration.	The CEMP must be regularly updated to account for changes in noise and vibration management issues and strategies.
Building condition surveys	Vibration Blasting	Undertake building dilapidation surveys on all buildings located within the buffer zone prior to commencement of activities with the potential to cause property damage
Source controls		

Action required	Applies to	Details
Construction hours and scheduling.	Airborne noise. Ground-borne noise & vibration.	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.
Construction respite period during normal hours and out- of-hours work	Ground-borne noise & vibration. Airborne noise.	Please refer to Appendix C for more details on the following respite measures: • Respite Offers (RO) • Respite Period 1 (R1) • Respite Period 2 (R2) • Duration Respite (DR)
Equipment selection.	Airborne noise. Ground-borne noise & vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits. Ensure plant including the silencer is well maintained.
Plant noise levels.	Airborne-noise.	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the criteria in Appendix H. Implement a noise monitoring audit program to ensure equipment remains within the more stringent of the manufacturers specifications or Appendix H.
Rental plant and equipment.	Airborne-noise.	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria in Table 2.
Use and siting of plant.	Airborne-noise.	The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers. Only have necessary equipment on site.

Action required	Applies to	Details
Plan worksites and activities to minimise noise and vibration.	Airborne noise. Ground-borne vibration.	Locate compounds away from sensitive receivers and discourage access from local roads. Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site. Where additional activities or plant may only result in a marginal noise increase and speed up works, consider limiting duration of impact by concentrating noisy activities at one location and move to another as quickly as possible. Very noise activities should be scheduled for normal working hours. If the work can not be undertaken during the day, it should be completed before 11:00pm. Where practicable, work should be scheduled to avoid major student examination periods when students are studying for examinations such as before or during Higher School Certificate and at the end of higher education semesters. If programmed night work is postponed the work should be re-programmed and the approaches in this guideline apply again.
Reduced equipment power	Airborne noise. Ground-borne vibration.	Use only the necessary size and power
Non-tonal and ambient sensitive reversing alarms	Airborne noise.	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.
Minimise disturbance arising from delivery of goods to construction sites.	Airborne noise.	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.

Action required	Applies to	Details
		Avoid or minimise these out of hours movements where possible.
Blasting regime	Airborne noise. Ground-borne vibration.	The noise and vibration impacts of blasting operations can be minimised by: • Choosing the appropriate blast charge configurations • Ensuring appropriate blast-hole preparation • Optimising blast design, location, orientation and spacing • Selecting appropriate blast times, and • Utilising knowledge of prevailing meteorological conditions. • AS 2187.2 Explosives-Storage, transport and use, Part 2: Use of Explosives provides more detailed advice on ground vibration and airblast overpressure impact minimisation options.
Engine compression brakes	Construction vehicles	Limit the use of engine compression brakes at night and in residential areas. Ensure vehicles are fitted with a maintained Original Equipment Manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's 'In-service test procedure' and standard.
Path controls		
Shield stationary noise sources such as pumps, compressors, fans etc.	Airborne noise.	Stationary noise sources should be enclosed or shielded where feasible and reasonable whilst ensuring that the occupational health and safety of workers is maintained. Appendix D of

Action required	Applies to	Details
		AS 2436:2010 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities.	Airborne noise.	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.
Receptor controls		
Structural surveys and vibration monitoring	Ground-borne vibration.	Pre-construction surveys of the structural integrity of vibration sensitive buildings may be warranted. At locations where there are high-risk receptors, vibration monitoring should be conducted during the activities causing vibration.
See Appendix C for additional measures	Airborne noise. Ground-borne vibration.	In some instances additional mitigation measures may be required.

Where exceedances are anticipated after implementing standard mitigation measures, additional mitigation measures can be applied where feasible and reasonable. The CNVG provides guidance for additional mitigation measures and may be used to minimise the impacts on the community from noise and vibration. The provision of additional mitigation is based on predicted exceedances above RBLs and when the exceedances occur. Additional mitigation measures taken from Appendix C of the CNVG are provided below.

Notification (letterbox drop or equivalent)

Advanced warning of works and potential disruptions can assist in reducing the impact on the community. The notification may consist of a letterbox drop (or equivalent) detailing work activities, time periods over which these will occur, impacts and mitigation measures. Notification should be a minimum of 5 working days prior to the start of works. The approval conditions for projects may also specify requirements for notification to the community about works that may impact on them.

Specific notifications (SN)

Specific notifications are letterbox dropped (or equivalent) to identified stakeholders no later than seven calendar days ahead of construction activities that are likely to exceed the noise objectives. The specific notification provides additional information when relevant and informative to more highly affected receivers than covered in general letterbox drops.

Phone calls (PC)

Phone calls detailing relevant information made to identified/affected stakeholders within seven calendar days of proposed work. Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs. Where the resident cannot be telephoned then an alternative form of engagement should be used.

Individual briefings (IB)

Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Project representatives would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project. Where the resident cannot be met with individually then an alternative form of engagement should be used.

Respite Offers (RO)

Respite Offers should be considered made where there are high noise and vibration generating activities near receivers. As a guide work should be carried out in continuous blocks that do not exceed 3 hours each, with a minimum respite period of one hour between each block. The actual duration of each block of work and respite should be flexible to accommodate the usage of and amenity at nearby receivers.

The purpose of such an offer is to provide residents with respite from an ongoing impact. This measure is evaluated on a project-by-project basis, and may not be applicable to all projects.

Respite Period 1 (R1)

Out of hours construction noise in out of hours period 1 shall be limited to no more than three consecutive evenings per week except where there is a Duration Respite. For night work these periods of work should be separated by not less than one week and no more than 6 evenings per month.

Respite Period 2 (R2)

Night time construction noise in out of hours period 2 shall be limited to two consecutive nights except for where there is a Duration Respite. For night work these periods of work should be separated by not less than one week and 6 nights per month. Where possible, high noise generating works shall be completed before 11pm.

Duration Respite (DR)

Respite offers and respite periods 1 and 2 may be counterproductive in reducing the impact on the community for longer duration projects. In this instance and where it can be strongly justified it may be beneficial to increase the work duration, number of evenings or nights worked through Duration Respite so that the project can be completed more quickly.

The project team should engage with the community where noise levels are expected to exceed the NML to demonstrate support for Duration Respite.

Where there are few receivers above the NML each of these receivers should be visited to discuss the project to gain support for Duration Respite.

Alternative Accommodation (AA)

Alternative accommodation options may be offered to residents living in close proximity to construction works that are likely to experience highly intrusive noise levels (Tables C1-C3). The specifics of the offer will be identified on a project-by-project basis. Additional aspects for consideration shall include whether the highly intrusive activities occur throughout the night or before midnight.

Verification

Verification of Noise and Vibration levels as part of routine checks of noise levels or following reasonable complaints. This verification should include measurement of the background noise level and construction noise. Note this is not required for projects less than three weeks unless to assist in managing complaints.

Table 4-9 provides how to implement additional airborne noise mitigation measures.

Table 4-9 Triggers for Additional Mitigations Measures - Airborne Noise

Predicted airborne $L_{Aeq(15min)}$ noise level at receiver			Additional mitigation measures	
Perception	**dB(A) above RBL**	**dB(A) above NML**	**type[10]:**	**Mitigation Levels [10]:**
All hours				
75dBA or greater			N, V, PC, RO	HA
Standard Hours: Mon - Fri (7am – 6pm), Sat (8am – 1pm), Sun/Pub Hol (Nil)				
Noticeable	5 to 10	0	-	NML
Clearly Audible	10 to 20	< 10	-	NML
Moderately intrusive	20 to 30	10 to 20	N, V	NML+10
Highly intrusive	> 30	> 20	N, V	NML+20
OOHW Period 1: Mon – Fri (6pm – 10pm), Sat (7am – 8am & 1pm – 10pm), Sun/Pub Hol (8am – 6pm)				
Noticeable	5 to 10	< 5	-	NML
Clearly Audible	10 to 20	5 to 15	N, R1, DR	NML+5
Moderately intrusive	20 to 30	15 to 25	V, N, R1, DR	NML+15
Highly intrusive	> 30	> 25	V, IB, N, R1, DR, PC, SN	NML+25
OOHW Period 2: Mon – Fri (10pm – 7am), Sat (10pm – 8am), Sun/Pub Hol (6pm – 7am)				
Noticeable	5 to 10	< 5	N	NML
Clearly Audible	10 to 20	5 to 15	V, N, R2, DR	NML+5
Moderately intrusive	20 to 30	15 to 25	V, IB, N, PC, SN, R2, DR	NML+15
Highly intrusive	> 30	> 25	AA, V, IB, N, PC, SN, R2, DR	NML+25

Note 10 1: AA = Alternative Accommodation, V = Verification, IB = Individual briefings, N = Notification, R1 = Respite Period 1, R2 = Respite Period 2, DR = Duration Respite, SN = Specific notifications, Perception = relates to level above RBL. NML = Noise Management Level, HA = Highly Affected (> 75 dB(A) - applies to residences only)

4.3 Vibration Mitigation Measures

While vibration generated by the proposal is expected to comply with established vibration goals, Table 4-10 provides further guidance for triggers for additional vibration mitigation measures taken from Table C3 of the CNVG.

Table 4-10 Vibration Mitigation Measures

Construction Hours	Receiver Perception	Above VML	Additional Management Measures
Standard Hours Monday – Friday (7am-6pm) Saturday (8am-1pm)	Human Disturbance	>HVML	P, V, RO
	Building Damage	>DVML	V, AC
OOHW Period 1 Monday – Friday (6pm-10pm) Saturday (7am-8am, 1pm-10pm) Sunday/Public Holiday (8am-6pm)	Human Disturbance	>HVML	PN, V, SN, RO, RP, DR
	Building Damage	>DVML	V, AC
OOHW Period 2 Monday-Saturday (12am-7am, 10pm-12am) Sunday/Public Holiday (12am-8am, 6pm-12am)	Human Disturbance	>HVML	PN, V, SN, RO, AA, RP, DR
	Building Damage	>DVML	V, AC

Note 11 PN=Project Notification; SN=Specific Notification, Individual Briefings, or Phone Call; V=Verification of Monitoring; AA=Alternative Accommodation; DR=Duration Reduction; RO=Project Specific Respite Offer; RP=Respite Period; AC=Alternative Construction Methodology

4.4 Construction Related Traffic Noise

While construction related traffic noise is not expected to impact local noise amenity, management of construction related traffic or traffic reroutes noise should as a minimum include the following controls:

- Scheduling and routing of vehicle movements
- Speed of vehicles
- Driver behaviour and avoidance of the use of engine compression brakes
- Ensuring vehicles are adequately silenced before allowing them to access the site

Consideration must be given to the following measures where feasible and reasonable:

- temporary noise barriers
- at-receiver noise mitigation

Feasible and reasonable considerations should also include:

- time of day of the noise increase and how far above the criteria the noise is expected to be
- time of use of affected receivers
- how many decibels the noise levels are expected to increase above the existing traffic noise
- how long the mitigation will provide benefit to the receiver during the project

4.5 Operational Noise

The GHD Document (*Mount Penang Parklands Traffic and Transport Impact Study Stage 2 Additional Traffic Modelling and Analysis January 2022)* investigated a proposed one-way system on The Avenue and Parklands Road was undertaken. Two options were assessed: Option 1 that follows an anti-clockwise direction, and Option 2 that follows a clockwise direction. It recognised one-way systems are recognised as carrying positive safety benefits, including reduced road exposure, crash conflict points, and crash impact speeds. Kerbside functions are improved through upgrades in footpaths, shared paths, green space and kerbside parking.

Additionally the results concluded Option 2 was preferred as it resulting in:

- A reduction of traffic volume on The Avenue, of up to 220 vehicles per hour by 2031, in comparison to the existing two-way arrangement.
- A reduction of traffic volume on The Avenue, of up to 175 vehicles per hour by 2031, in comparison to Option 1.
- A reduction in traffic volume on Festival Drive in the eastbound direction, consequently improving vehicular access to Kariong Mountains High School.
- Additional queueing capacity and a more direct route for vehicles exiting Mt Penang, via the Avenue toward Central Coast Highway, which is critical in the congested PM peak.

The results of this configuration would also provide a road noise benefit rather than increasing road traffic noise.

It is understood the Parklands connection to Baxter is currently under review with the intention to provide a north-south link between existing Parklands to Baxter to suit the future urban design of this area. The areas next to the new road would be the subject to future Development Applications.

5. Conclusion

This acoustic assessment has been undertaken by RAPT Consulting to inform a Review of Environmental Factors (REF) for the road and infrastructure works at Mt Penang Gardens.

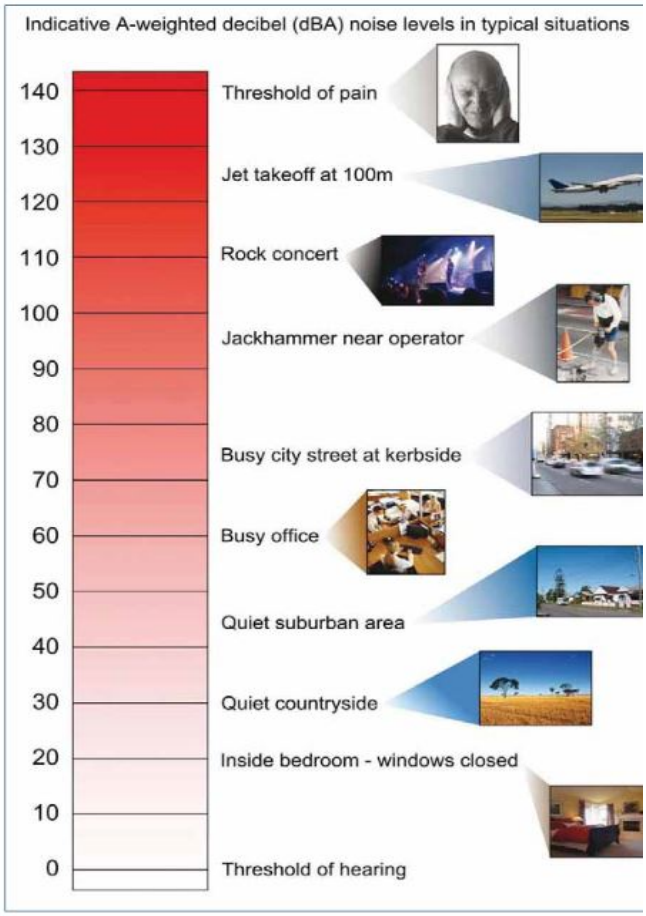
Construction

The assessment outlined in this report indicates that construction noise management levels will be complied with in most situations. However, there is the potential for exceedances for some receivers assessed in certain situations. A set of standard mitigation measures for construction noise and vibration have been provided based on anticipated requirements of the proposal. It is believed construction noise can be minimised and managed to be acceptable to the local community through the implementation of a CNVMP similar to what has been recommended in this report.

Operation

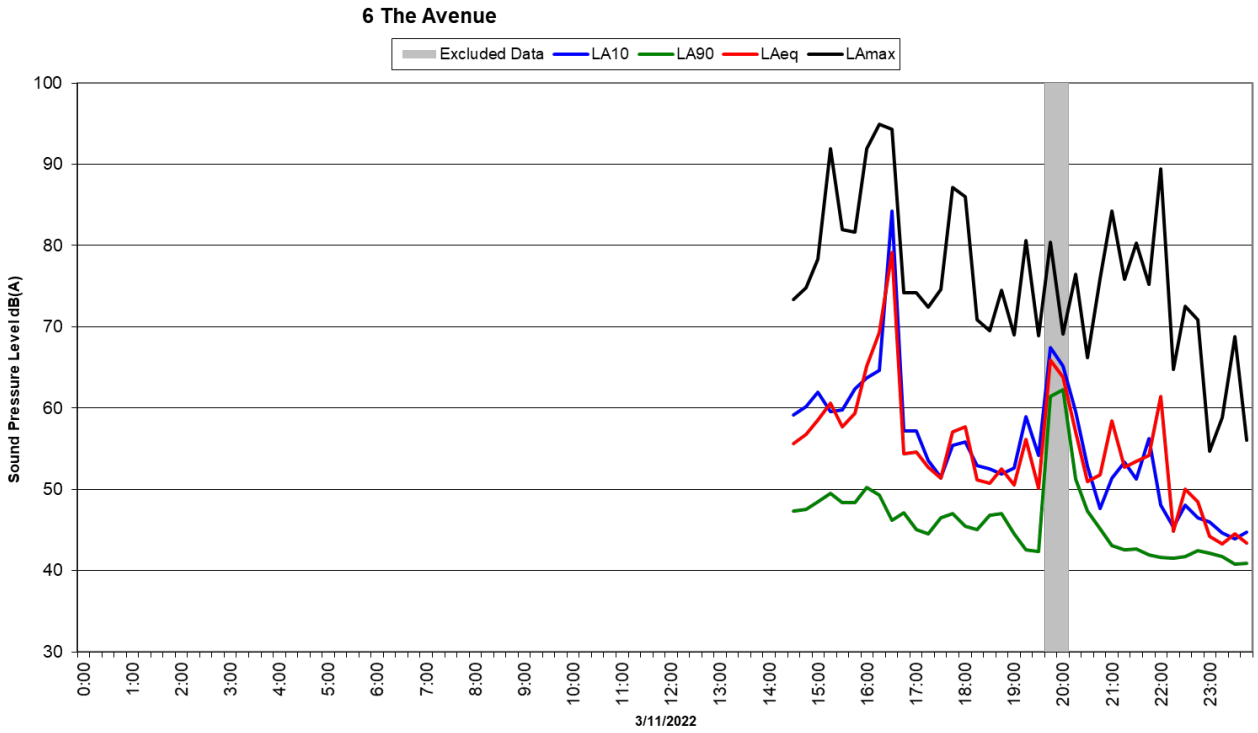
The results of the assessment indicate the proposal will comply with established project noise trigger levels.

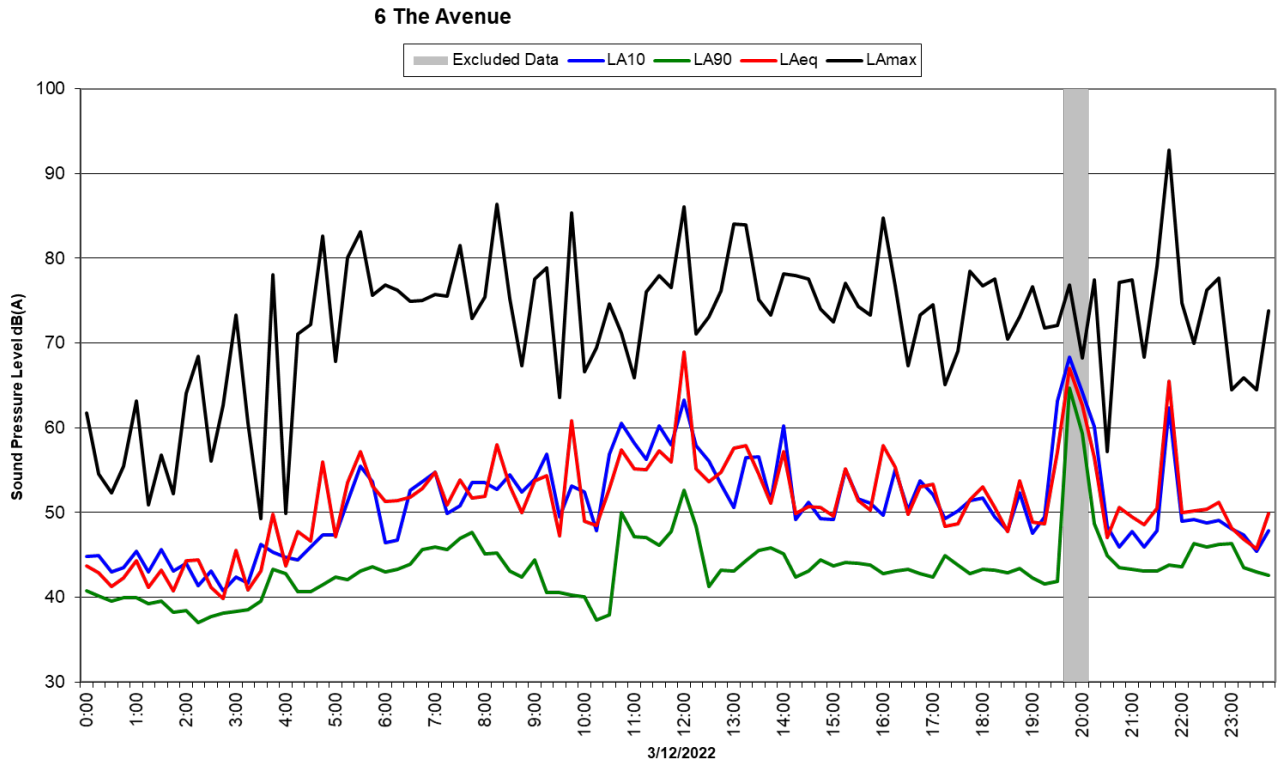
Appendix A: Glossary of Acoustic Terms

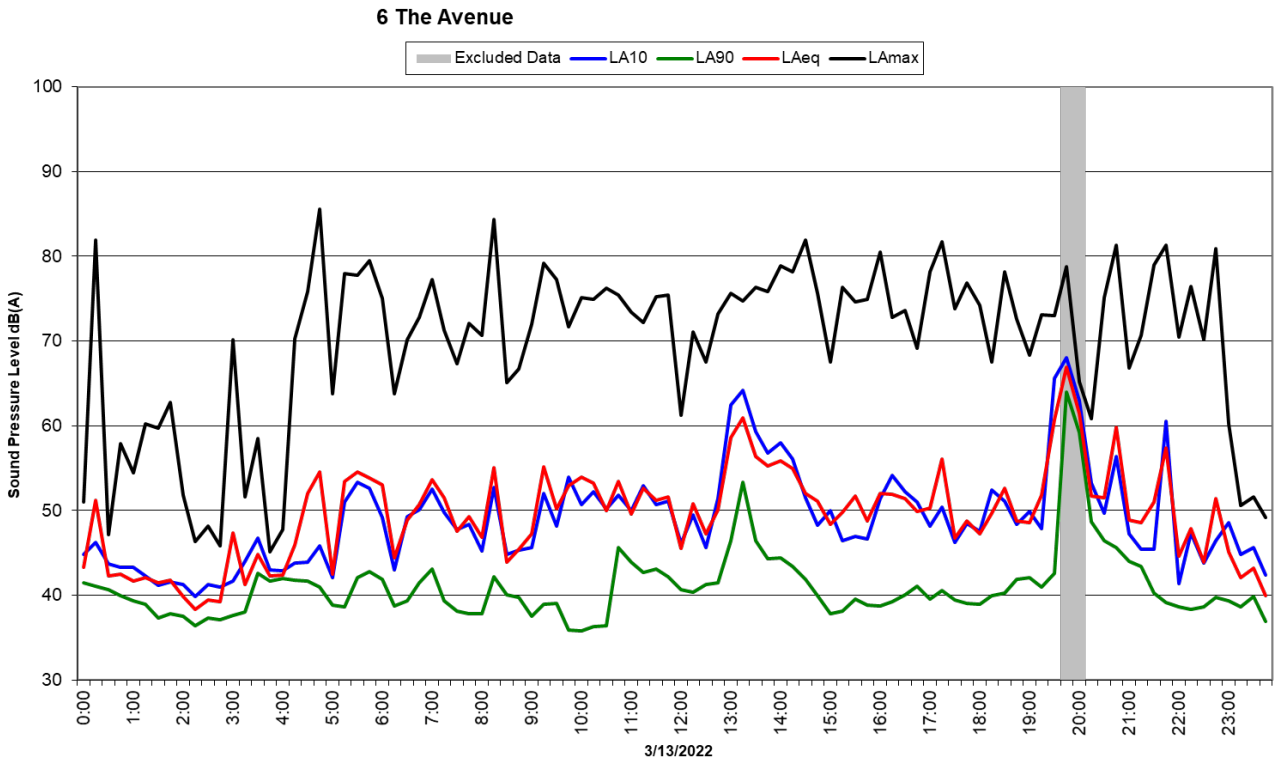
Term	Definition
dB	Decibel is the unit used for expressing the sound pressure level (SPL) or power level (SWL) in acoustics. The picture below indicates typical noise levels from common noise sources. 
dB(A)	Frequency weighting filter used to measure 'A-weighted' sound pressure levels, which conforms approximately to the human ear response, as our hearing is less sensitive at very low and very high frequencies.
$L_{Aeq(period)}$	Equivalent sound pressure level: the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
$L_{A10(period)}$	The sound pressure level that is exceeded for 10% of the measurement period.
$L_{A90(period)}$	The sound pressure level that is exceeded for 90% of the measurement period.
L_{Amax}	The maximum sound level recorded during the measurement period.
Noise sensitive receiver	An area or place potentially affected by noise which includes:

	A residential dwelling. An educational institution, library, childcare centre or kindergarten. A hospital, surgery or other medical institution. An active (e.g. sports field, golf course) or passive (e.g. national park) recreational area. Commercial or industrial premises. A place of worship.
Rating Background Level (RBL)	The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period.
Feasible and Reasonable (Noise Policy for Industry Definition)	**Feasible** mitigation measure is a noise mitigation measure that can be engineered and is practical to build and/or implement, given project constraints such as safety, maintenance and reliability requirements. Selecting **Reasonable** measures from those that are feasible involves judging whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the mitigation measure. To make a judgement, consider the following: Noise impacts Noise mitigation benefits Cost effectiveness of noise mitigation Community views.
Sound power level (SWL)	The sound power level of a noise source is the sound energy emitted by the source. Notated as SWL, sound power levels are typically presented in dB(A).

