APPENDIX 10
NOISE AND VIBRATION ASSESSMENT BLUE SPRINGS ROAD UPGRADE

RAPT CONSULTING

Noise and Vibration Impact Assessment – Stubbo Solar Farm

Addendum – Blue Springs Road upgrade, May 2021

Relationships Attention Professional Trust

Document Details

Acoustic Assessment – Blue Springs Road Upgrade

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1. Introduction

1.1 Background

RAPT Consulting has been engaged to undertake an addendum to the Stubbo Solar Farm noise and vibration impact assessment to consider the proposed upgrade of Blue Springs Road and the Cope Road. It is understood the purpose of the upgrade is to improve safety for the road.

The extent of the project alignment is shown in Figure 1-1.

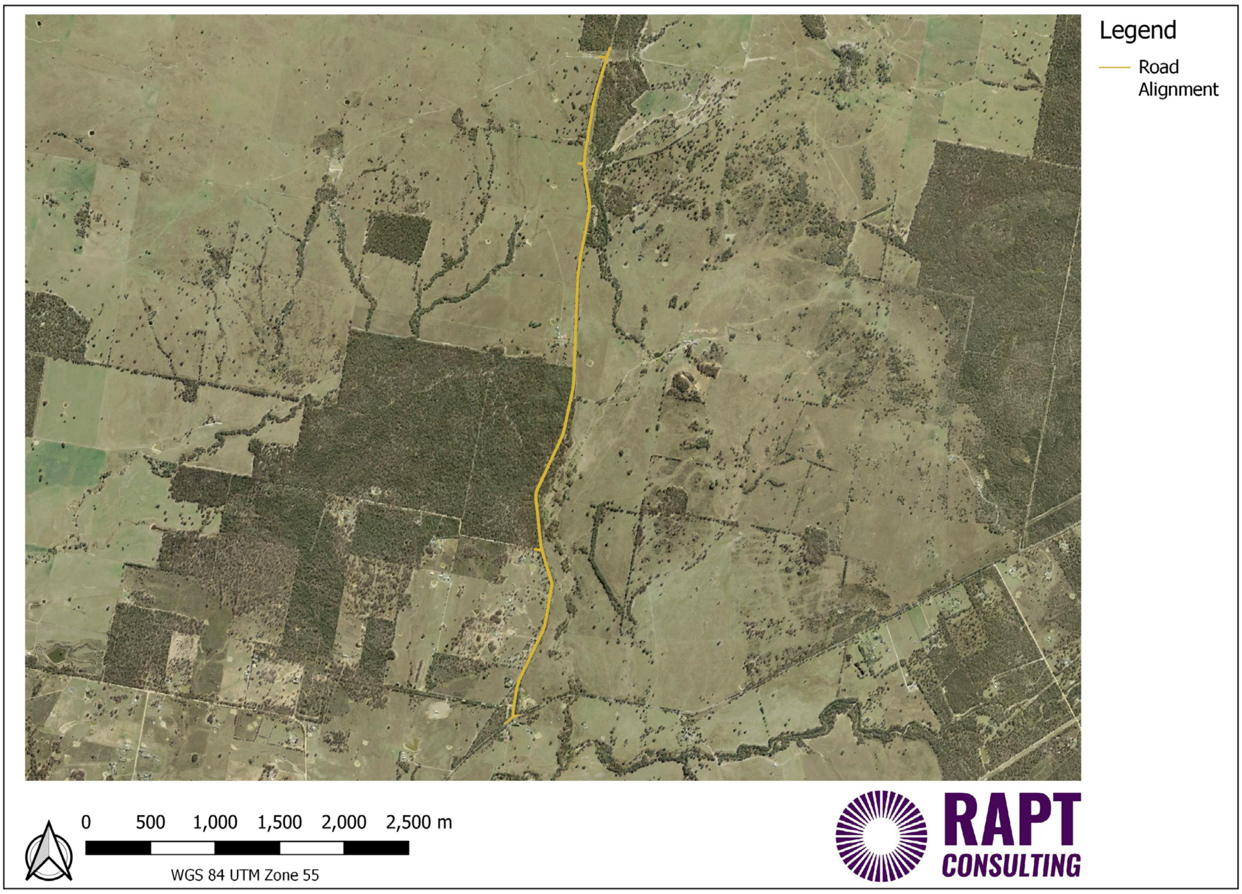


Figure 1-1 Extent of Project and Alignment

1.2 Assessment Objectives

This acoustic assessment considers the potential impacts of the construction and operation of the Blue Springs Road upgrade. 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 proposed project
- Identify the likely principal noise sources during construction, operation and their associated noise levels
- assessment of potential noise and vibration 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
- German Standard 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
- The NSW Roads and Maritime Services (RMS) Procedure – Preparing an Operational Traffic and Construction Noise and Vibration Assessment Report

- Noise Criteria Guideline / Noise Mitigation Guideline (NMG, RMS, 2015)
- 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