Appendix B Noise Monitoring Charts



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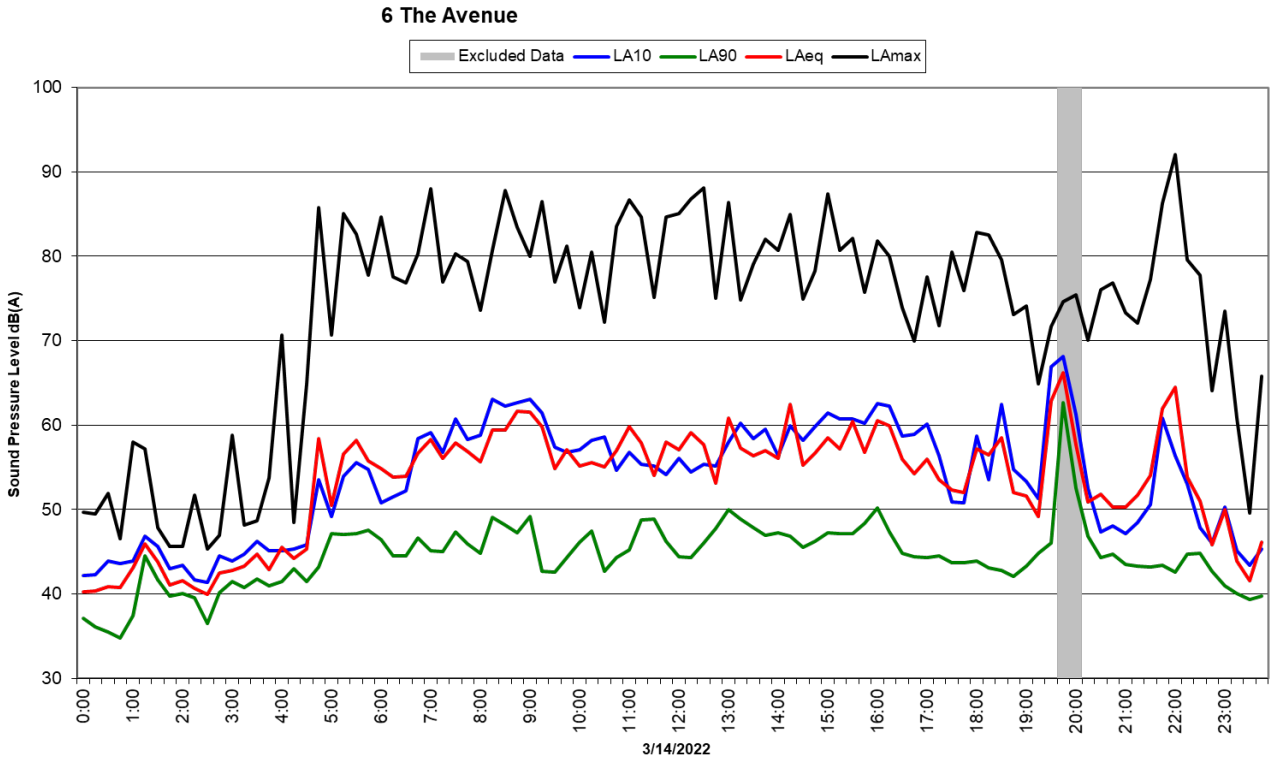
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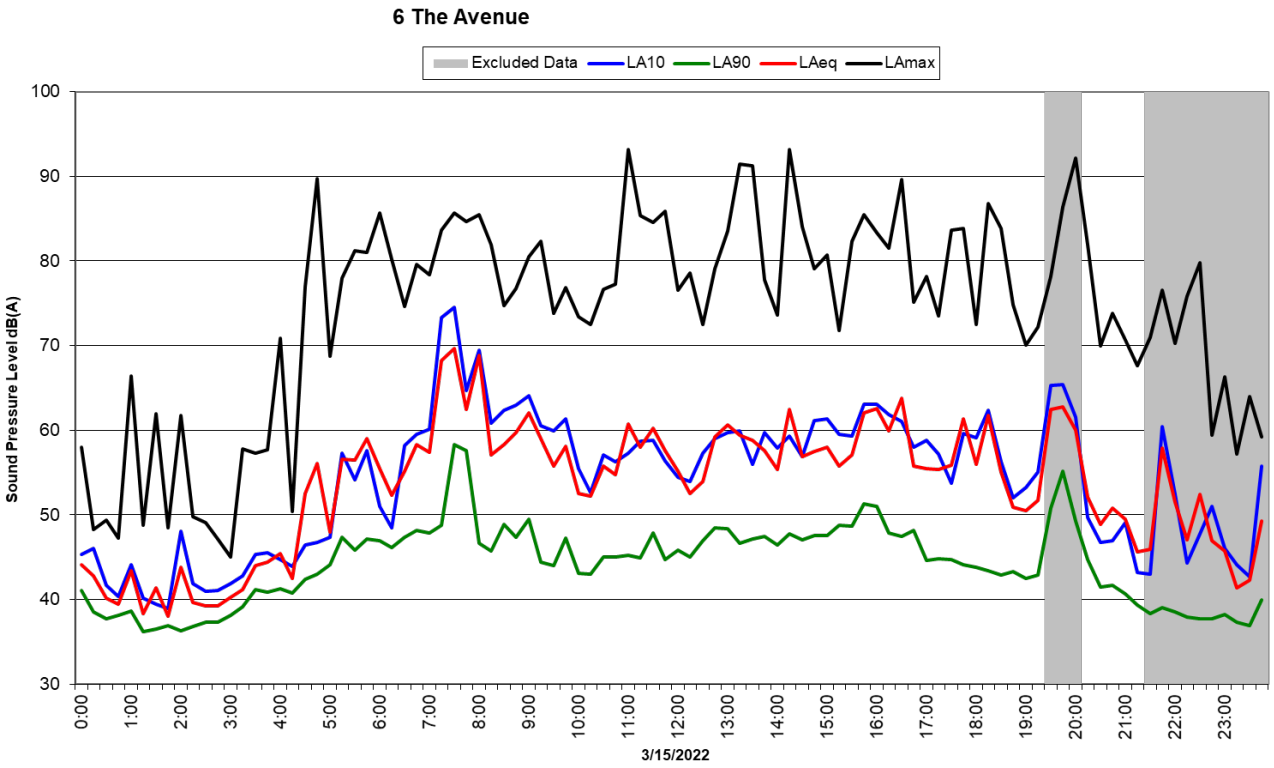
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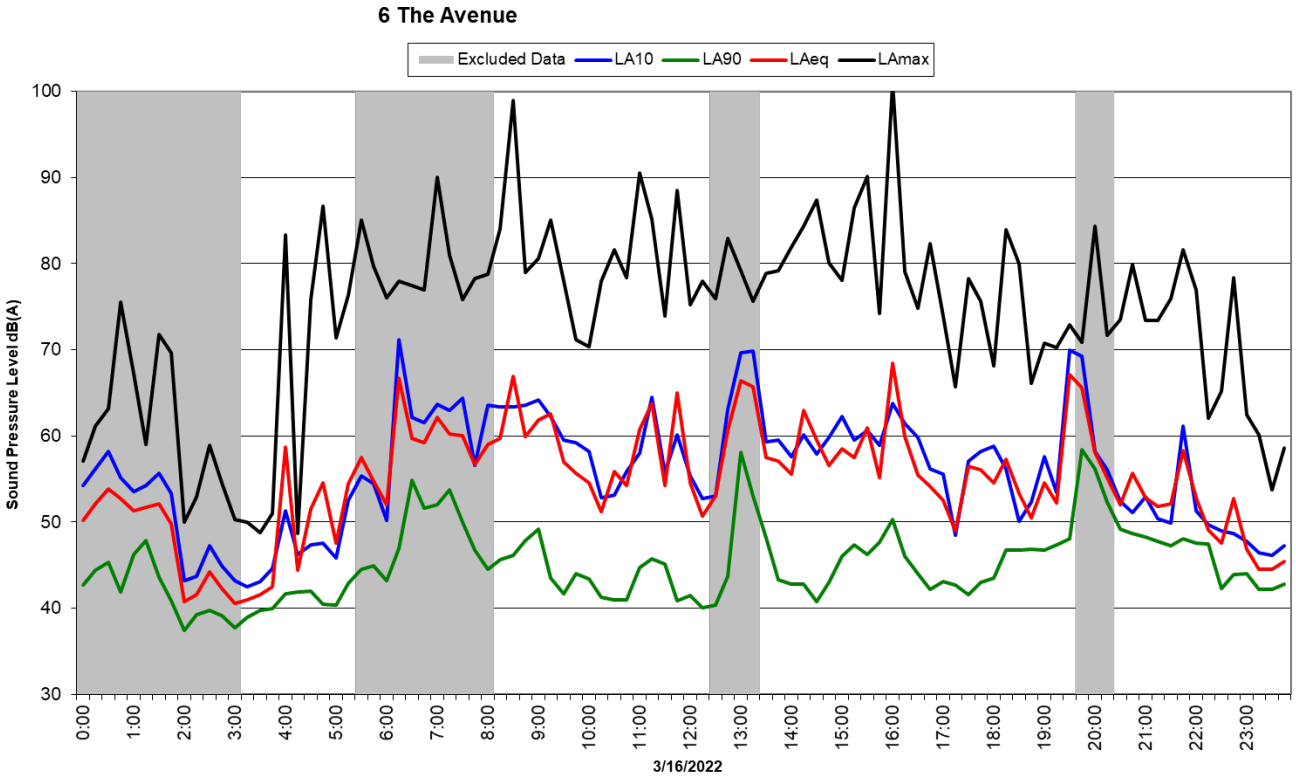
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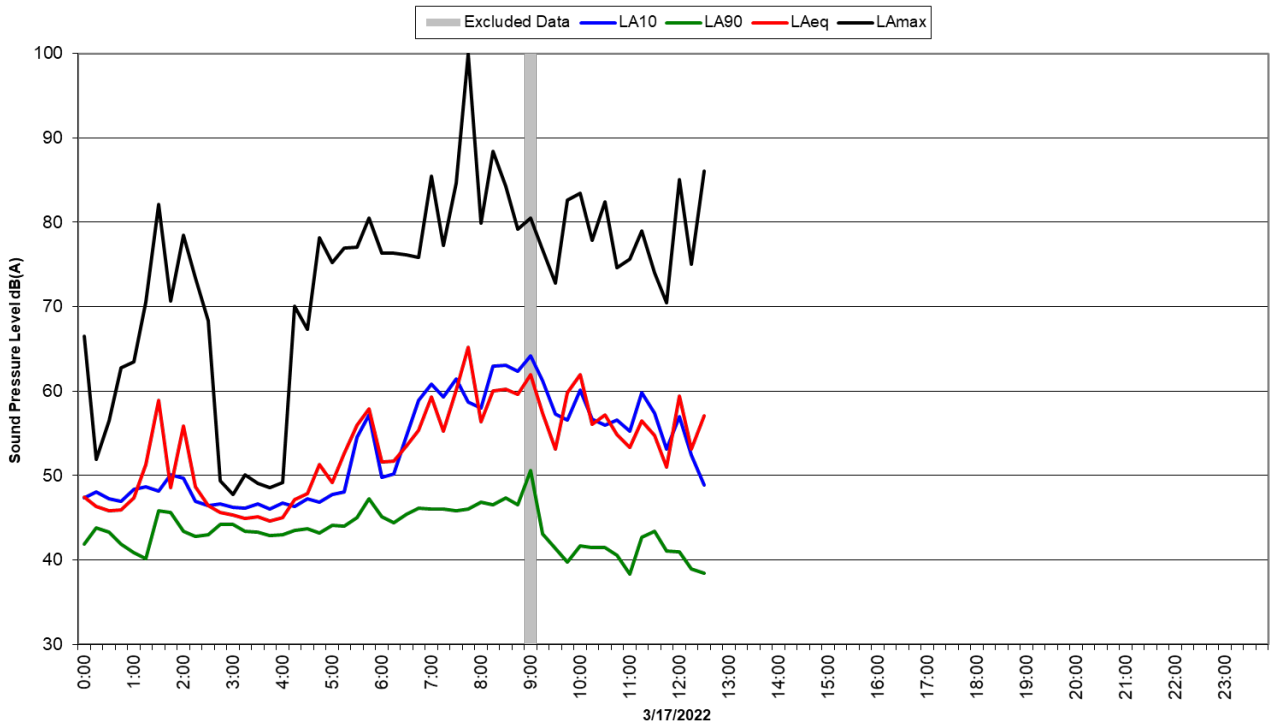

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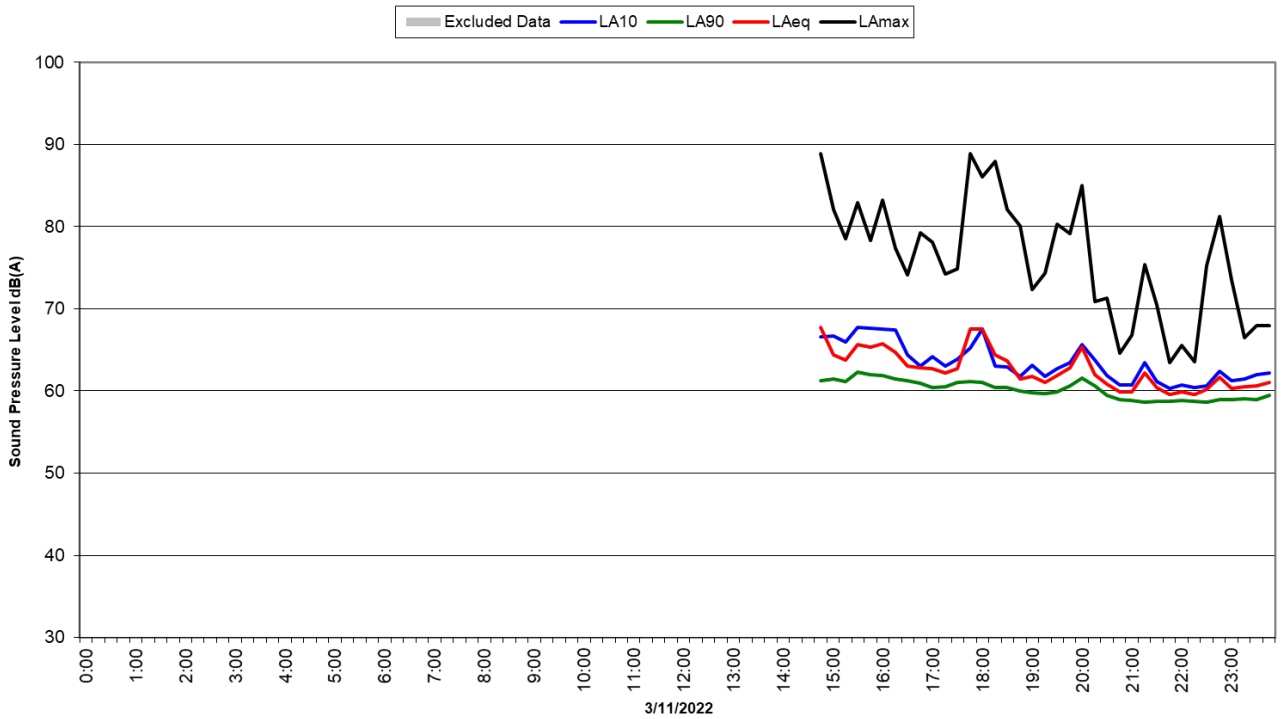

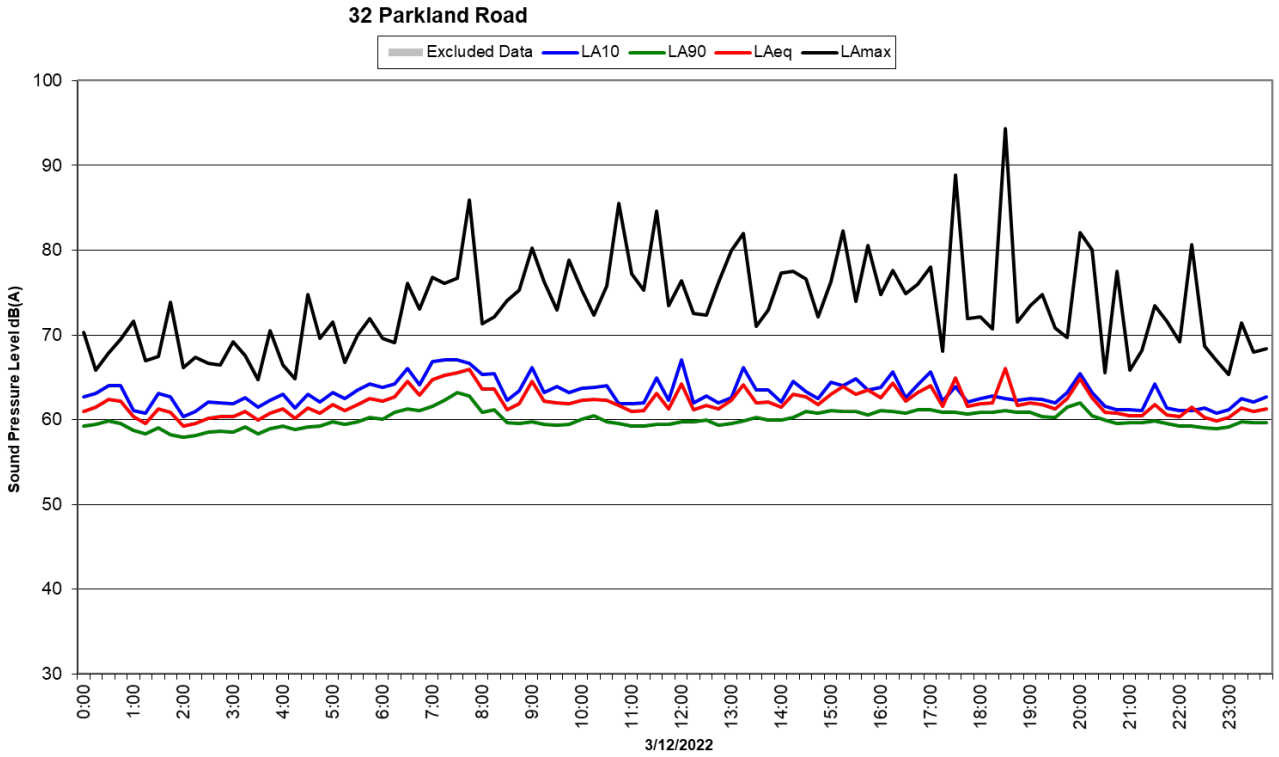
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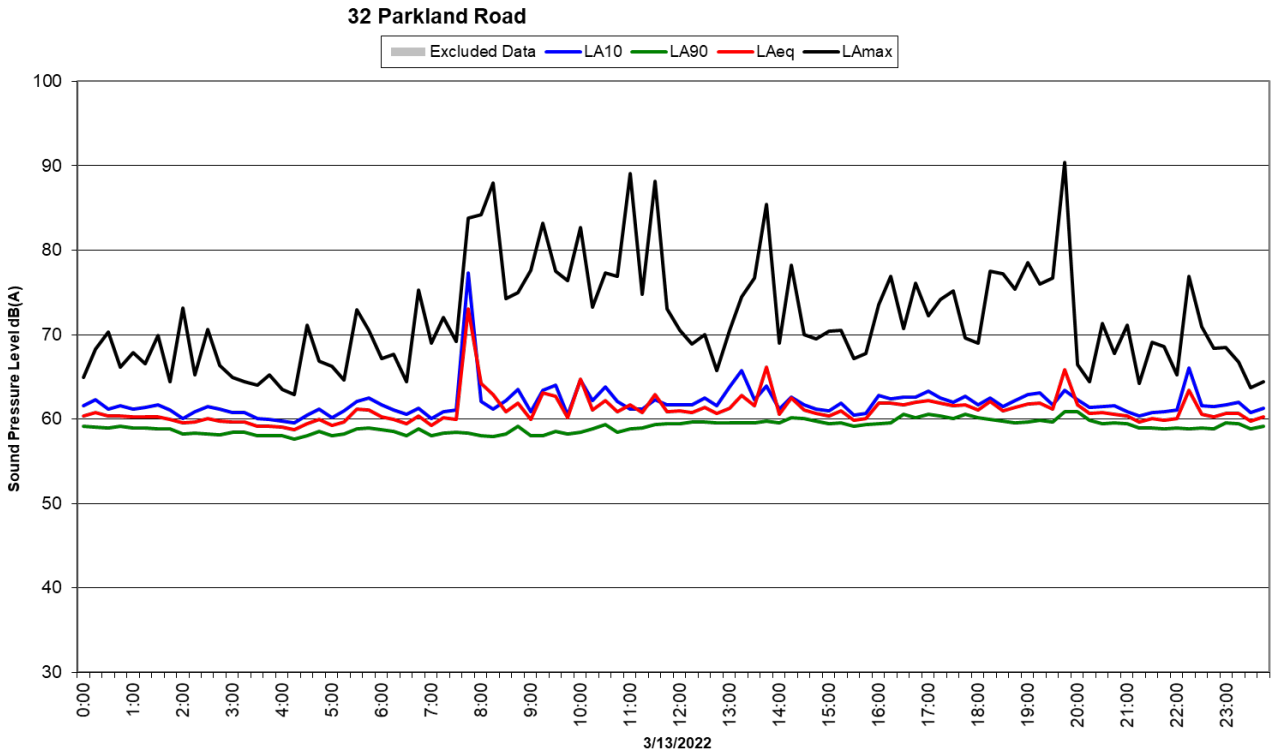
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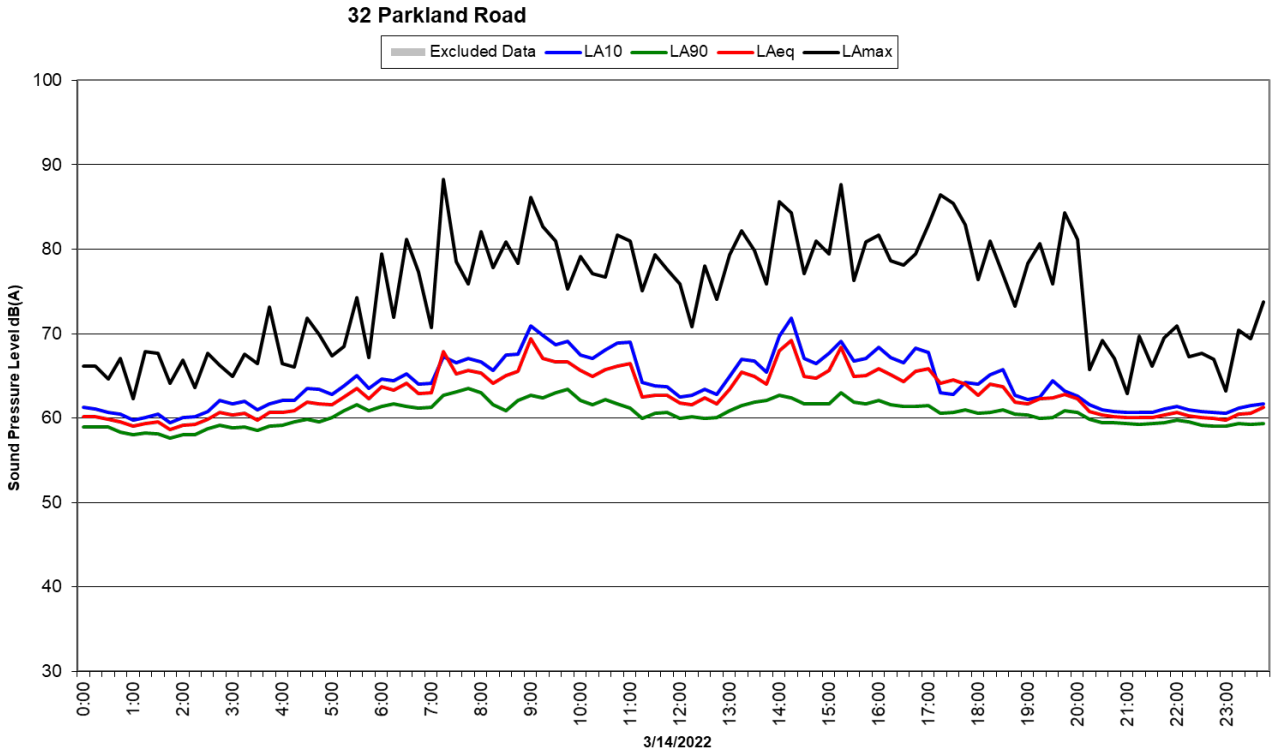
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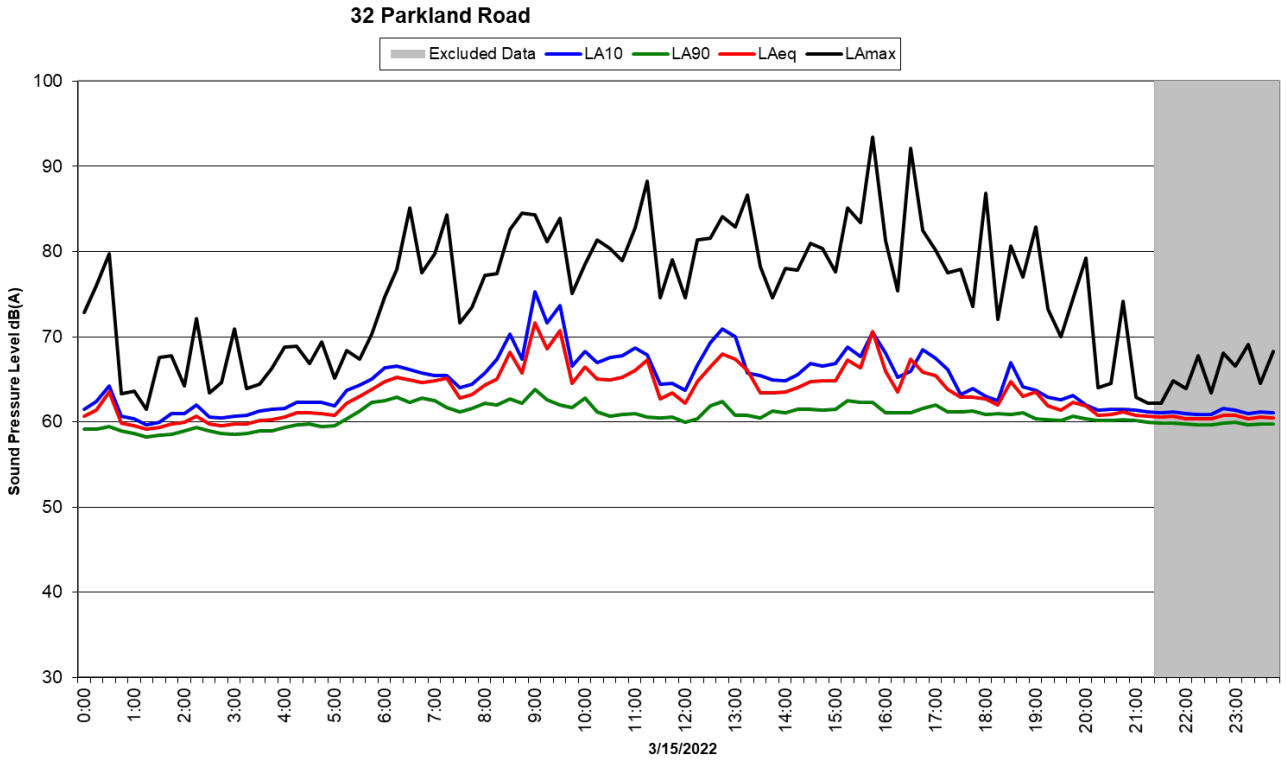
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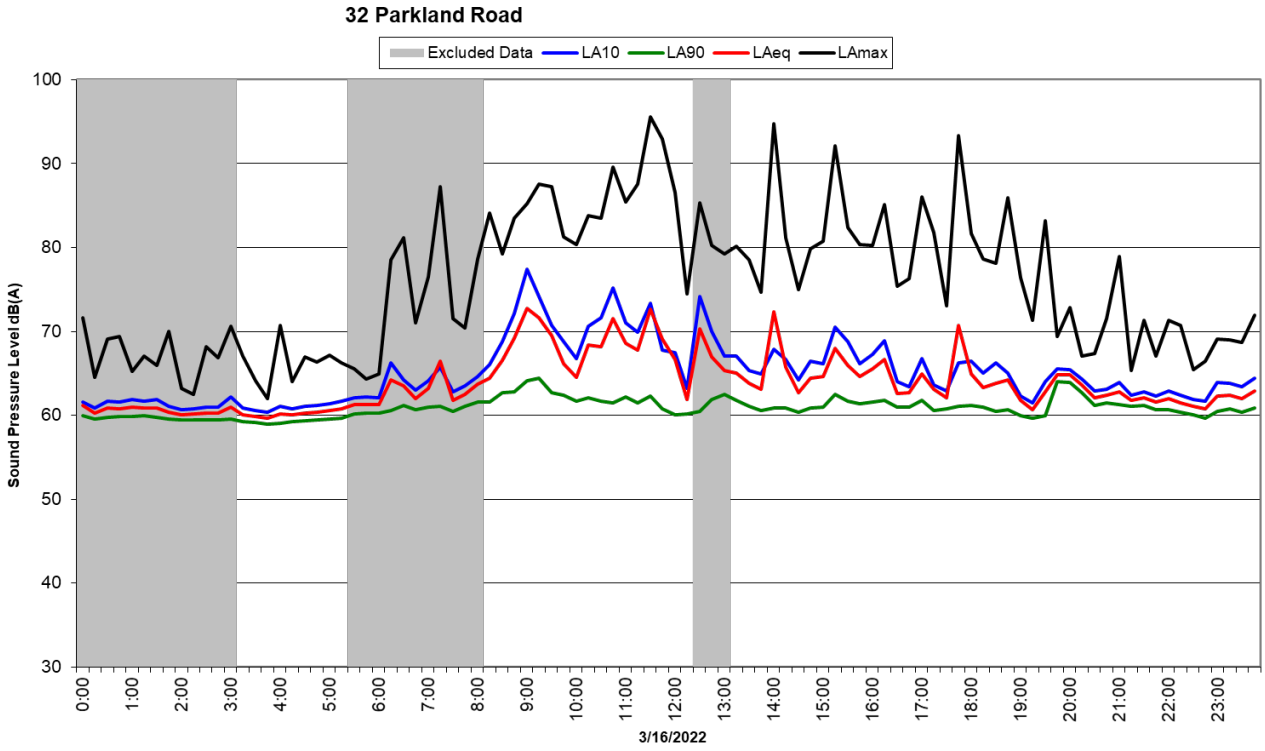
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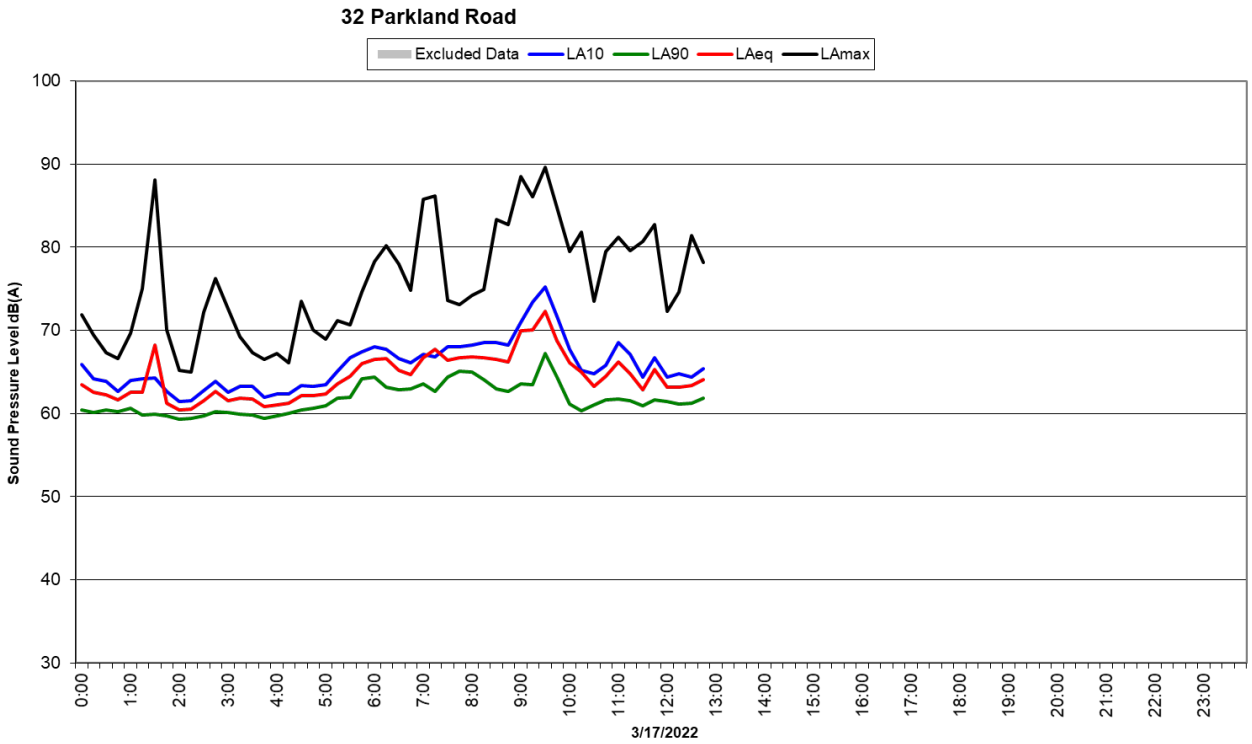
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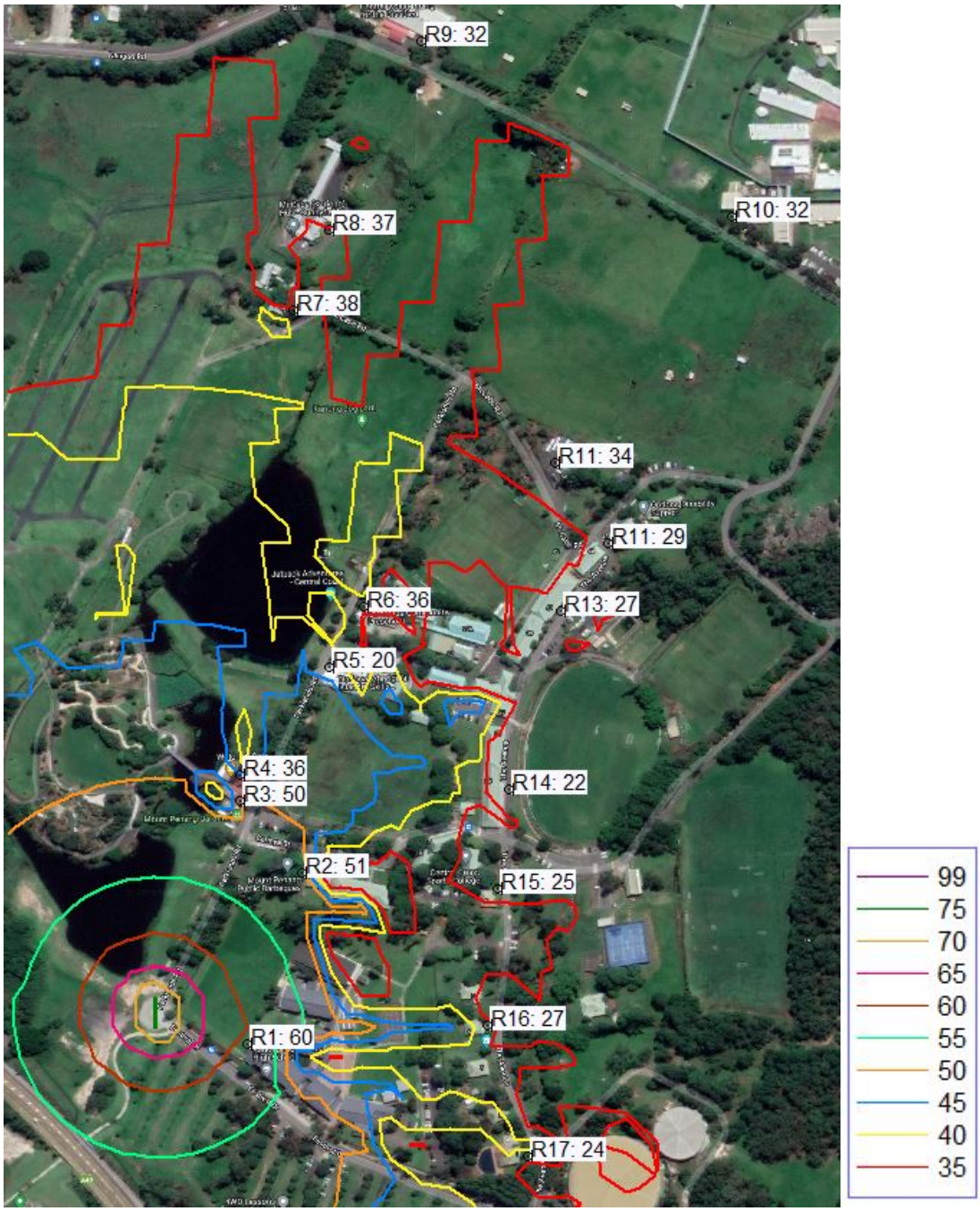
Appendix C Noise Modelling Results dB(A) Leq(15min)



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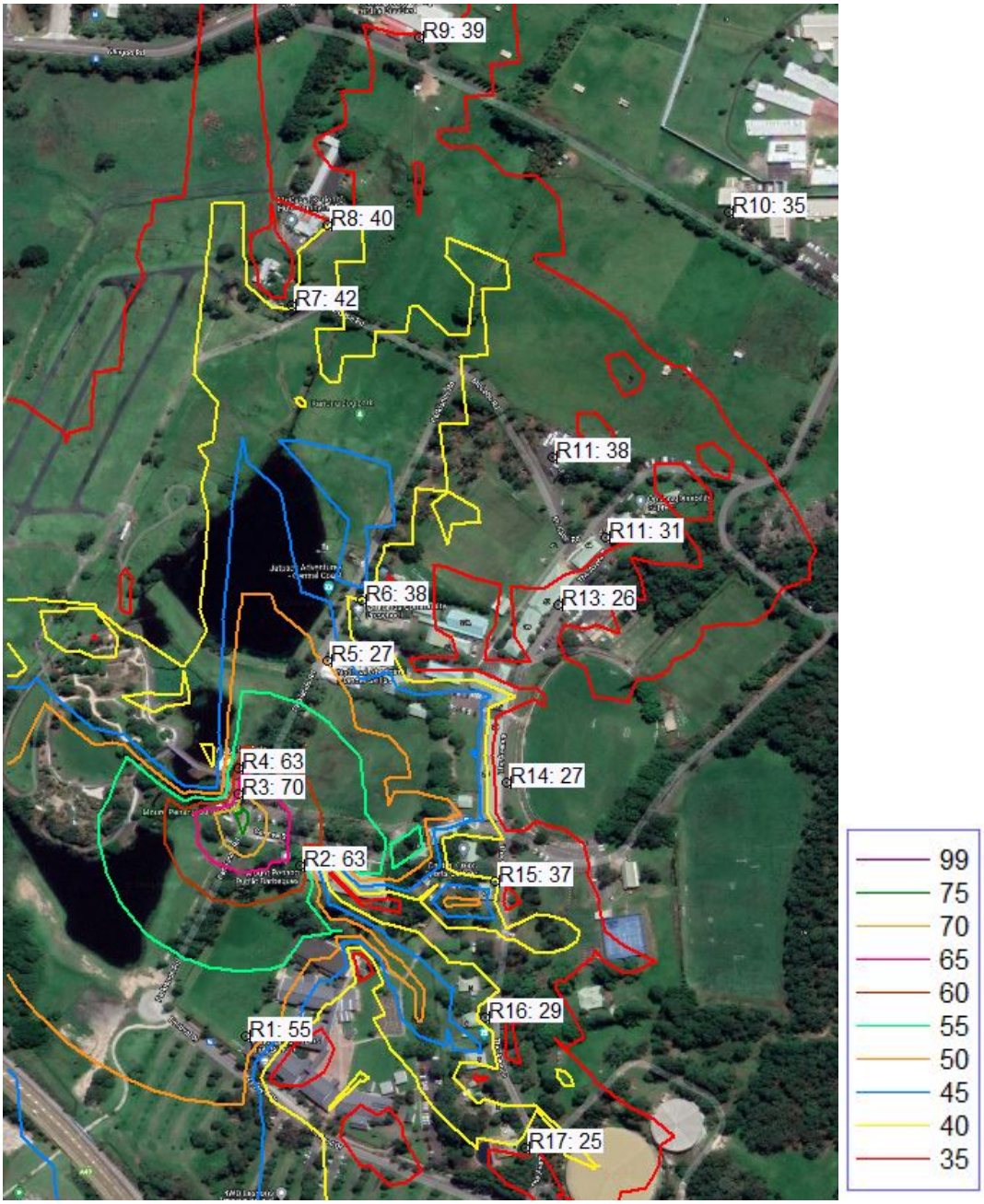

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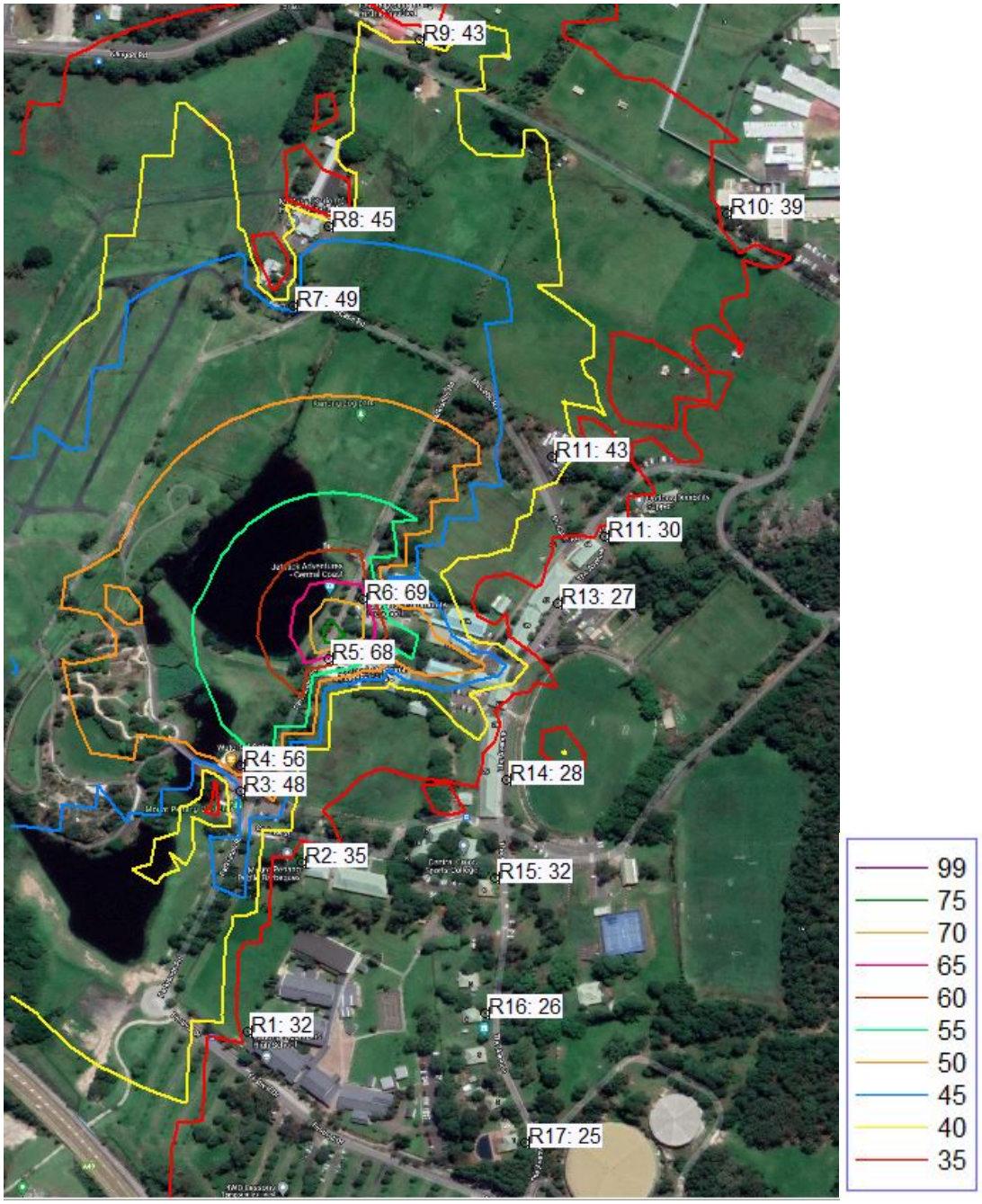

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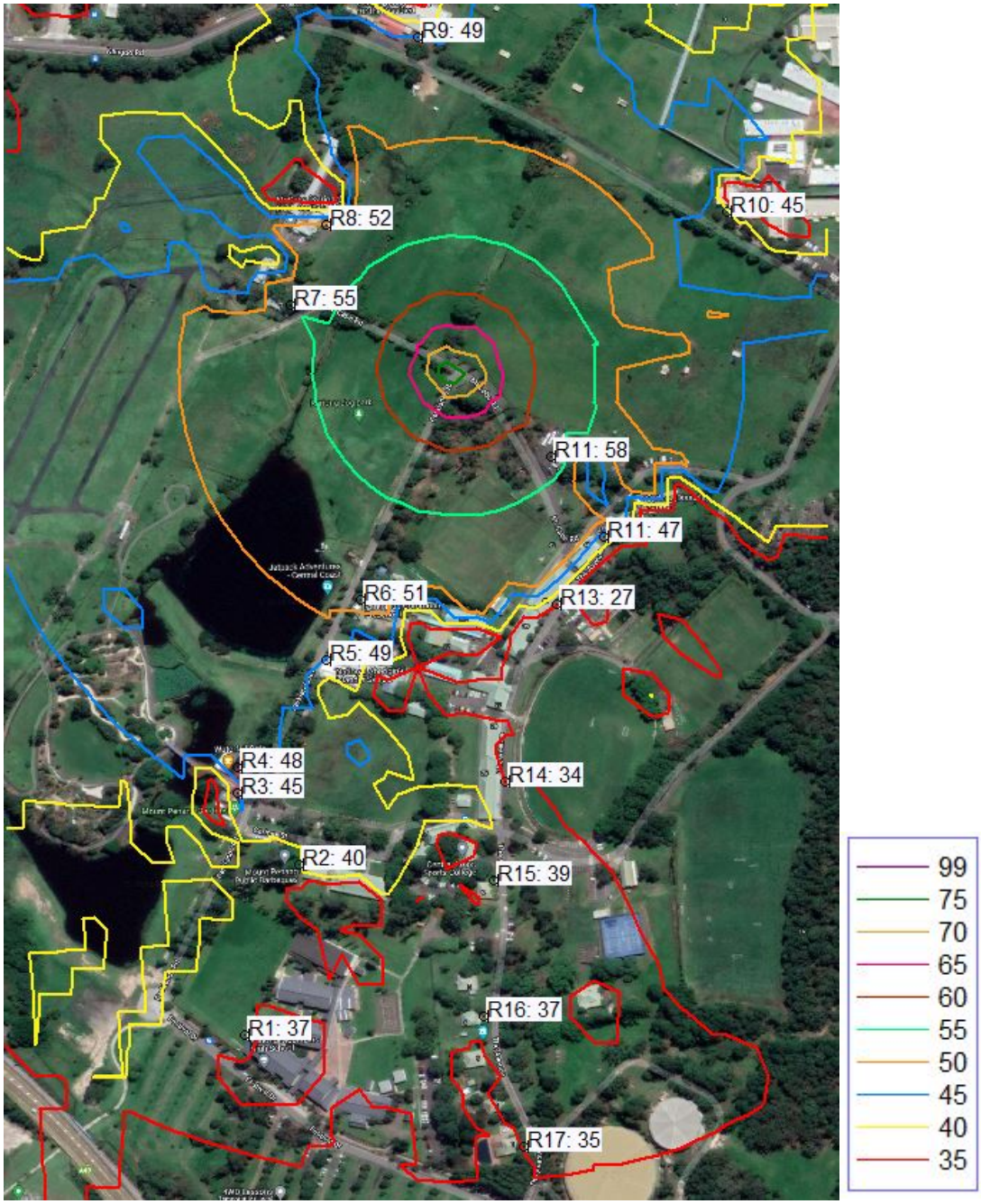

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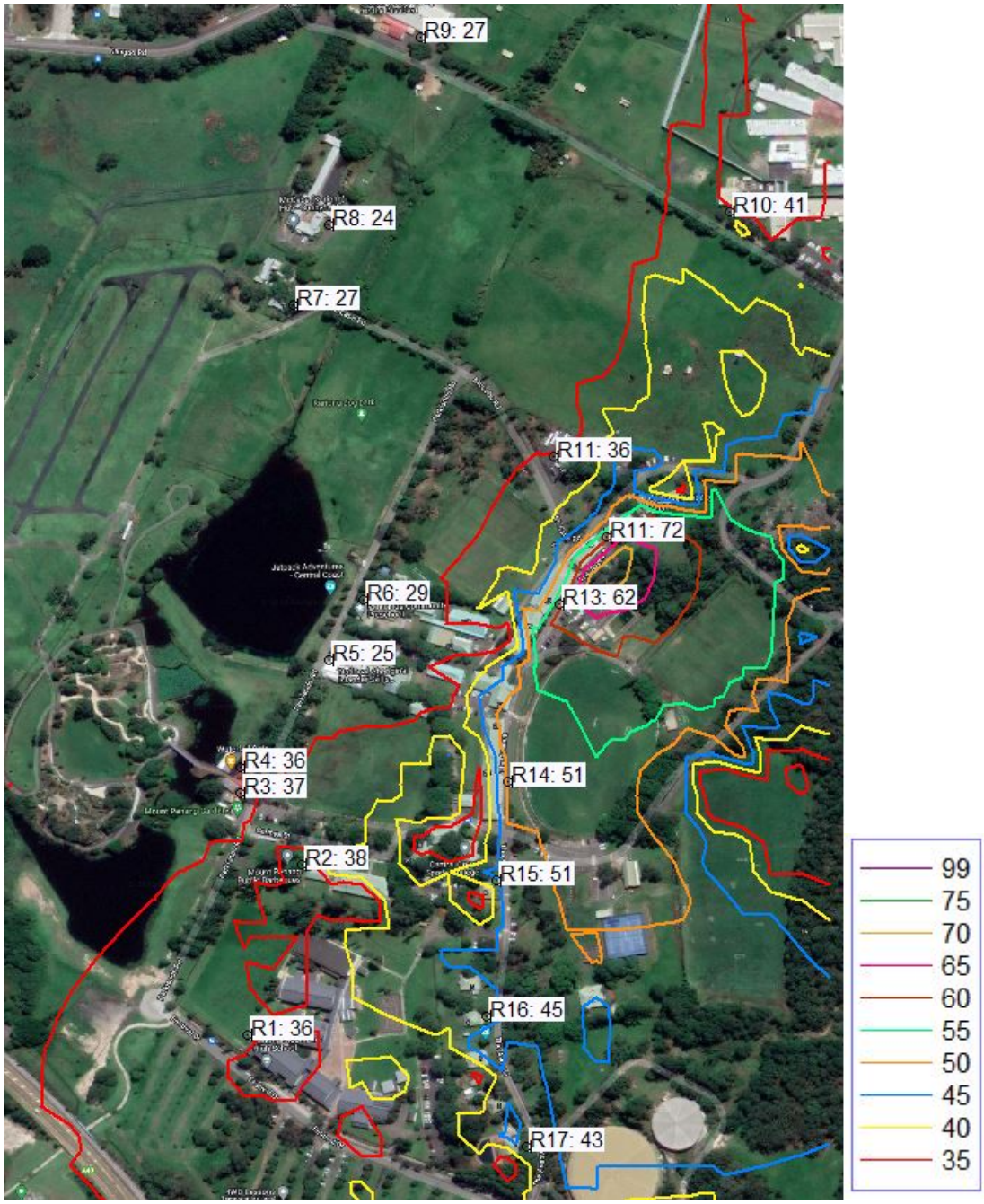

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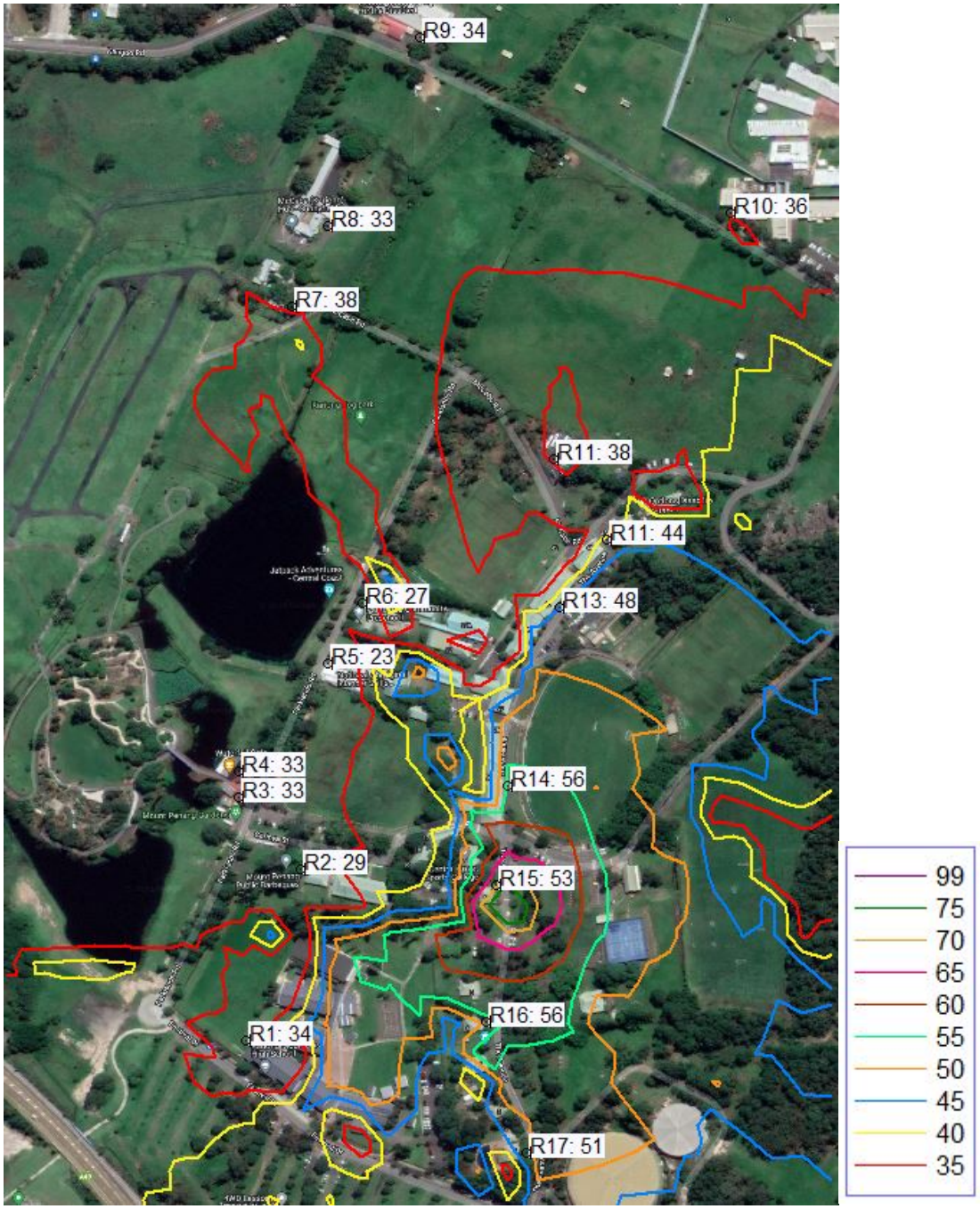

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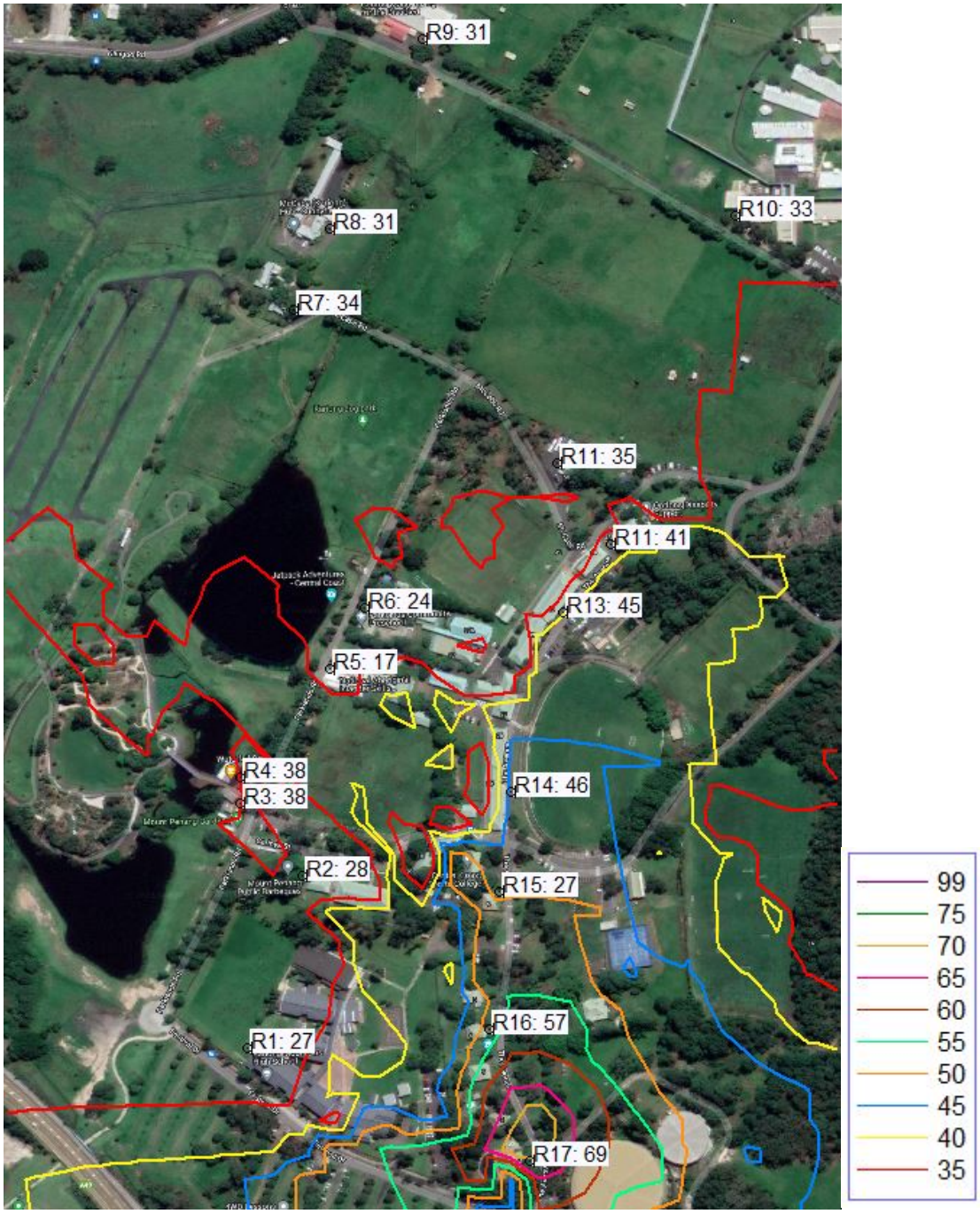

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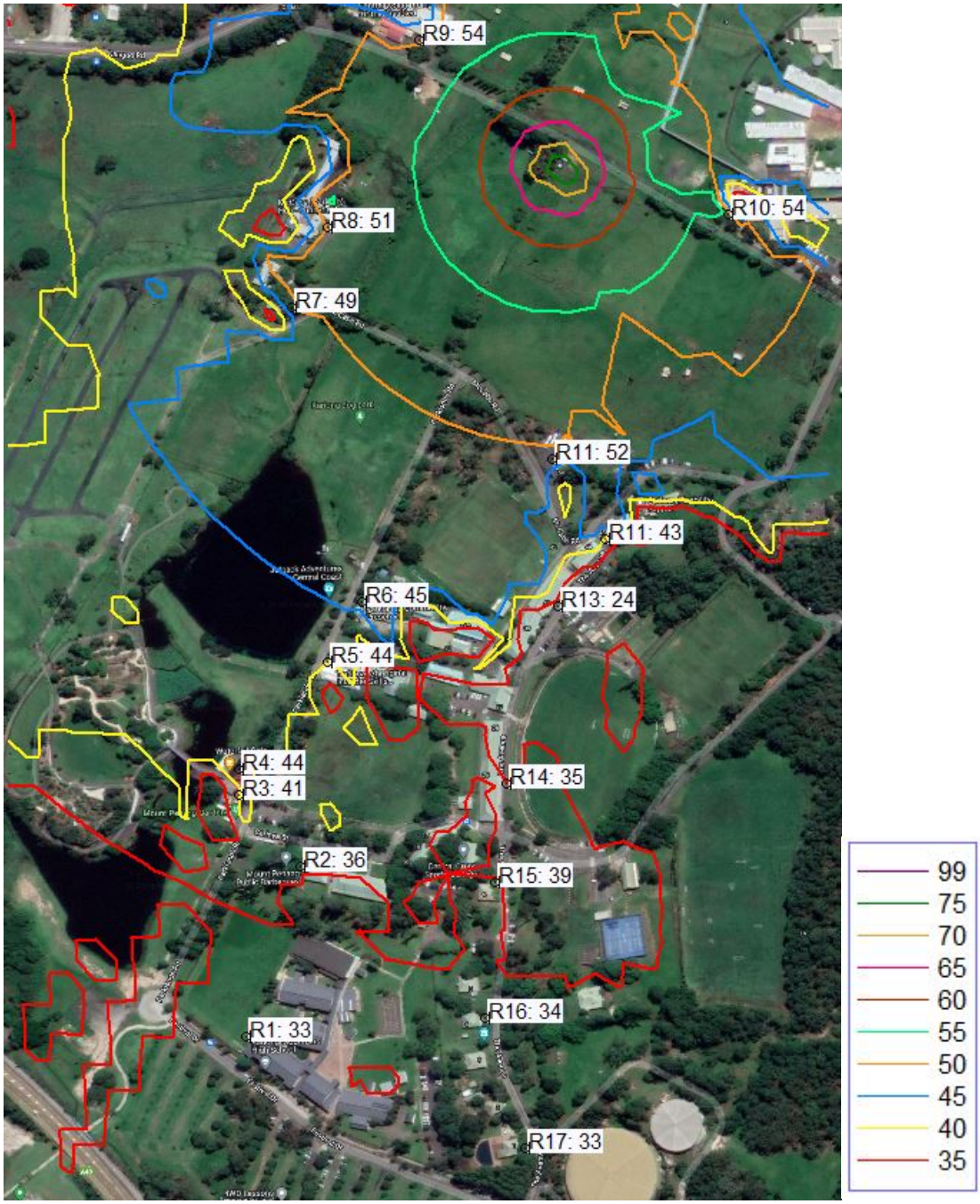

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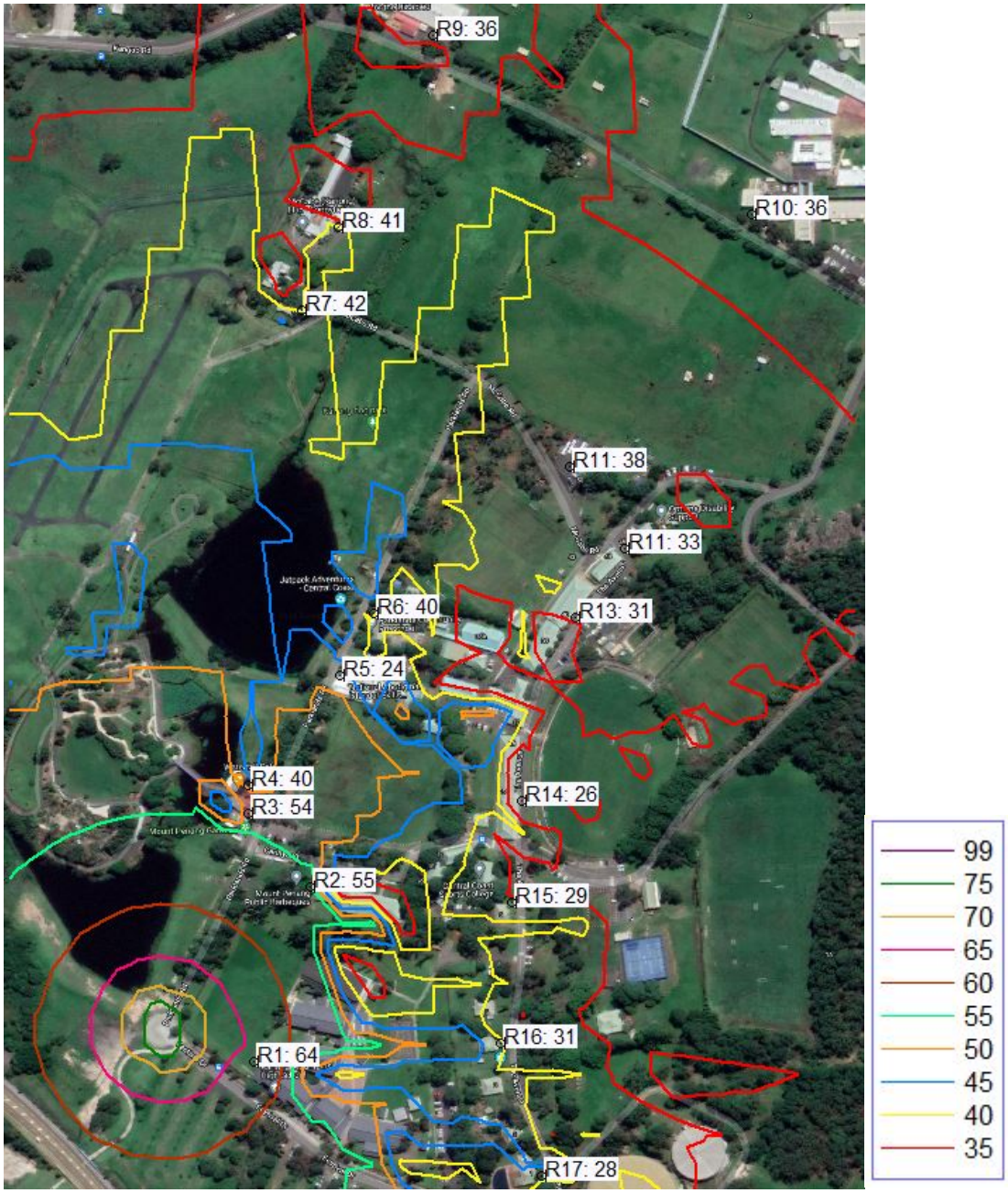

Figure 0-9 L1 Utilities

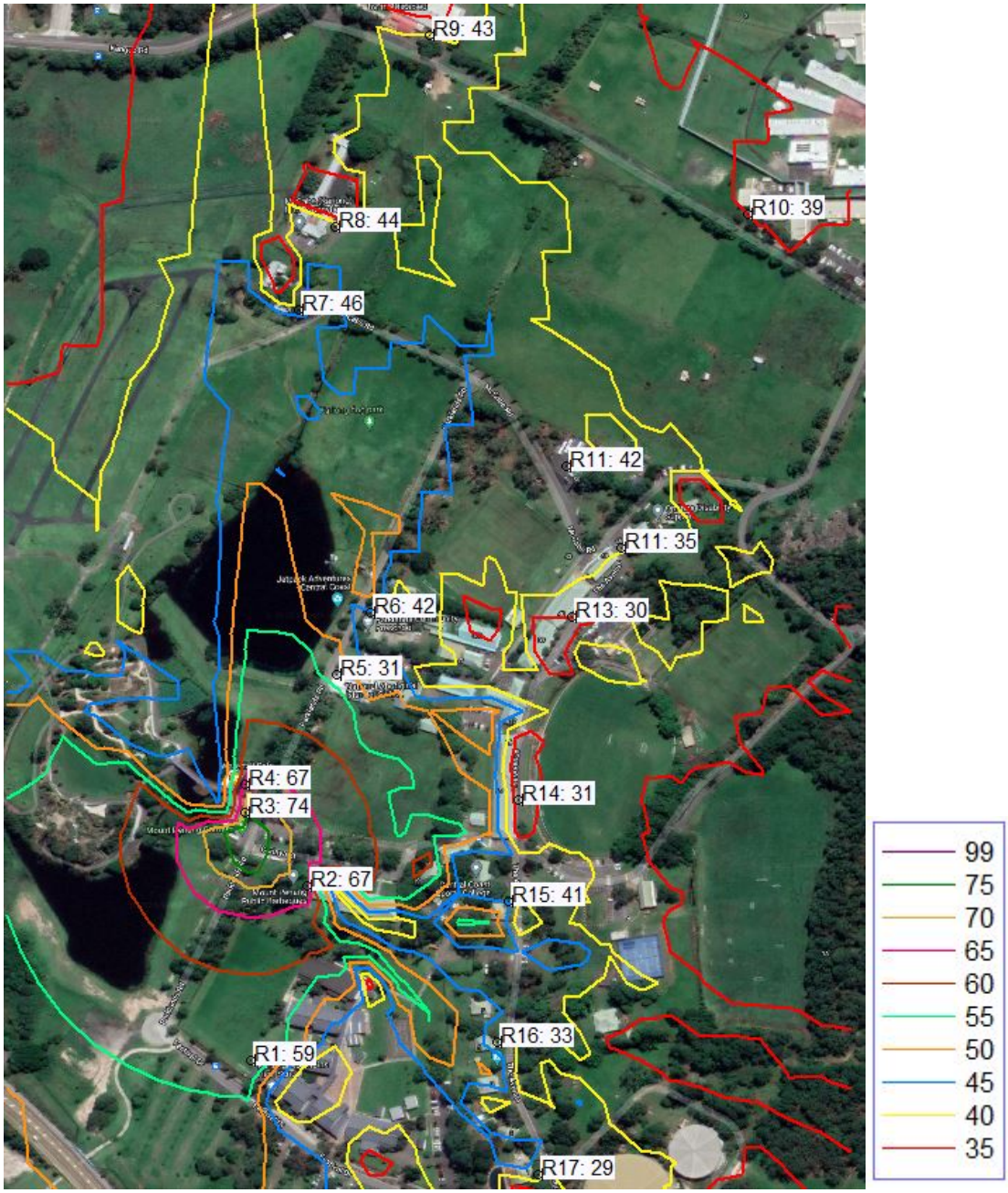

Figure 0-10 L2 Utilities

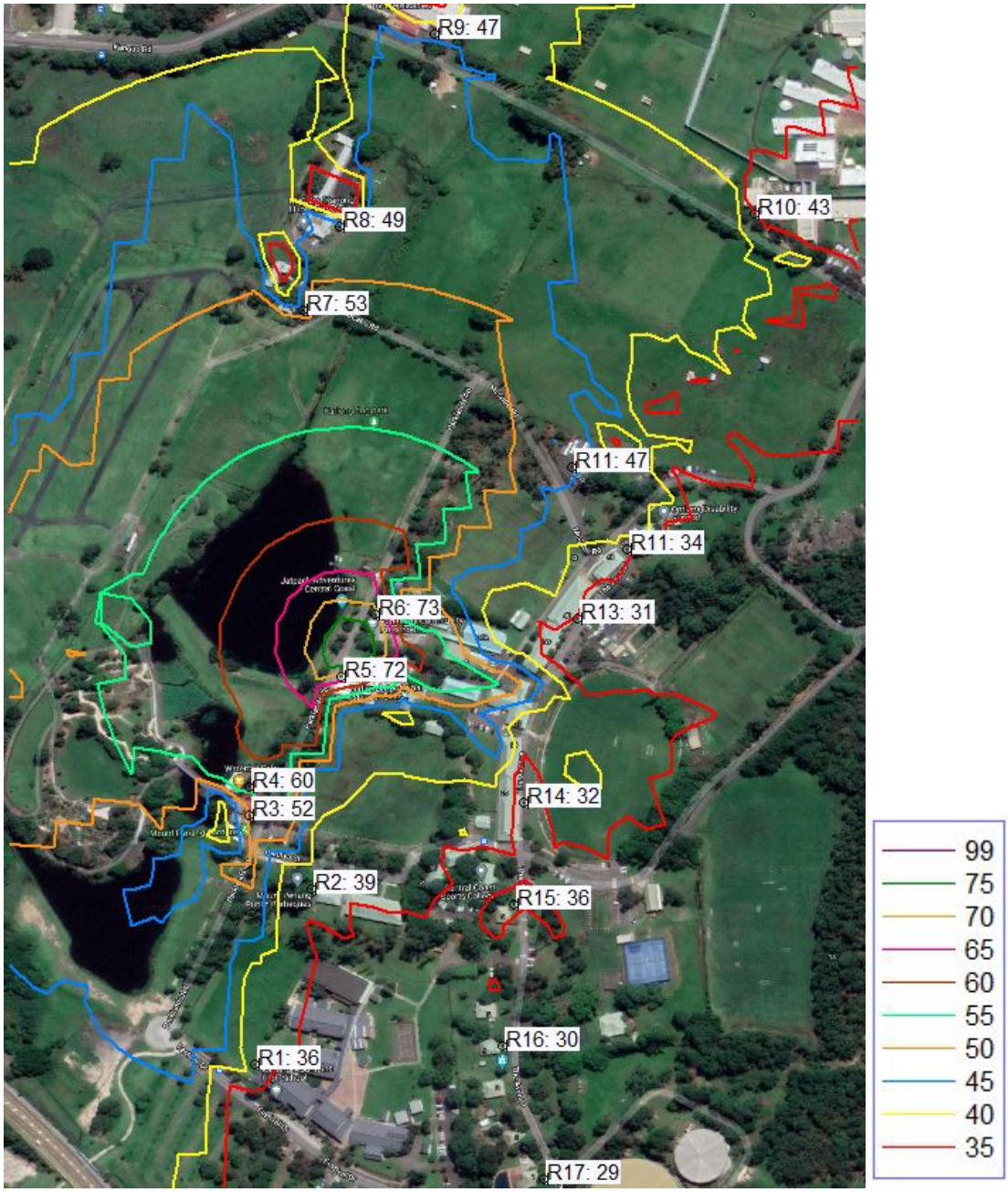

Figure 0-11 L3 Utilities

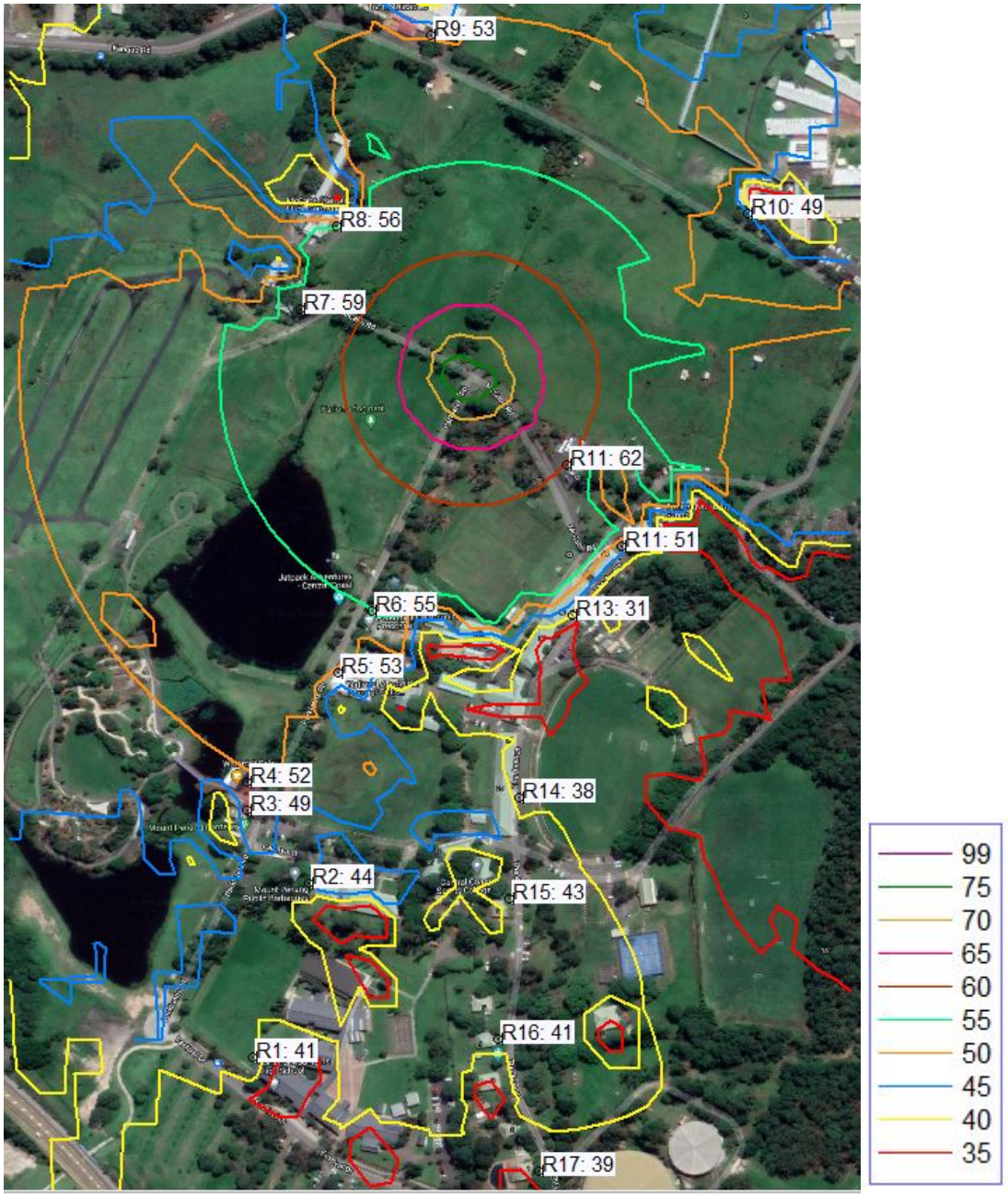

Figure 0-12 L4 Utilities

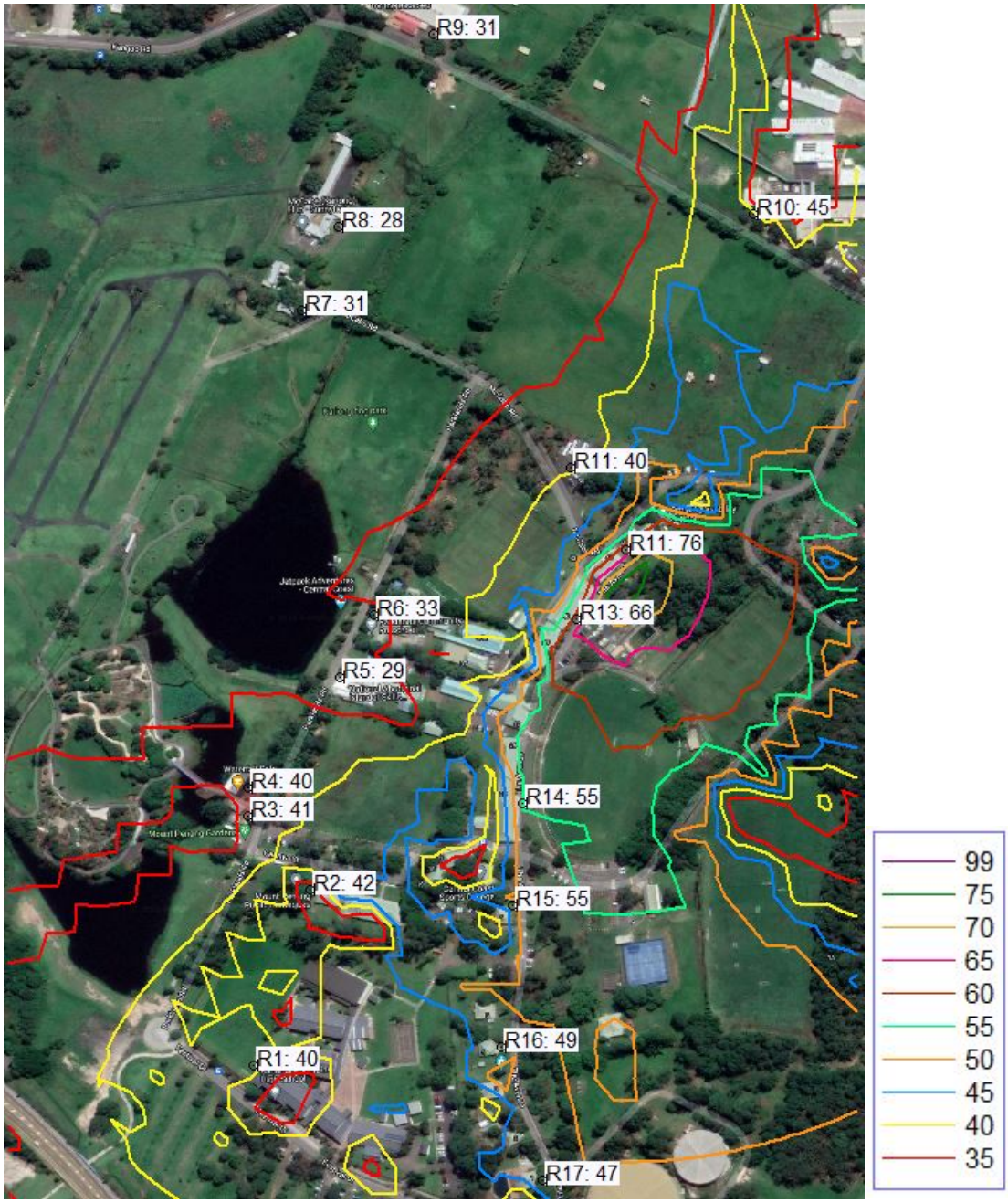

Figure 0-13 L5 Utilities

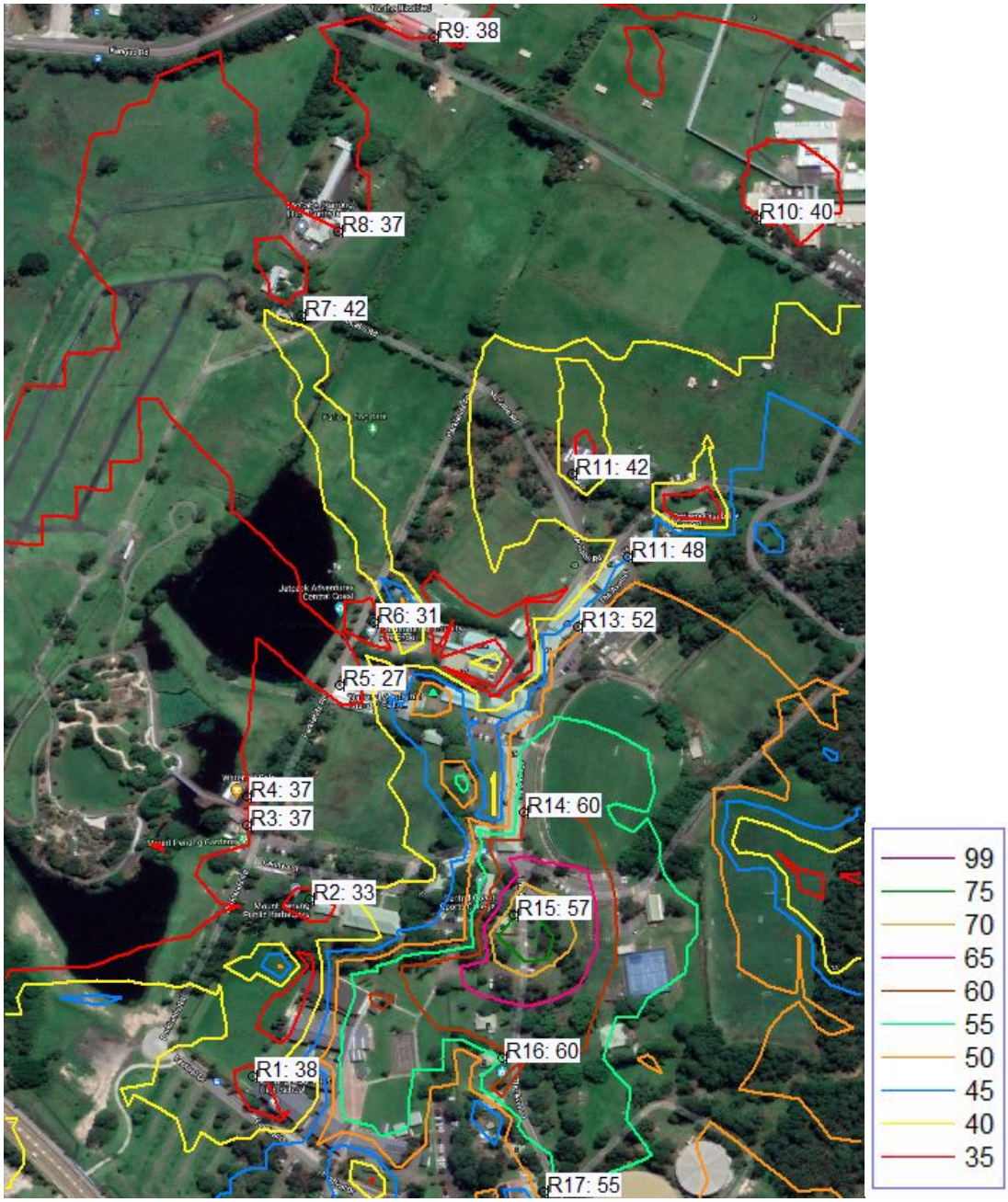

Figure 0-14 L6 Utilities

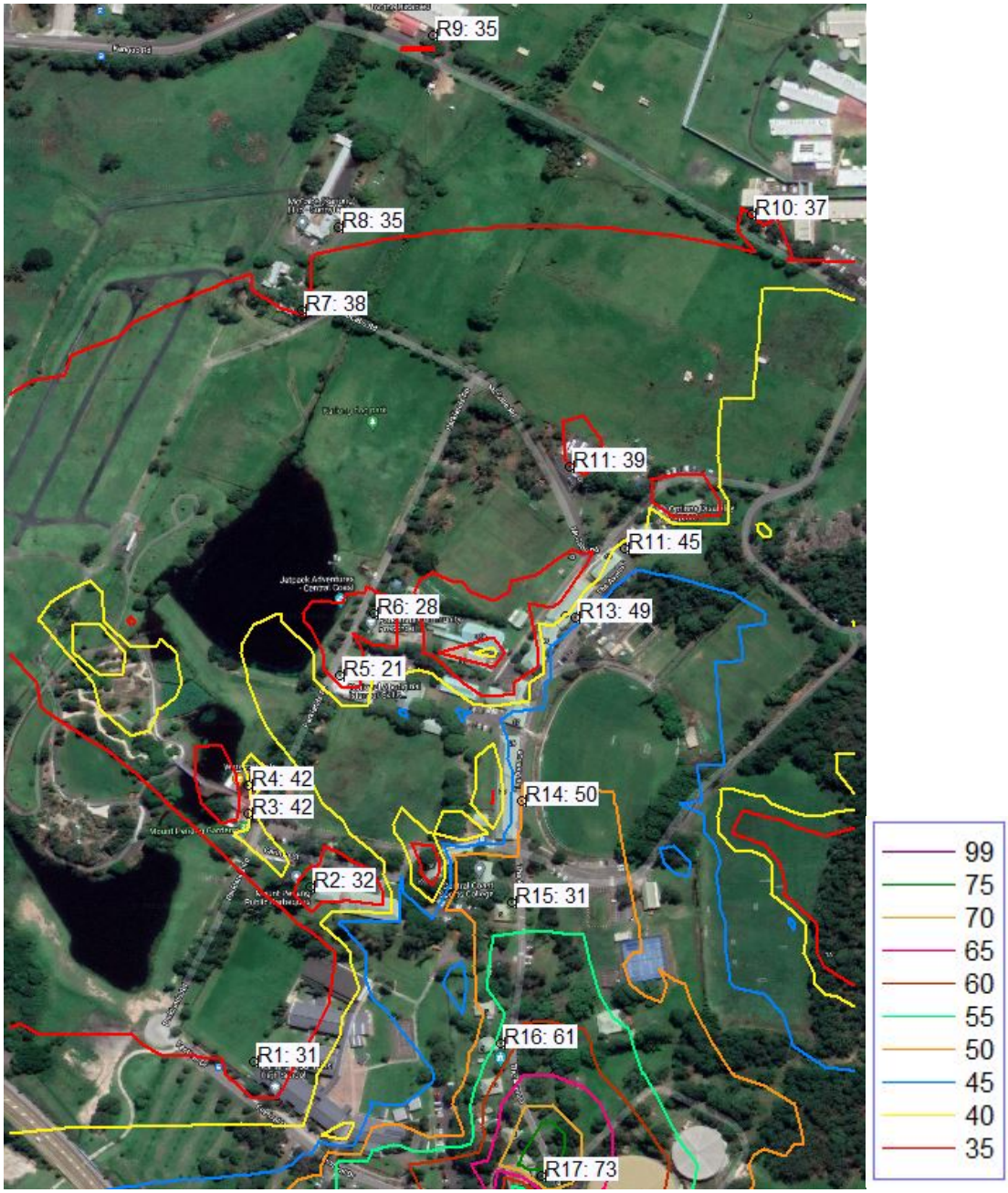

Figure 0-15 L7 Utilities

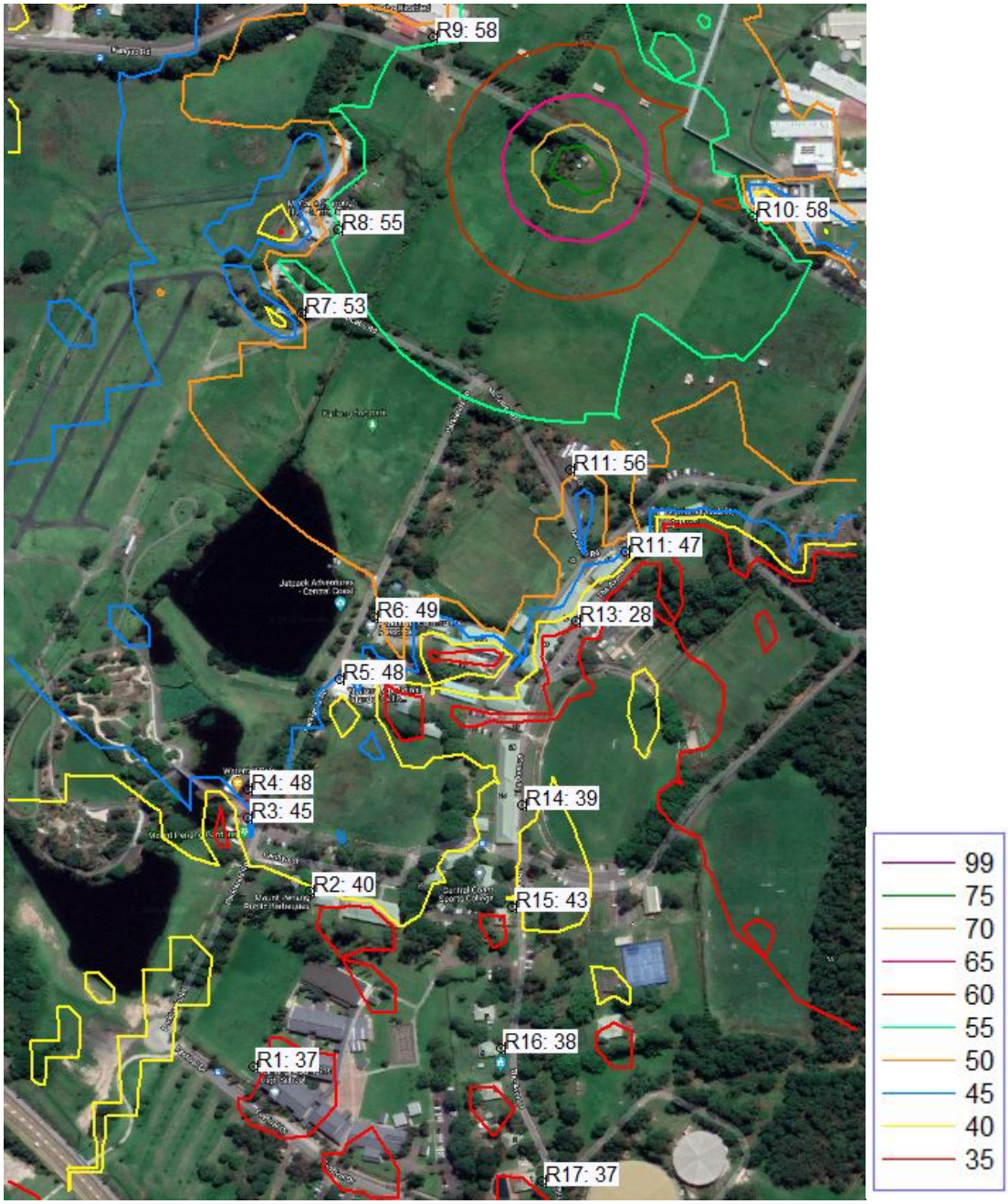

Figure 0-16 L8 Utilities

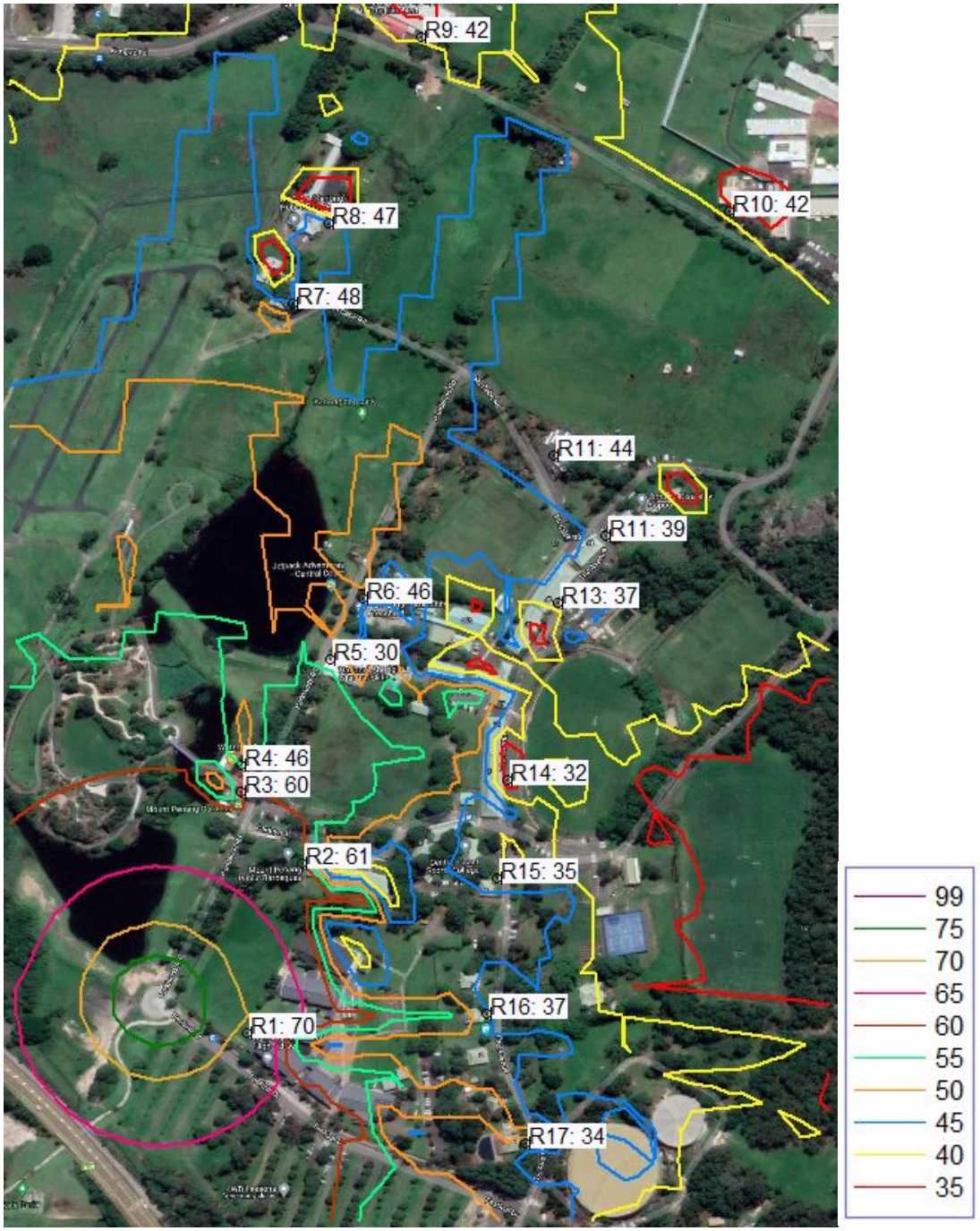

Figure 0-17 L1 Veg Removal

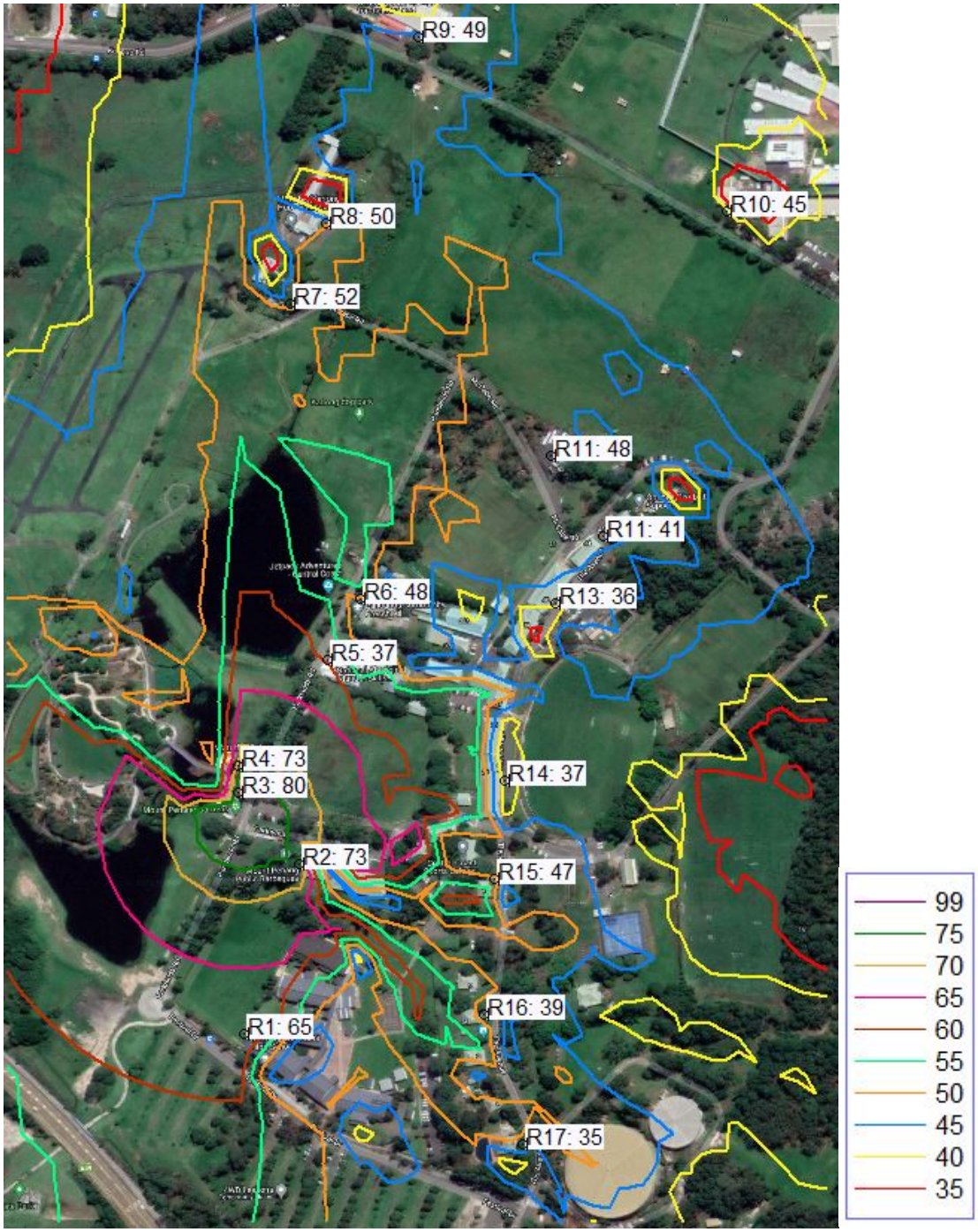

Figure 0-18 L2 Veg Removal

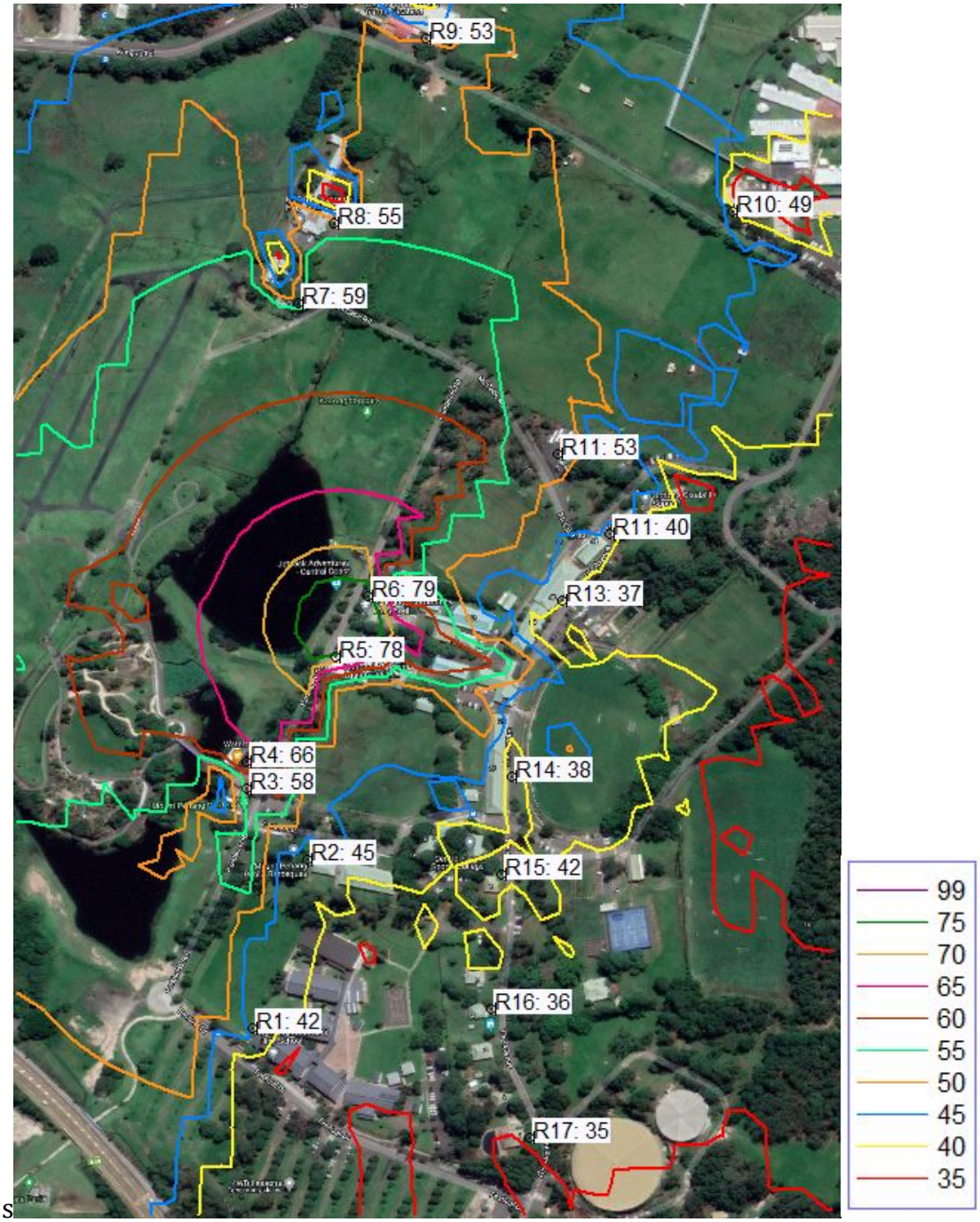

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Figure 0-19 L3 Veg Removal

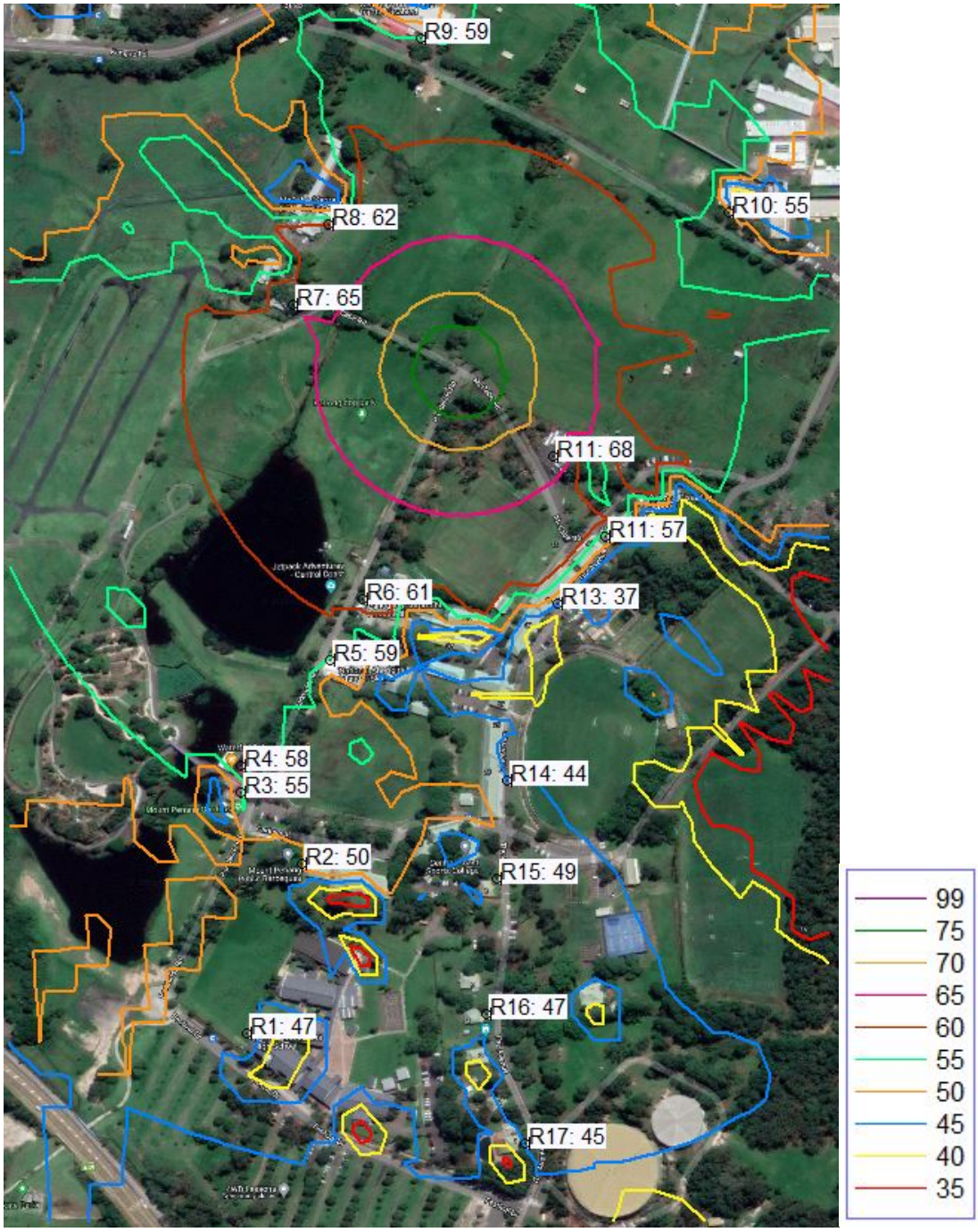

Figure 0-20 L4 Veg Removal

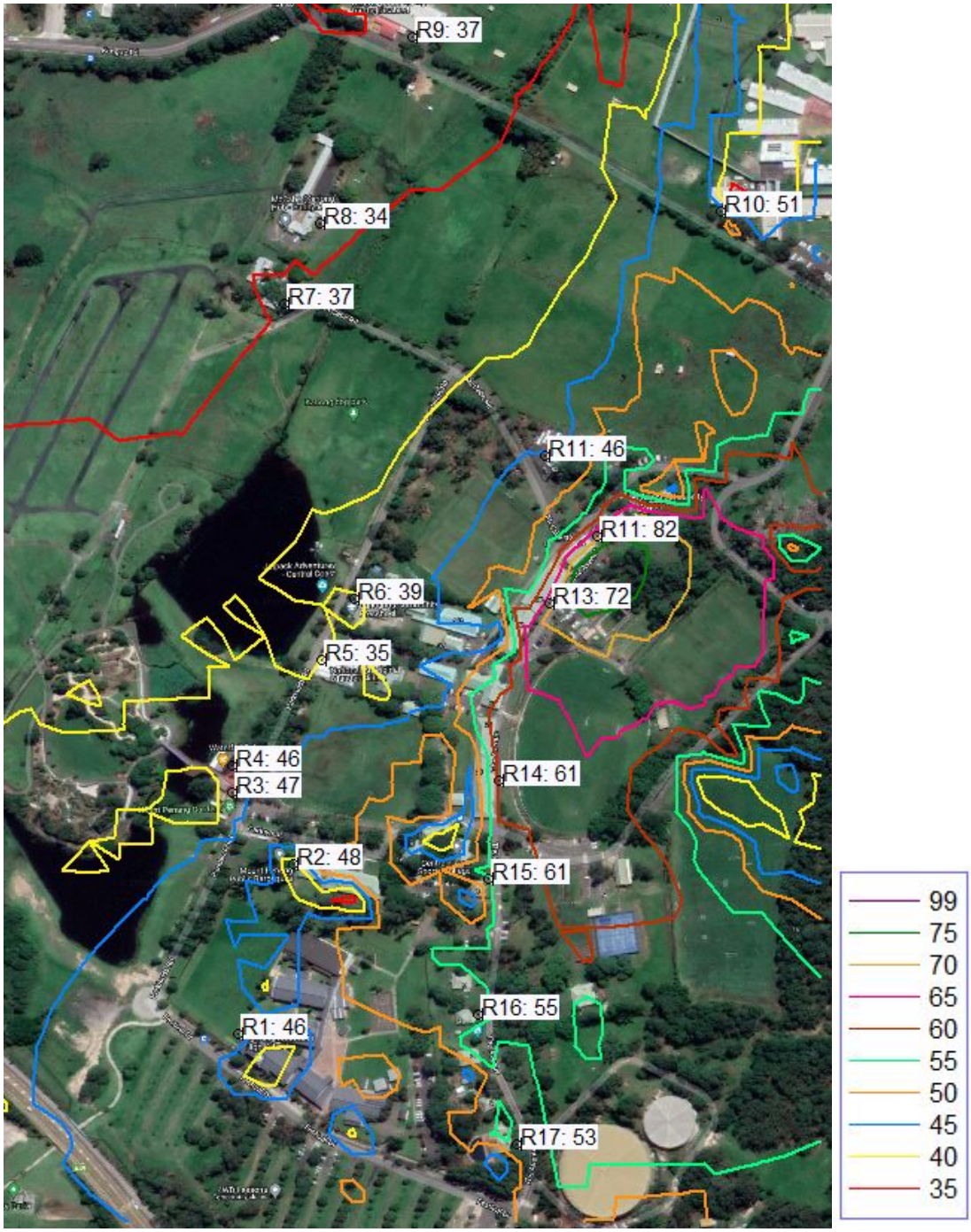

Figure 0-21 L5 Veg Removal

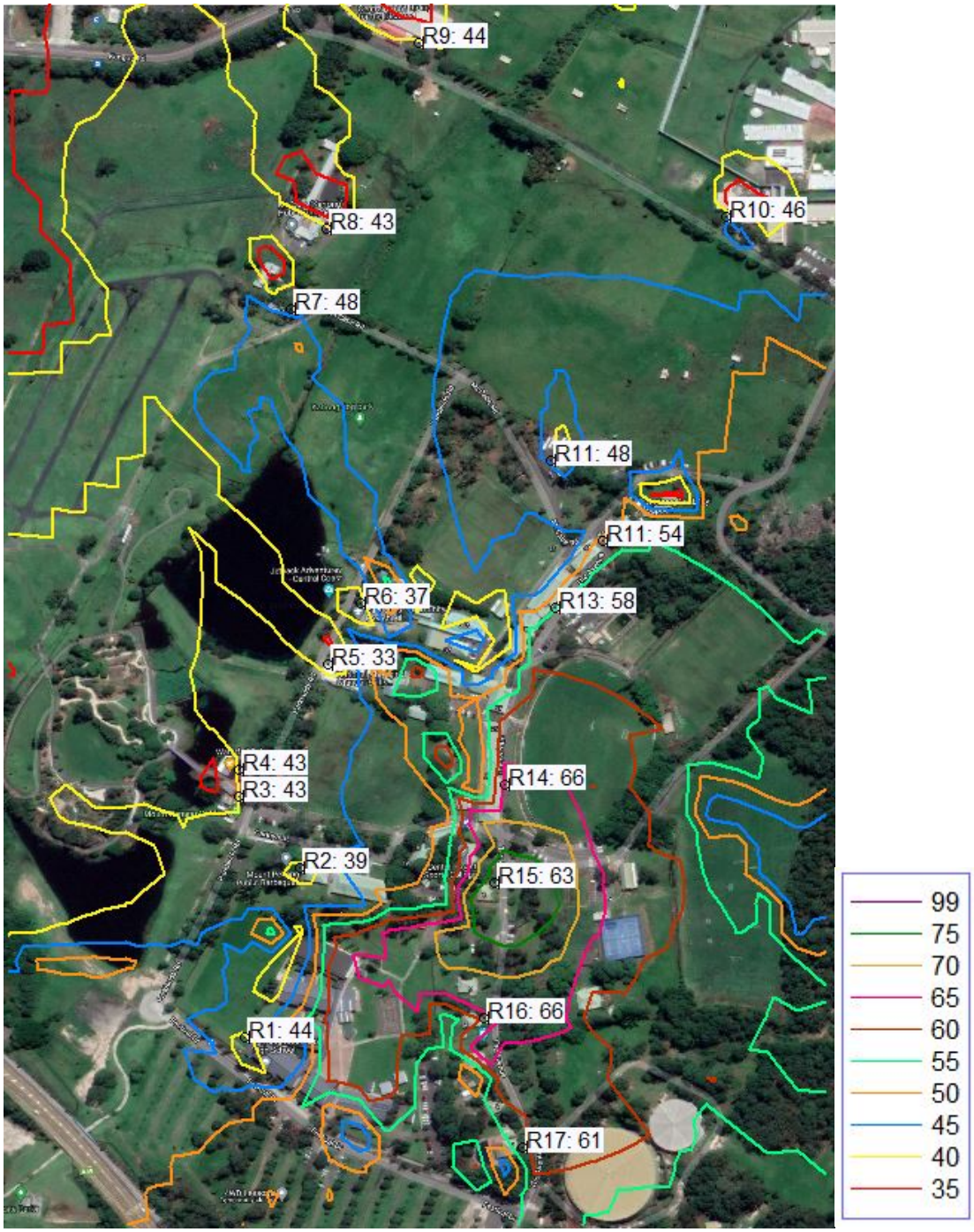

Figure 0-22 L6 Veg Removal

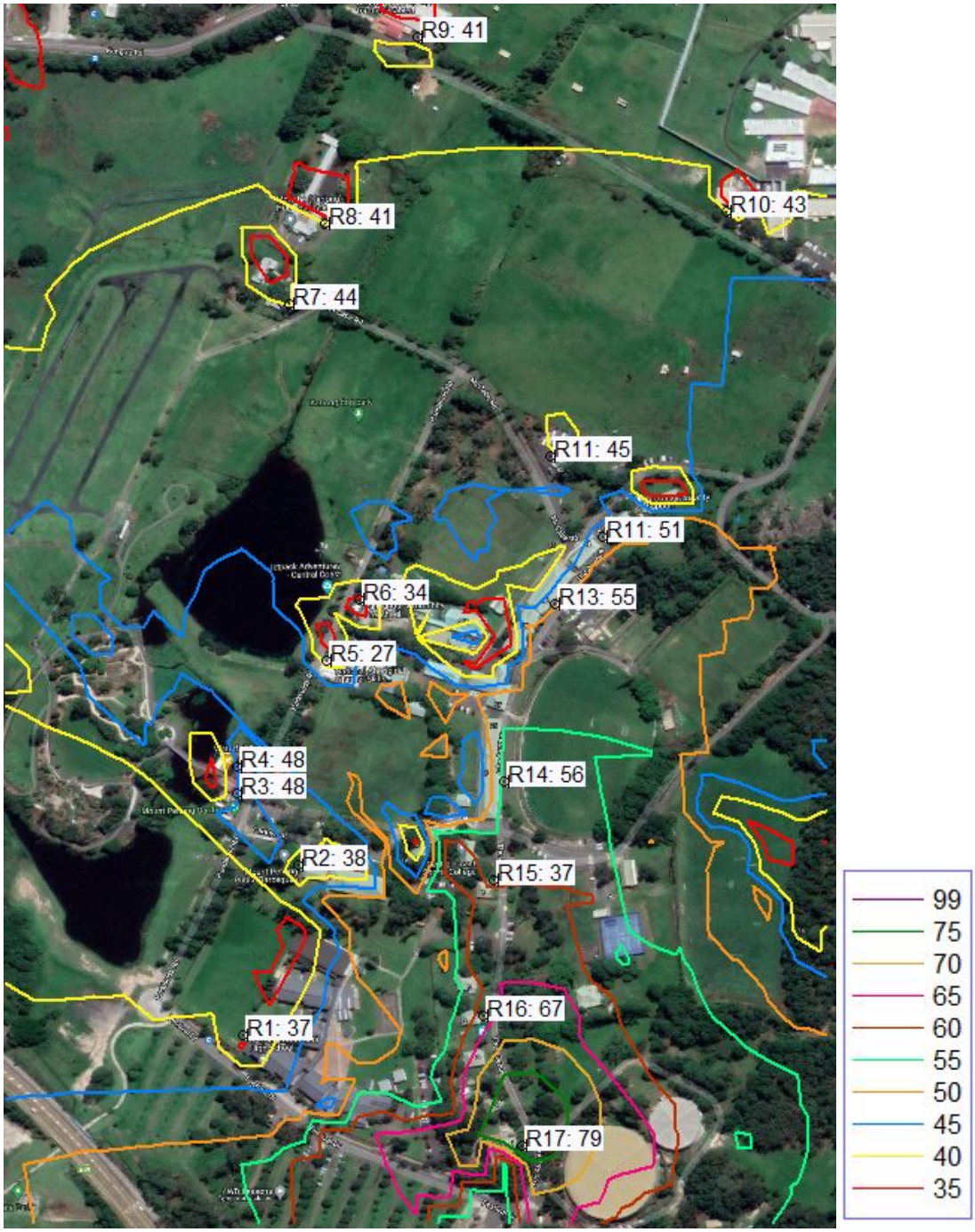

Figure 0-23 L7 Veg Removal

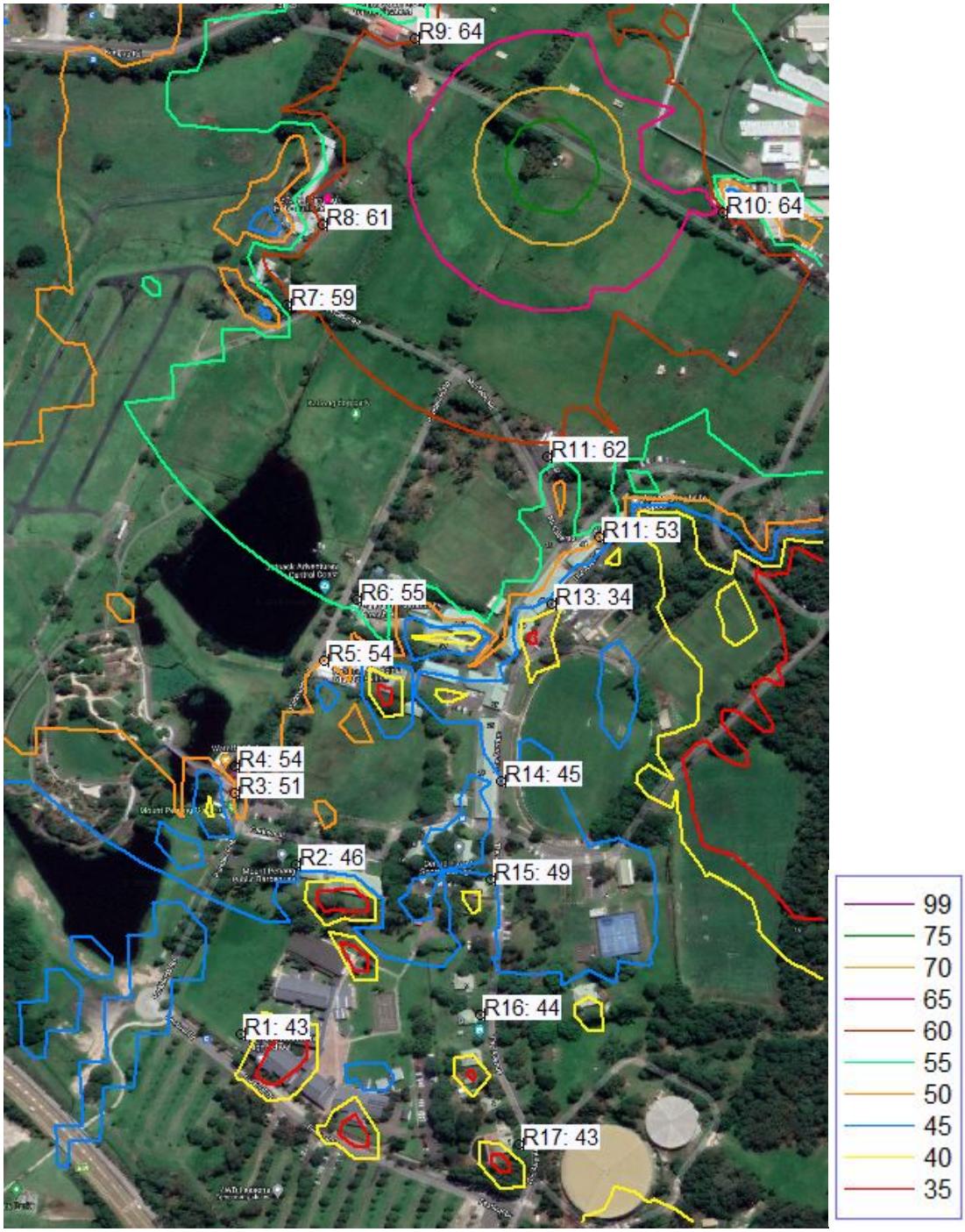

Figure 0-24 L8 Veg Removal

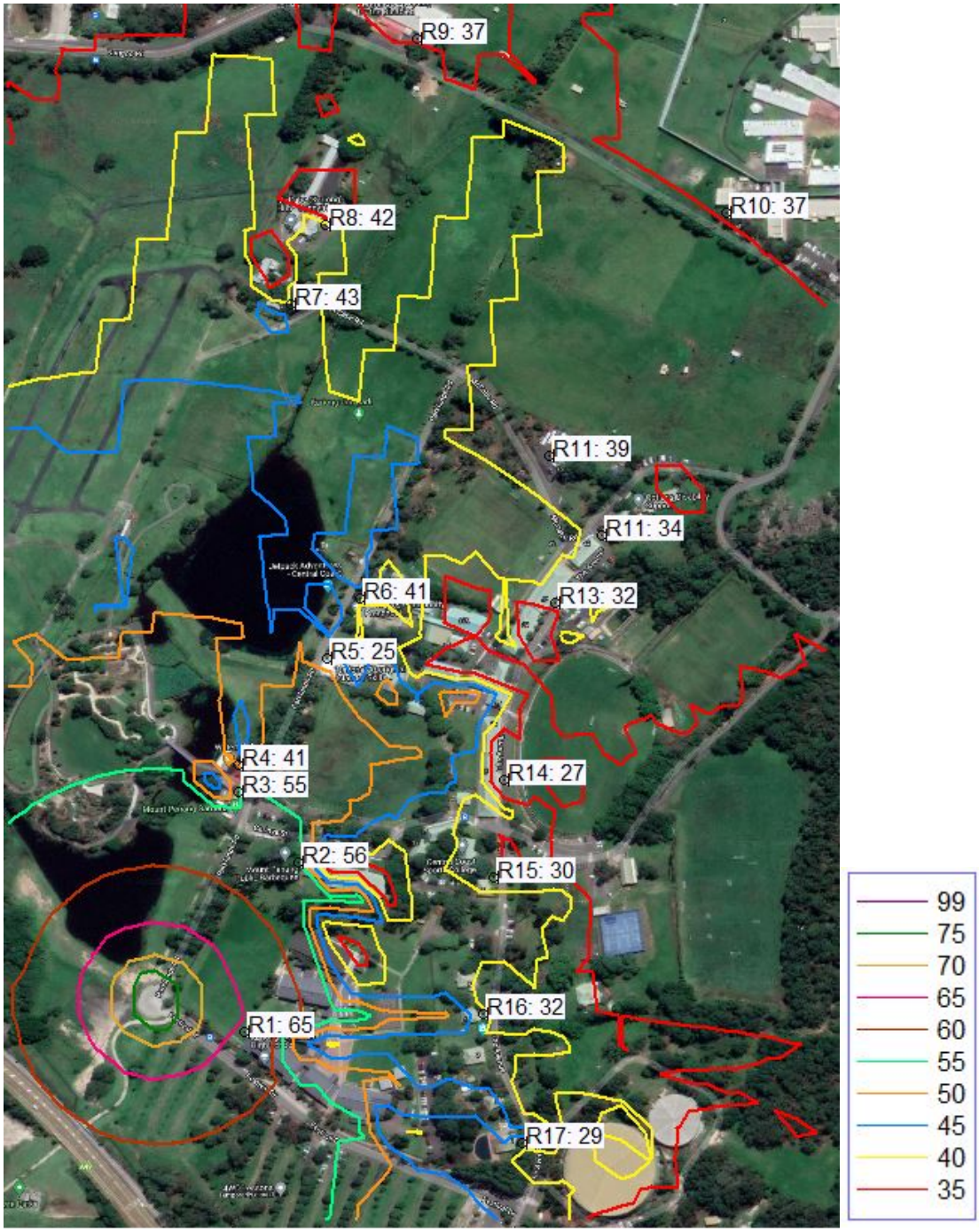

Figure 0-25 L1 Drainage / Paving

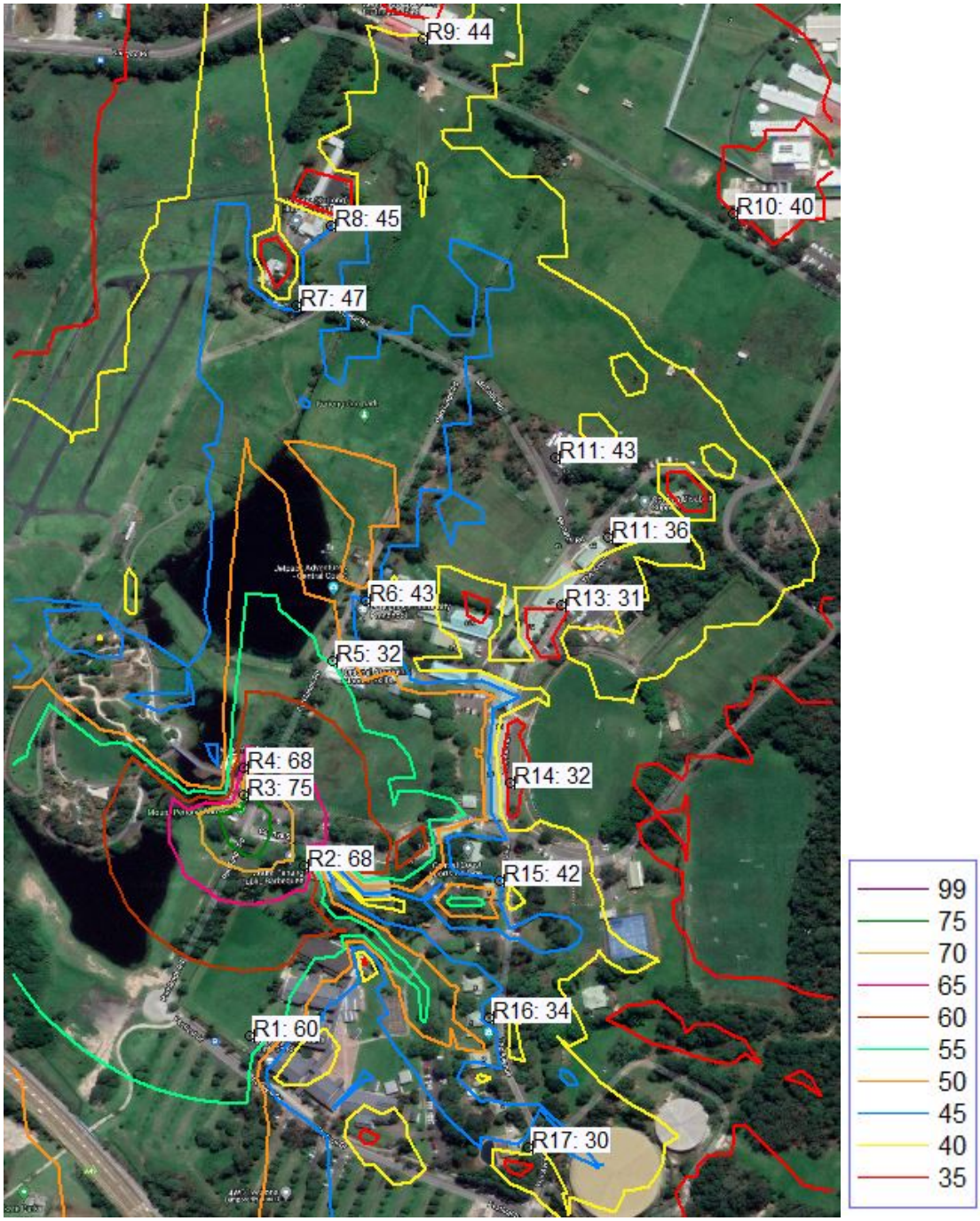

Figure 0-26 L2 Drainage / Paving

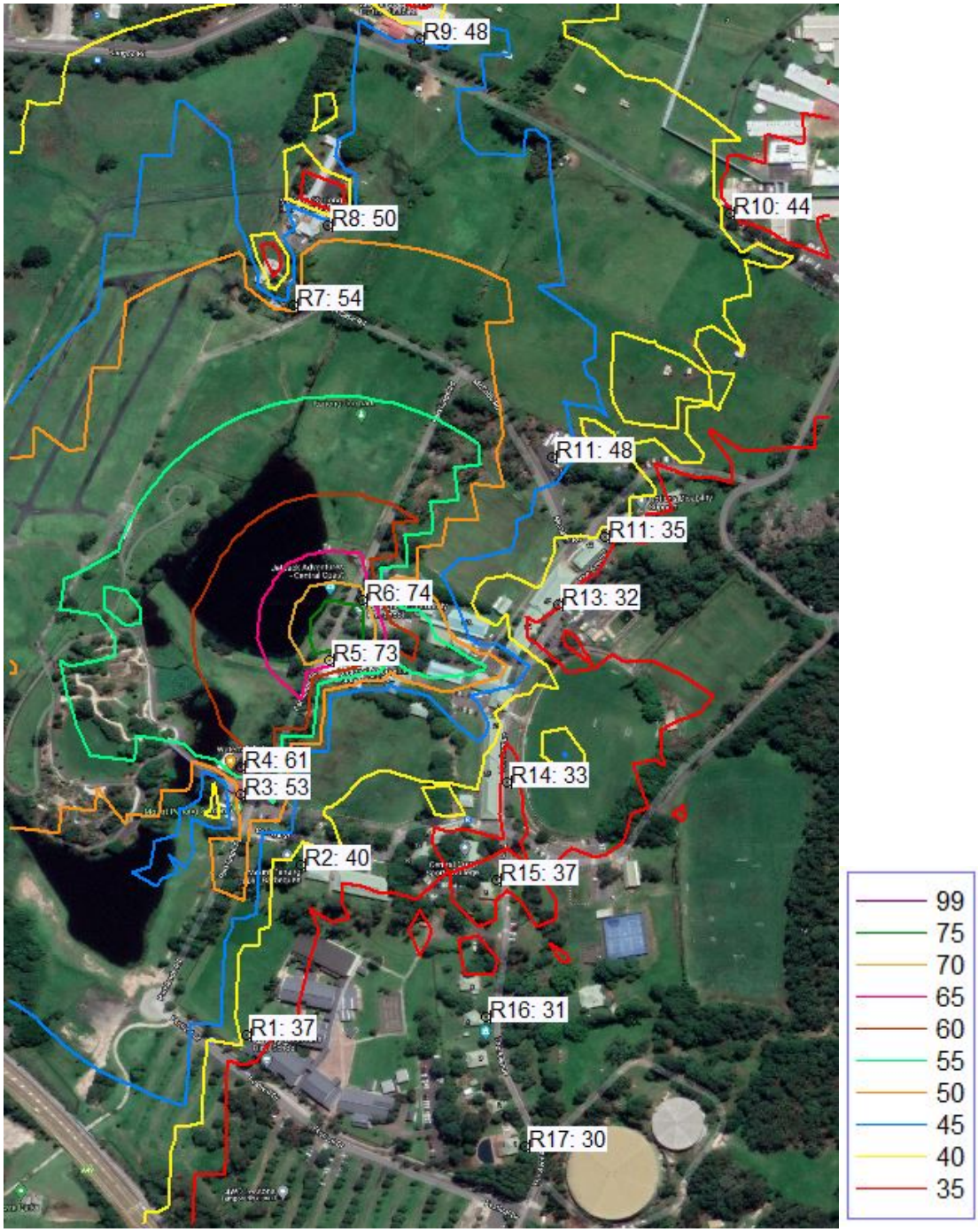

Figure 0-27 L3 Drainage / Paving

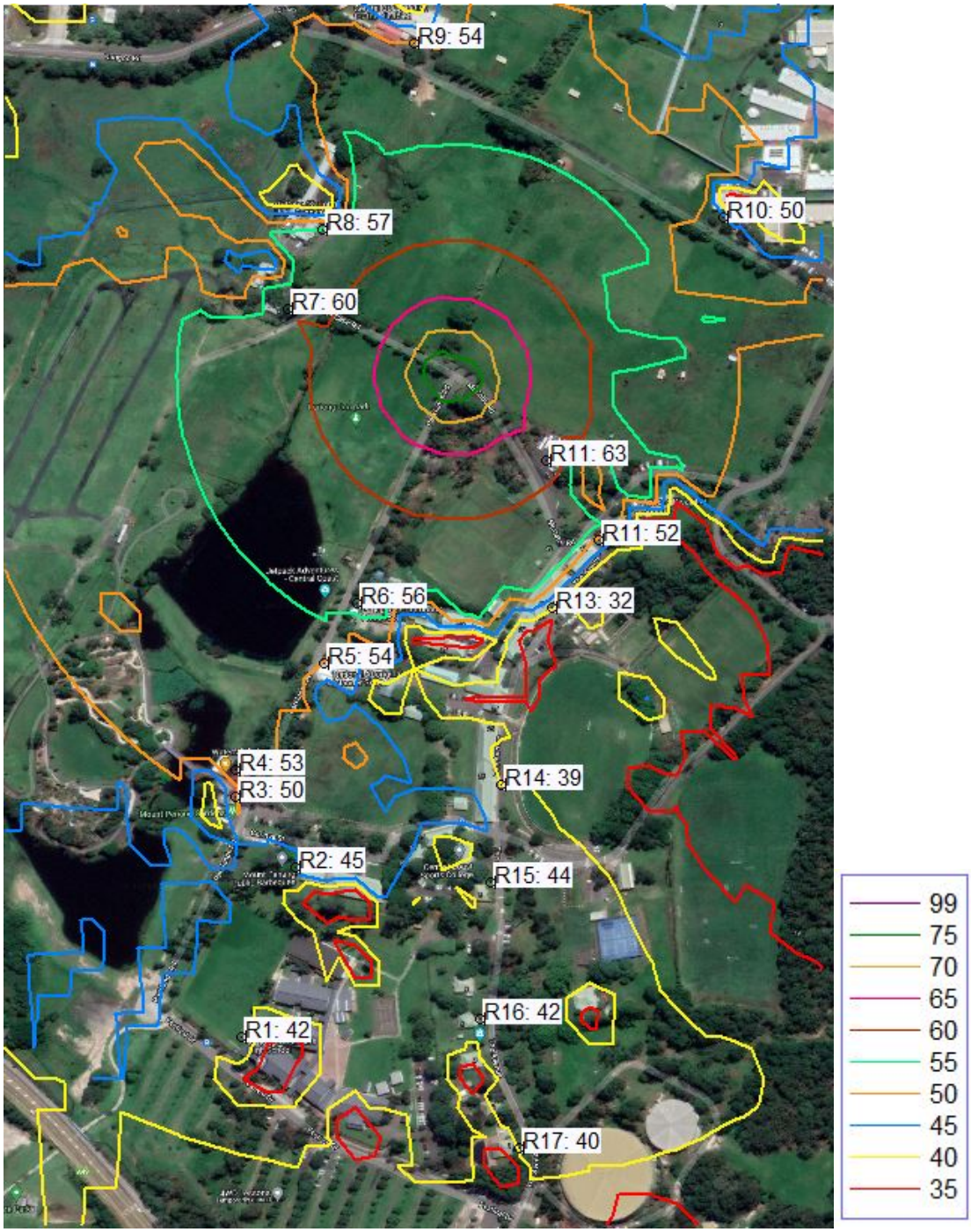

Figure 0-28 L4 Drainage / Paving

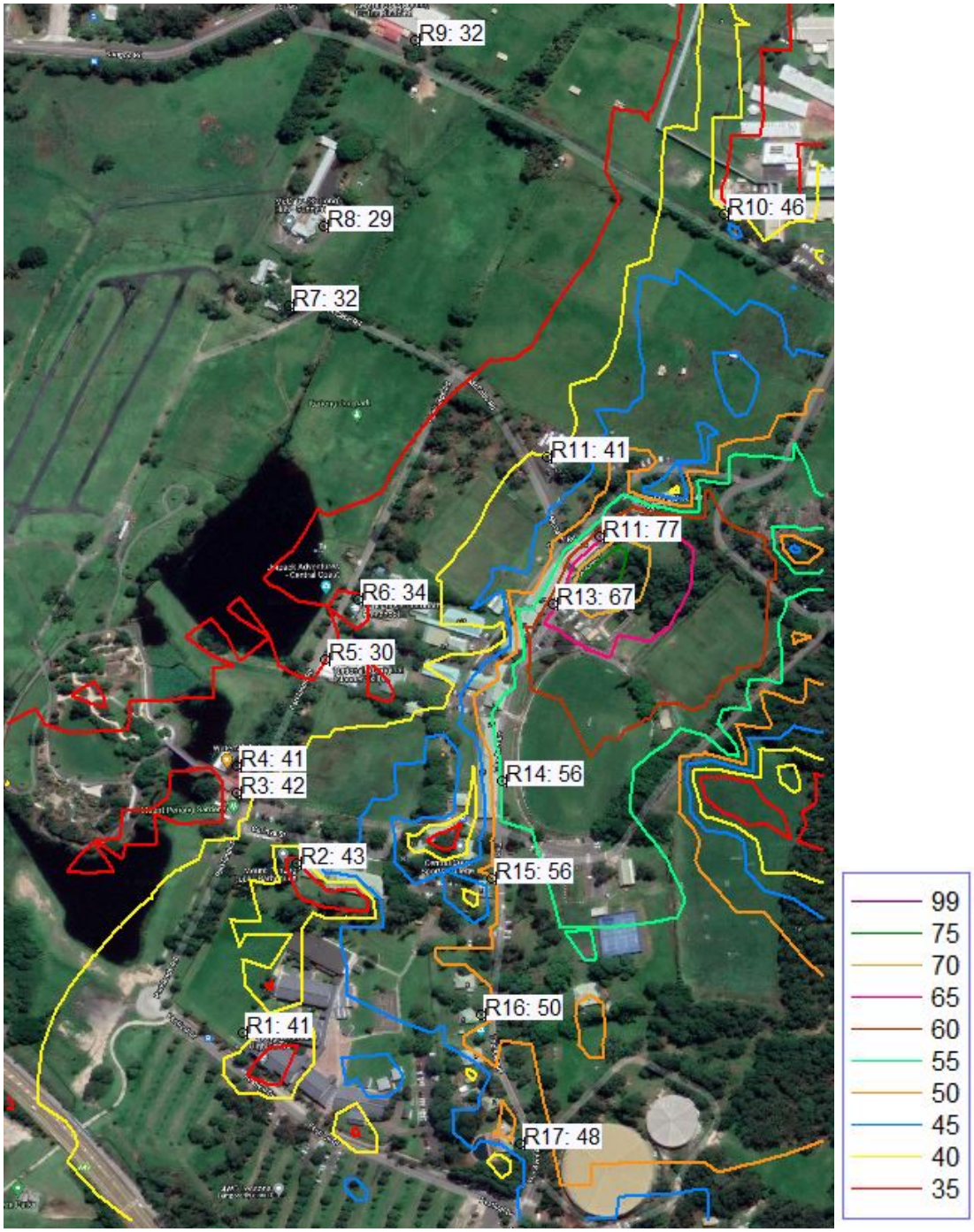

Figure 0-29 L5 Drainage / Paving

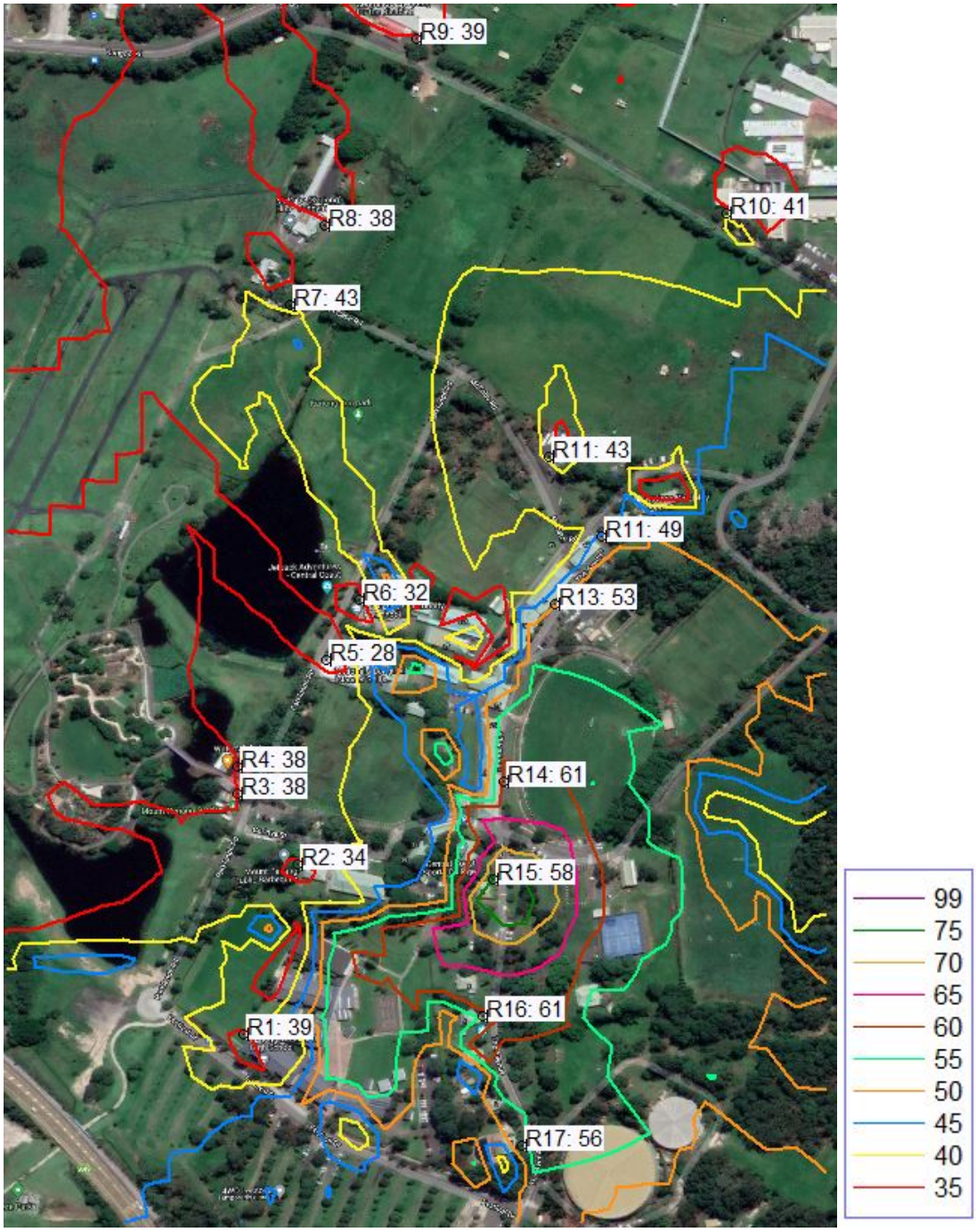

Figure 0-30 L6 Drainage / Paving

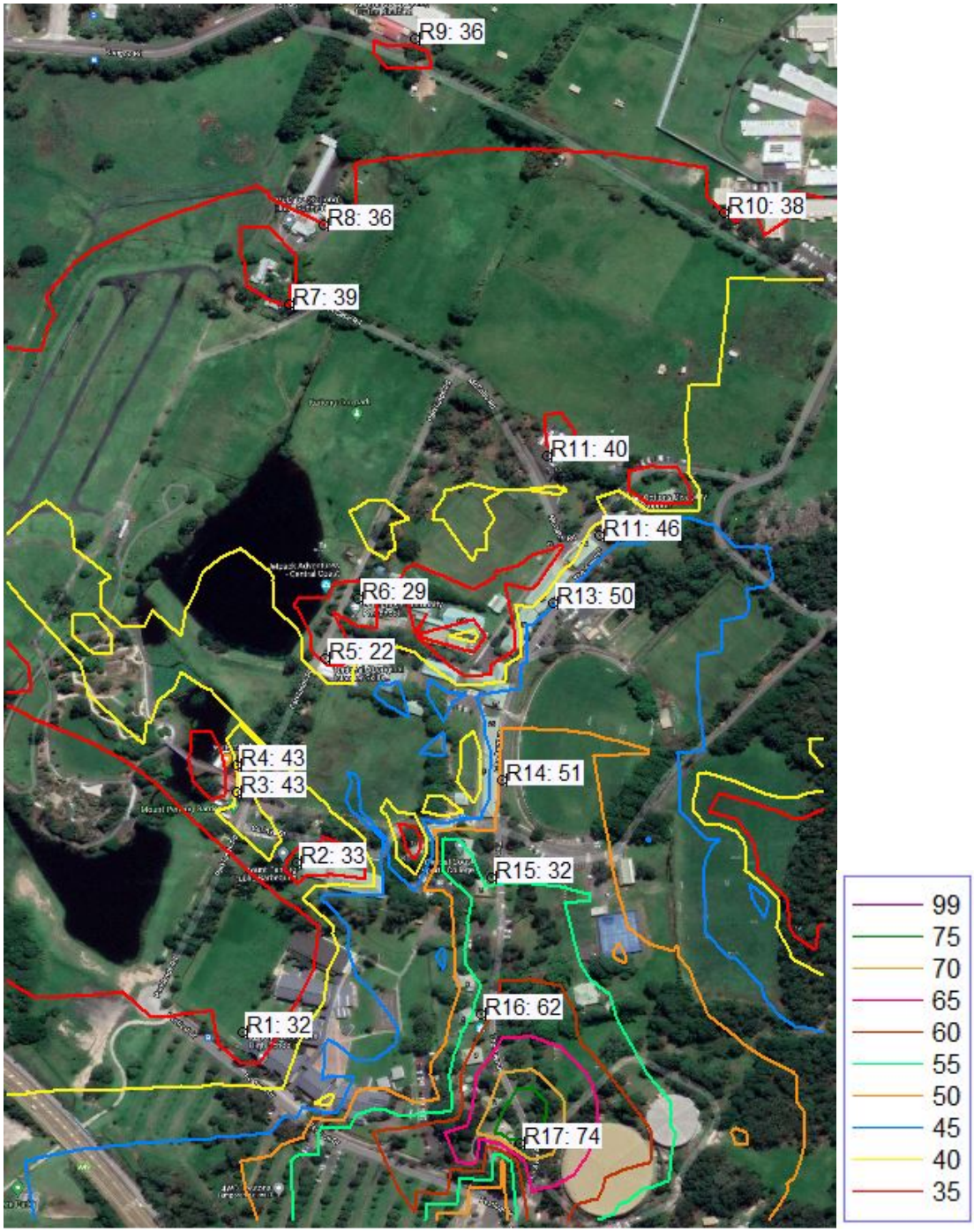

Figure 0-31 L7 Drainage / Paving

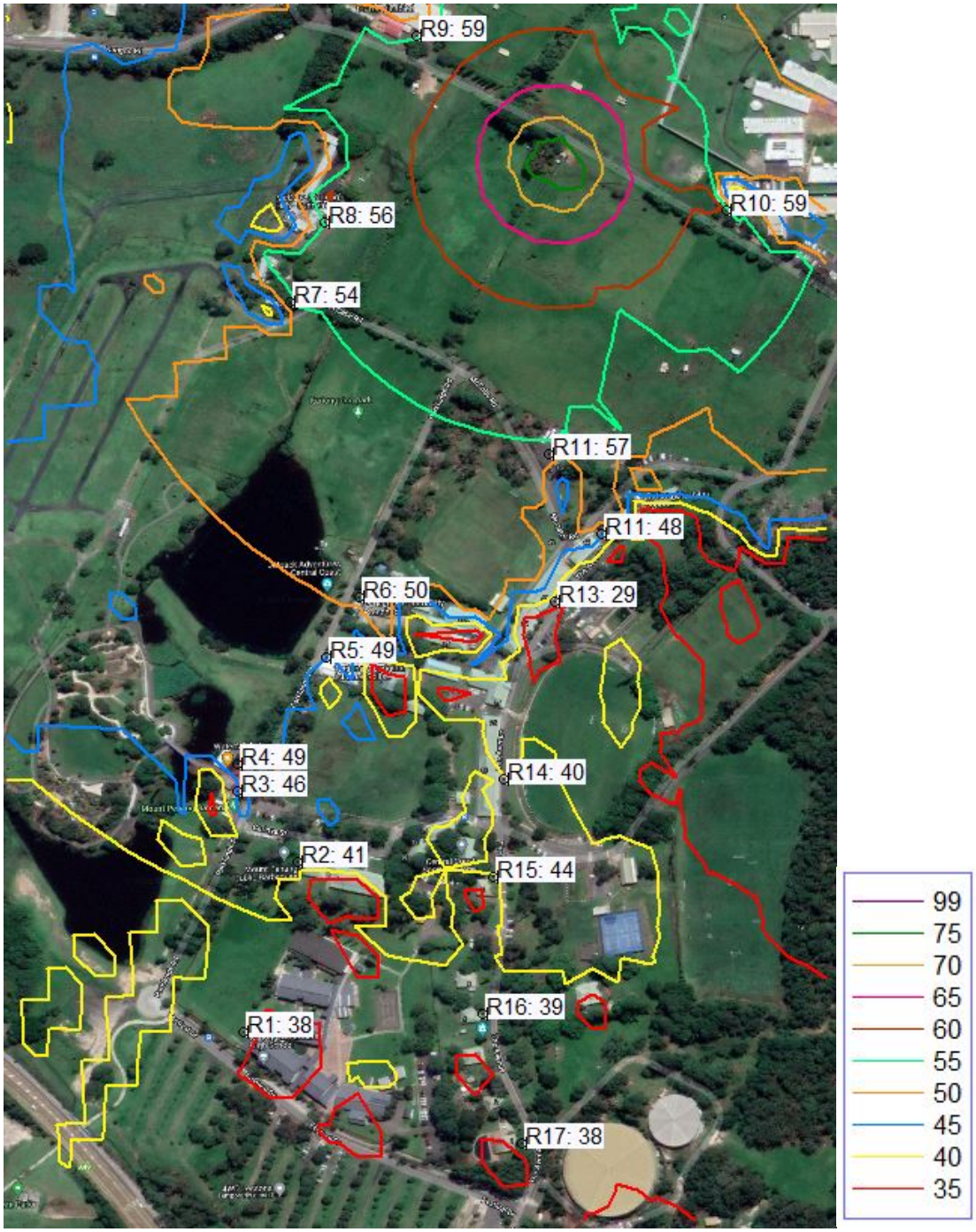

Figure 0-32 L8 Drainage / Paving

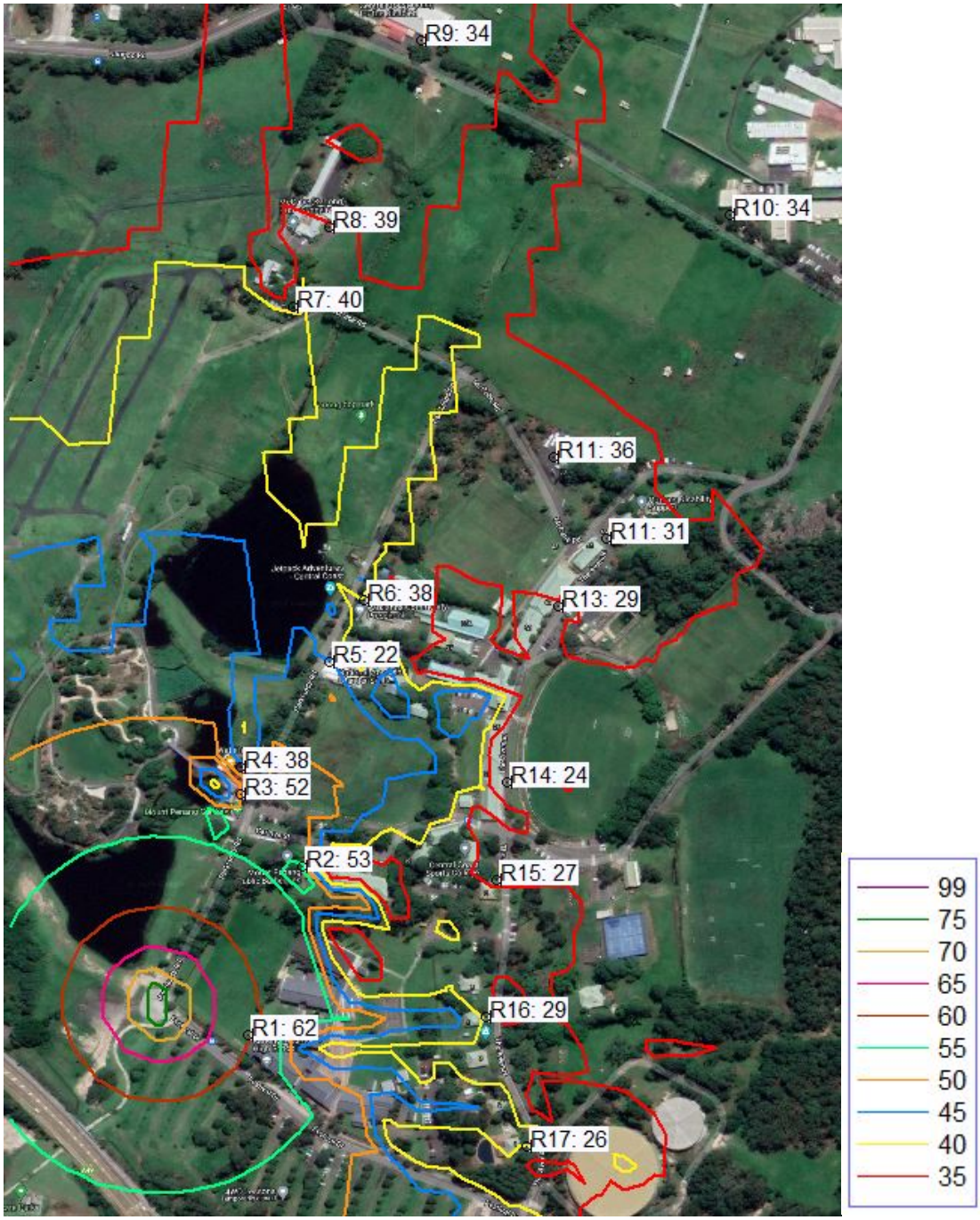

Figure 0-33 L1 Finishing

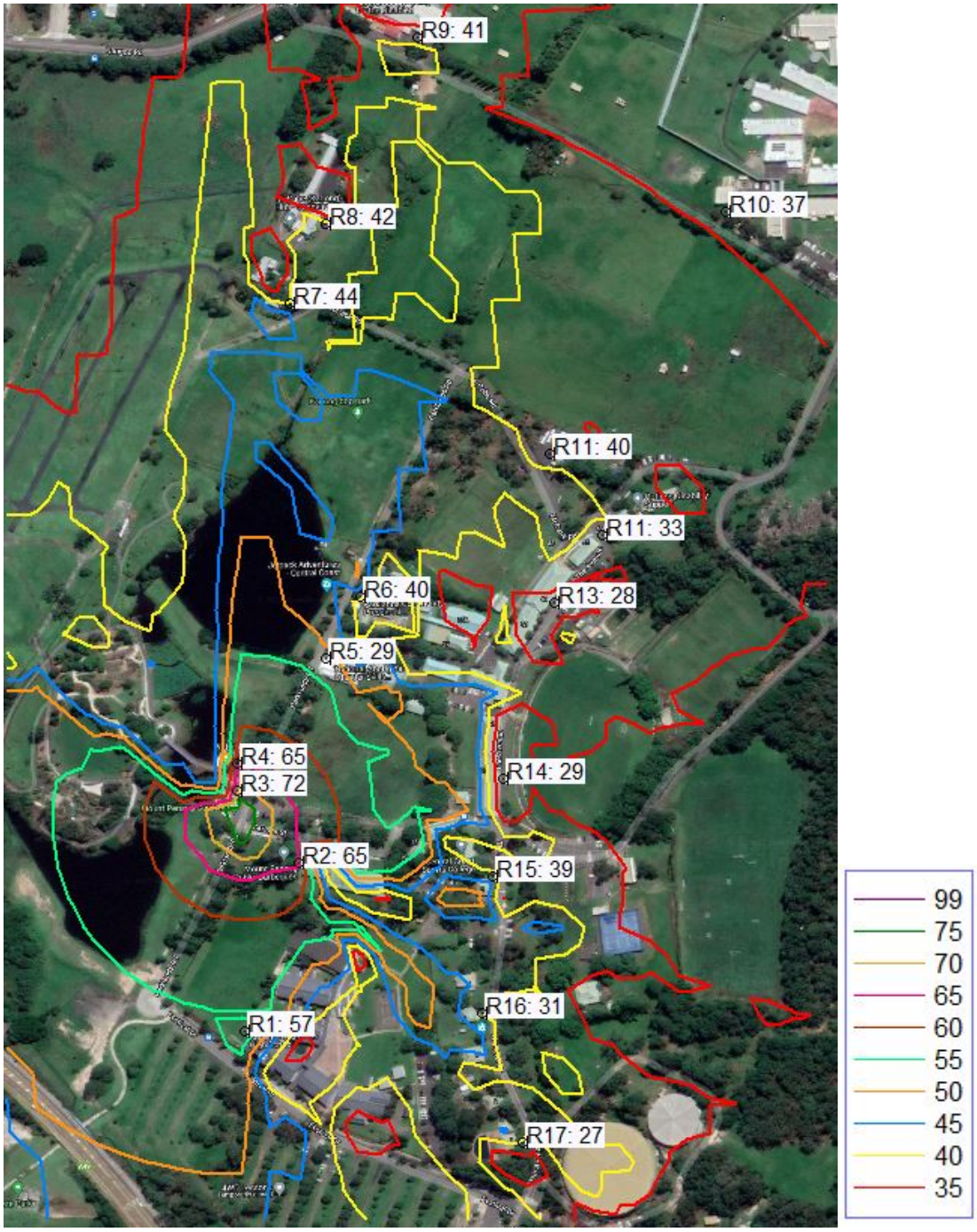

Figure 0-34 L2 Finishing

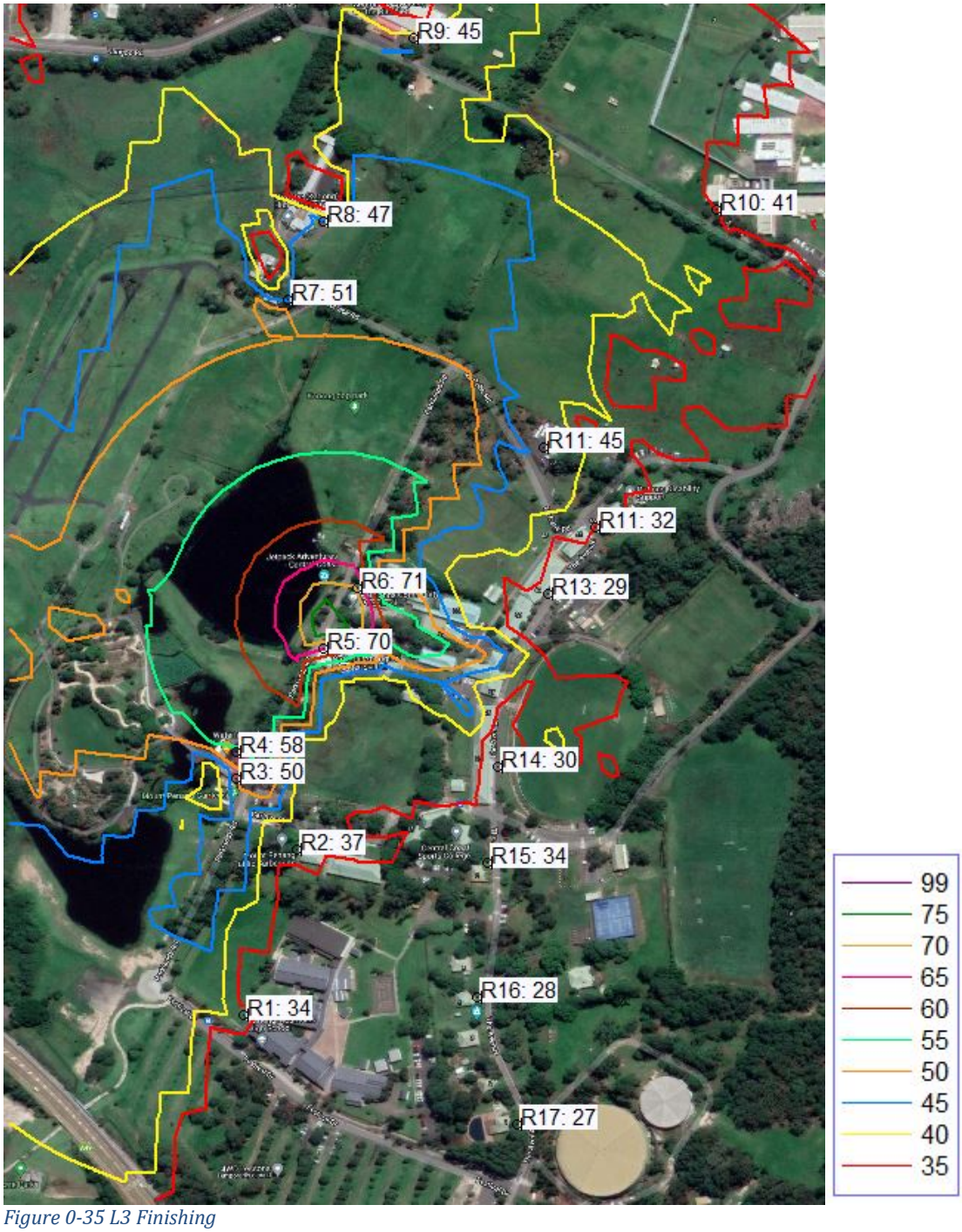

Figure 0-35 L3 Finishing

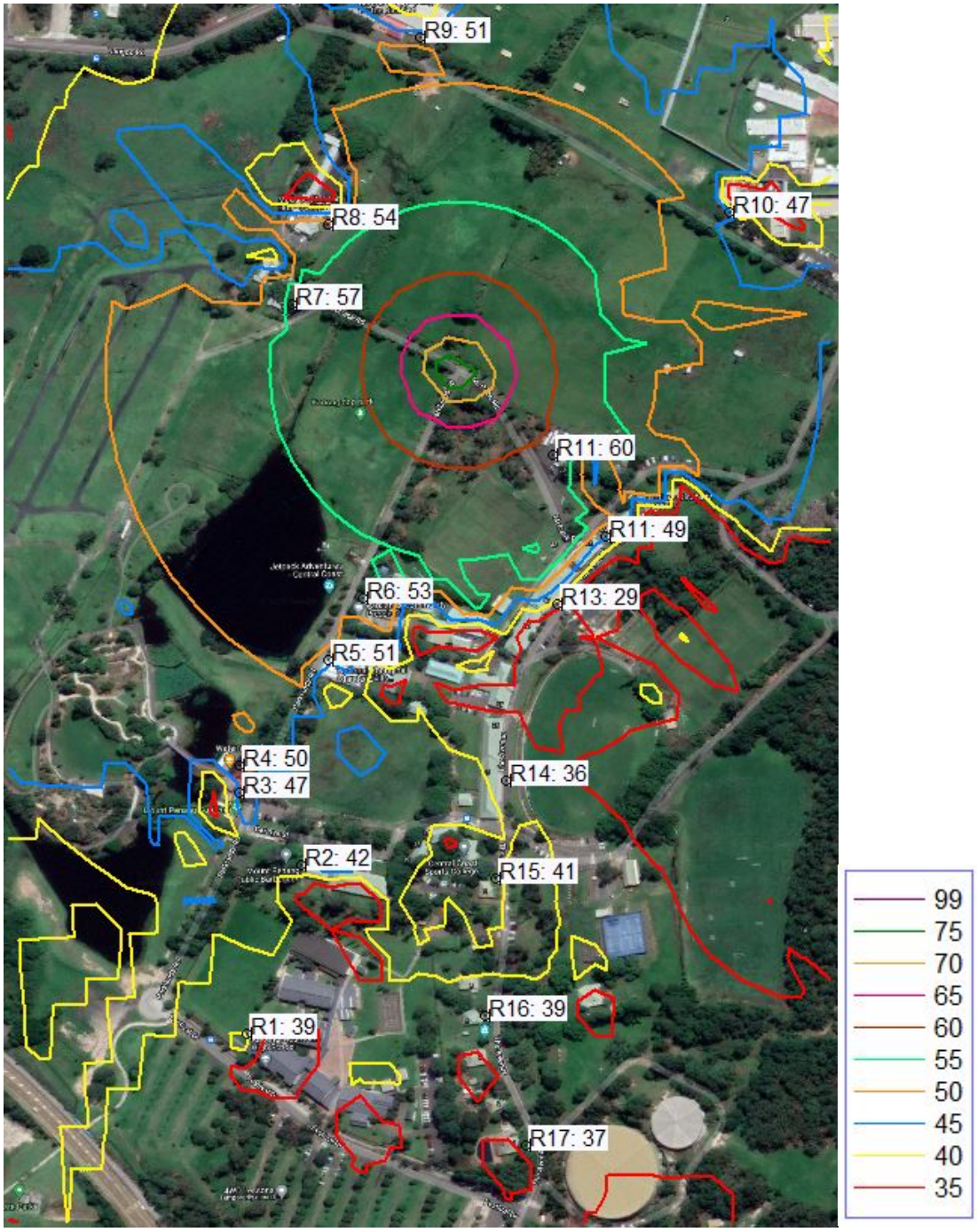

Figure 0-36 L4 Finishing

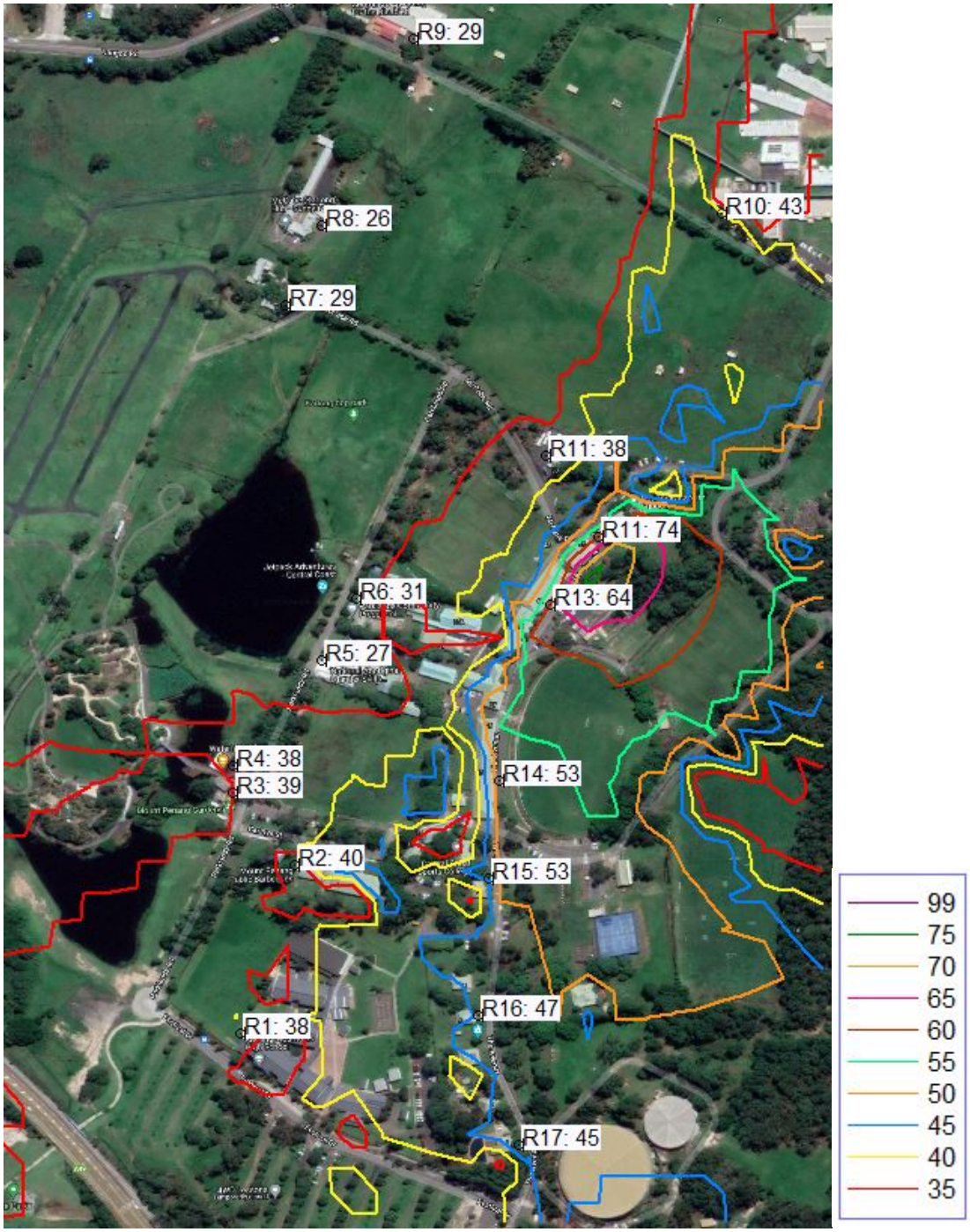

Figure 0-37 L5 Finishing

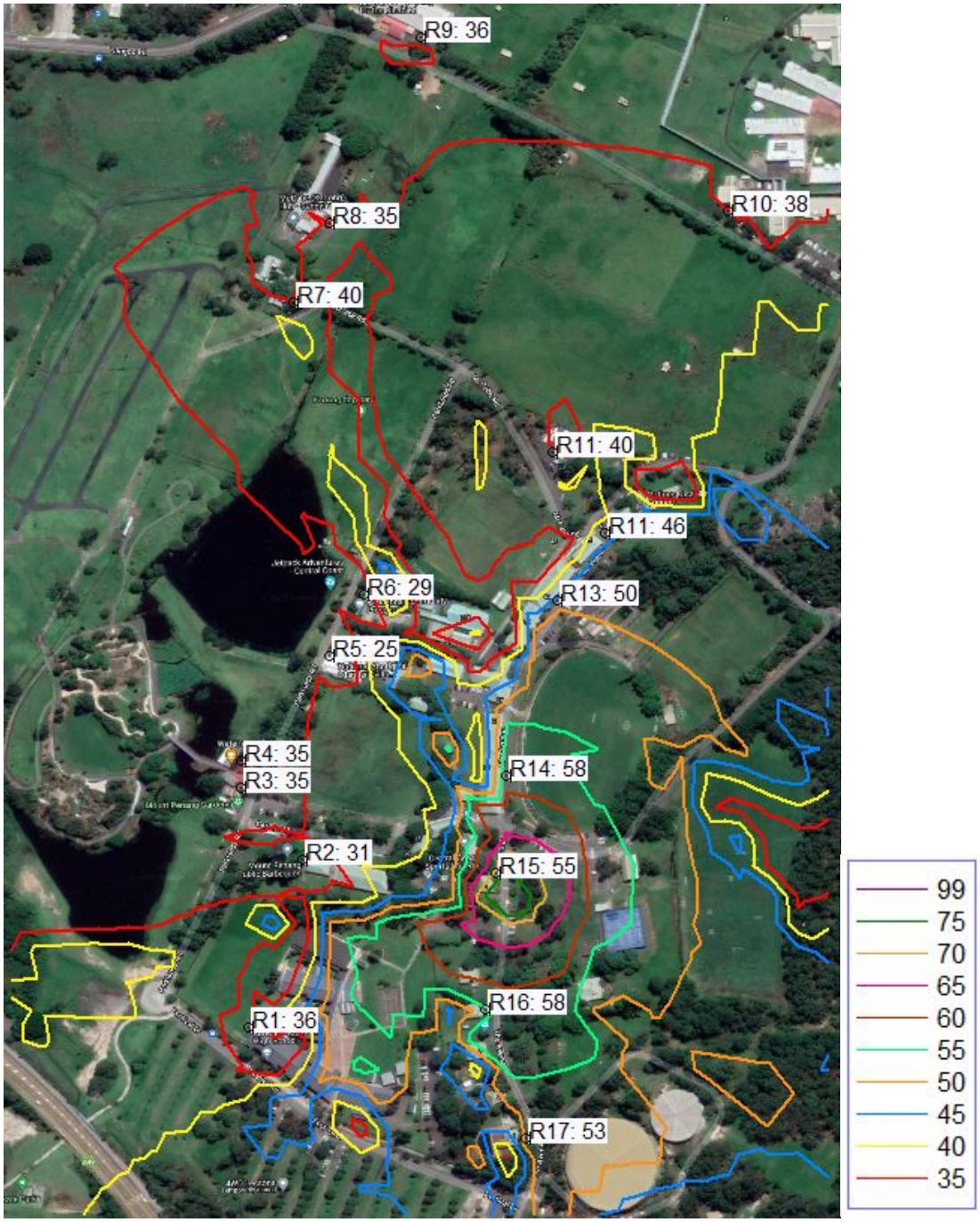

Figure 0-38 L6 Finishing

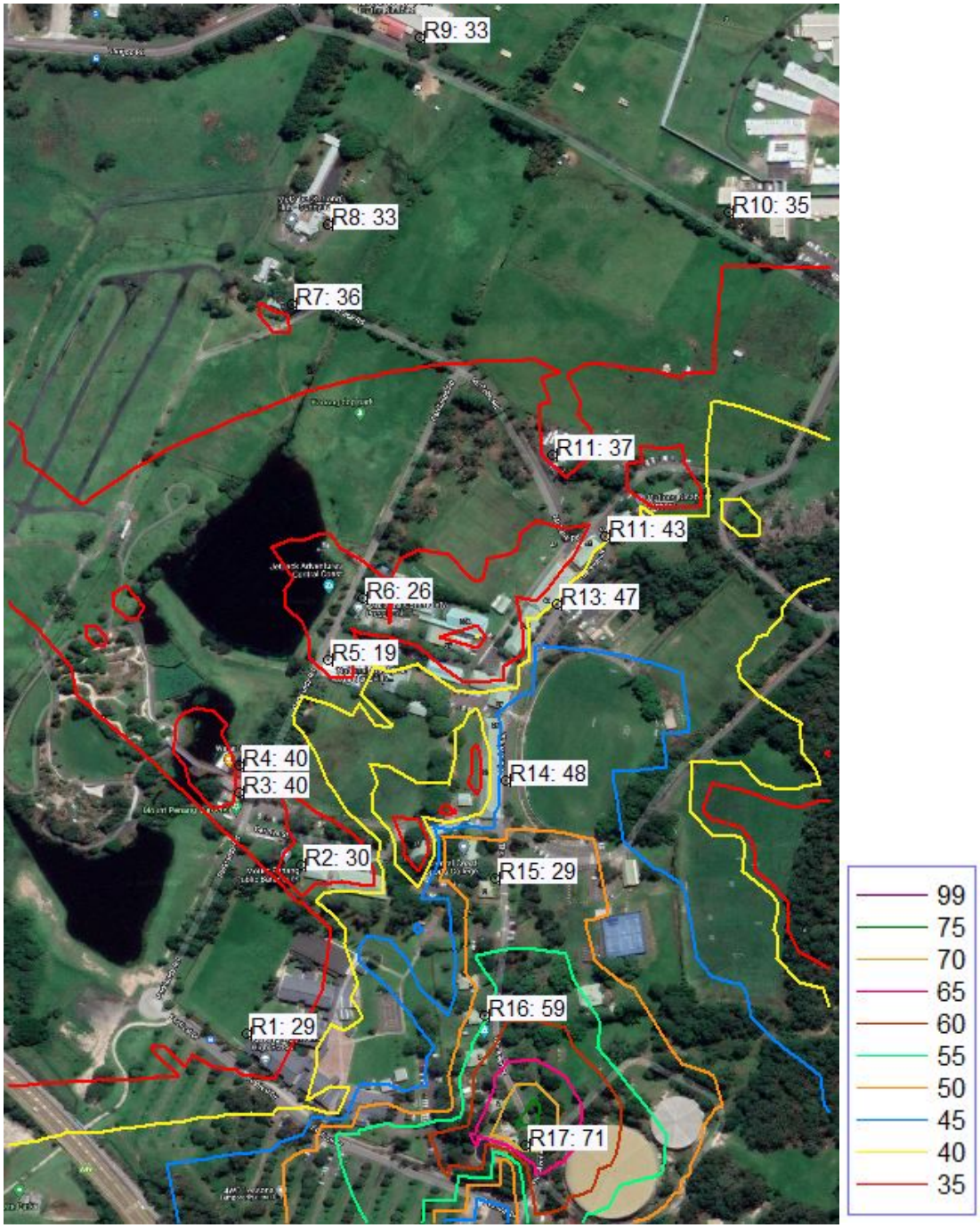

Figure 0-39 L7 Finishing

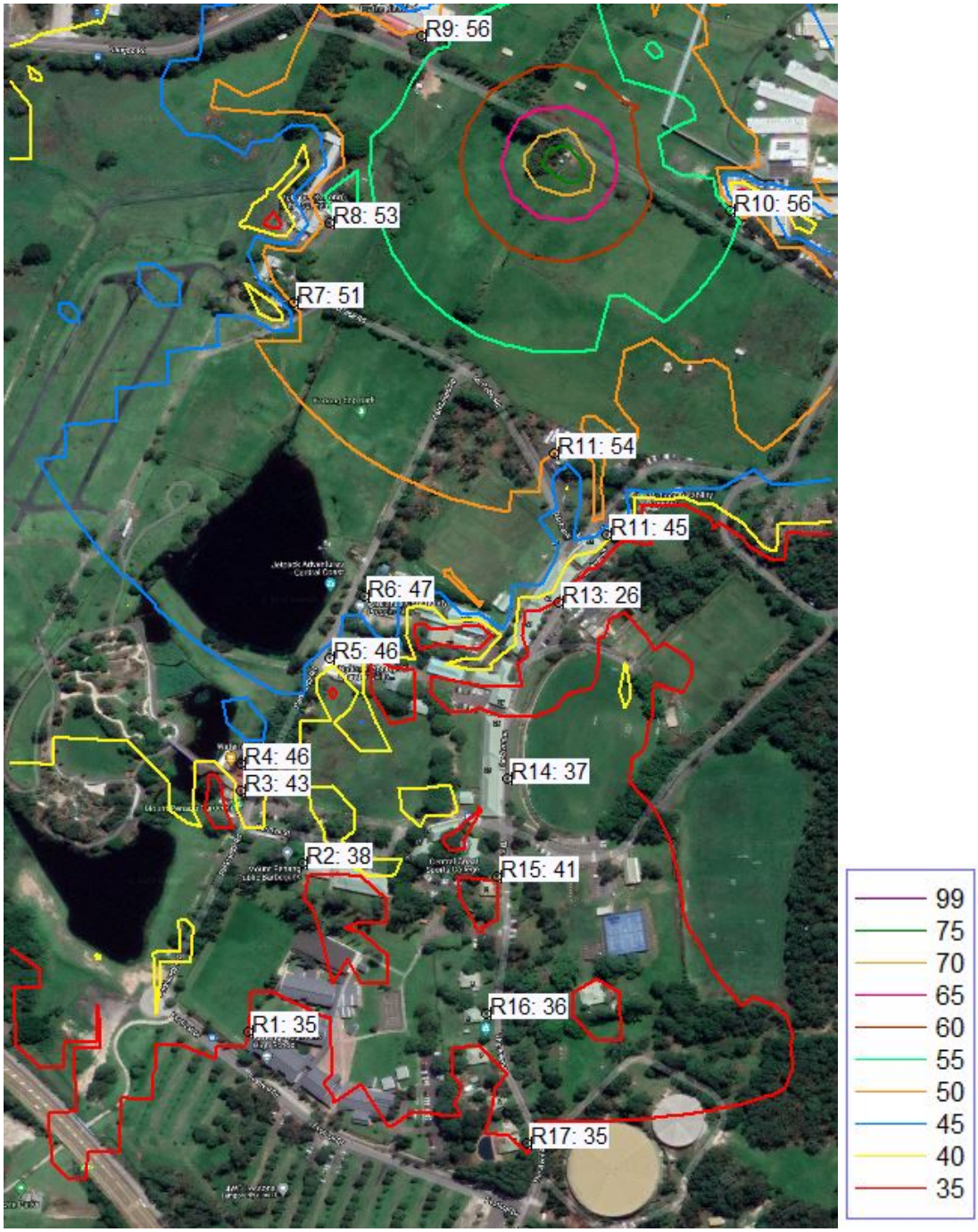

Figure 0-40 L8 Finishing