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

Table 2-1 Receptors and Approximate Distance to Blue Springs Road

Receiver ID	Address	Distance from Project Area	Easting	Northing
R1	Lot 142 DP750765	120m	745133	6422750
R2	Lot 121 DP1005646	130m	745293	6422807
R3	Lot 127 DP750765	50m	745180	6423156
R4	Lot 12 DP248716	300m	745075	6423531
R5	Lot 13 DP248716	275m	745182	6423795
R6	Lot 14 DP248716	125m	745295	6424129
R7	Lot 1 DP1018333	80m	745585	6425774
R8	Lot 2 DP1018333	65m	745609	6425843
R9	Lot 24 DP750765	700m	746369	6425686
R10	Lot 20 DP750765	810m	746489	6425758

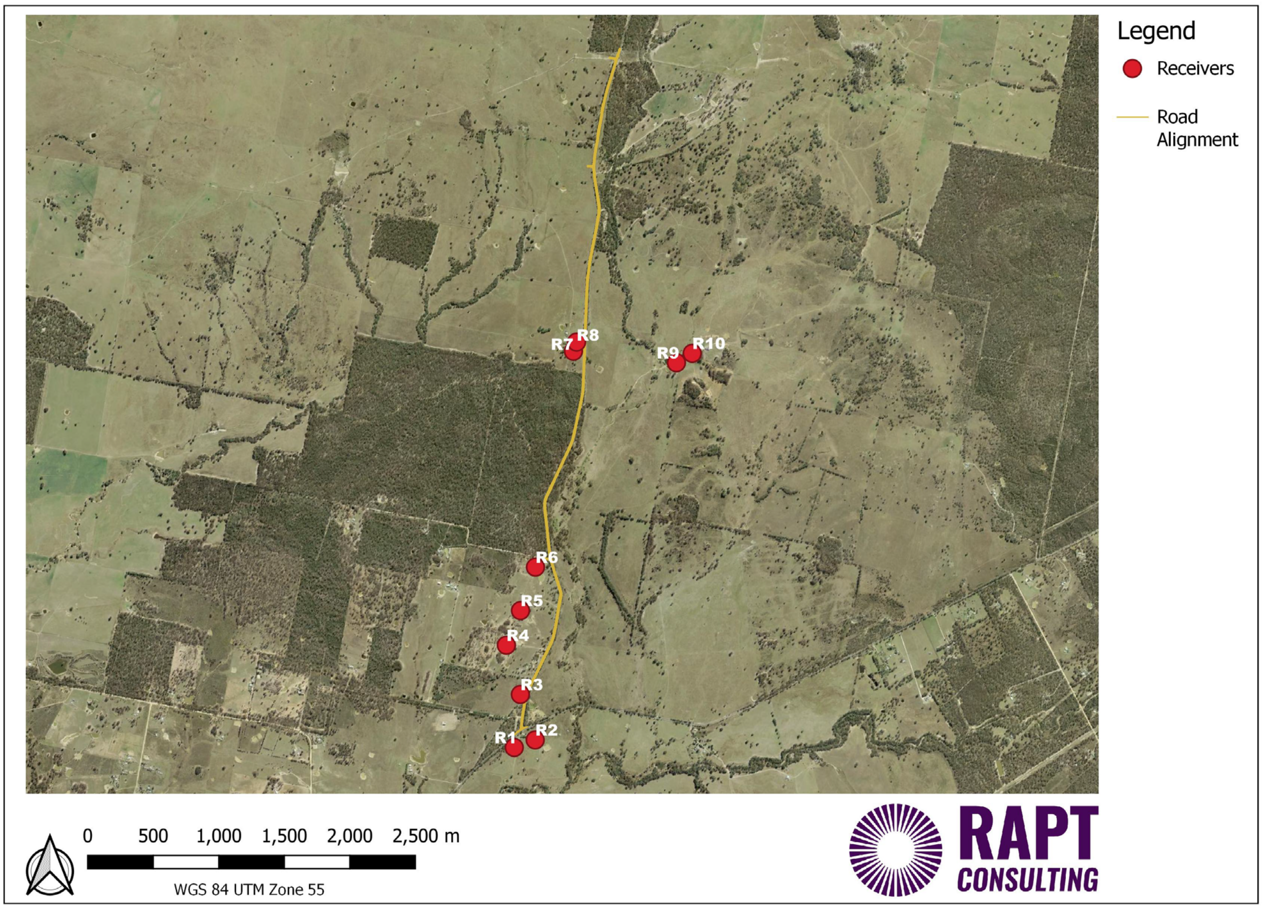


Figure 2-1 Sensitive Receptors Surrounding Blue Springs Road

2.2 Background and Ambient Noise

To establish background and ambient noise levels, operator attended measurements were conducted on 17 May 2021 and unattended noise monitoring was undertaken by RAPT Consulting from 17 May to 23 May 2021. The monitoring was undertaken at R7 Lot 1 DP1018333 303 Blue Springs Road. Site observations noted the location was considered indicative of the local ambient noise environment and this site also presented as secure location whereby minimising the risk of theft or vandalism to the monitoring equipment. During site visits it was noted that road traffic noise was not prominent and natural wildlife primarily described the ambient noise environment and is indicative of a rural noise environment.

The monitoring location is shown in Figure 2-2 and 2-3.

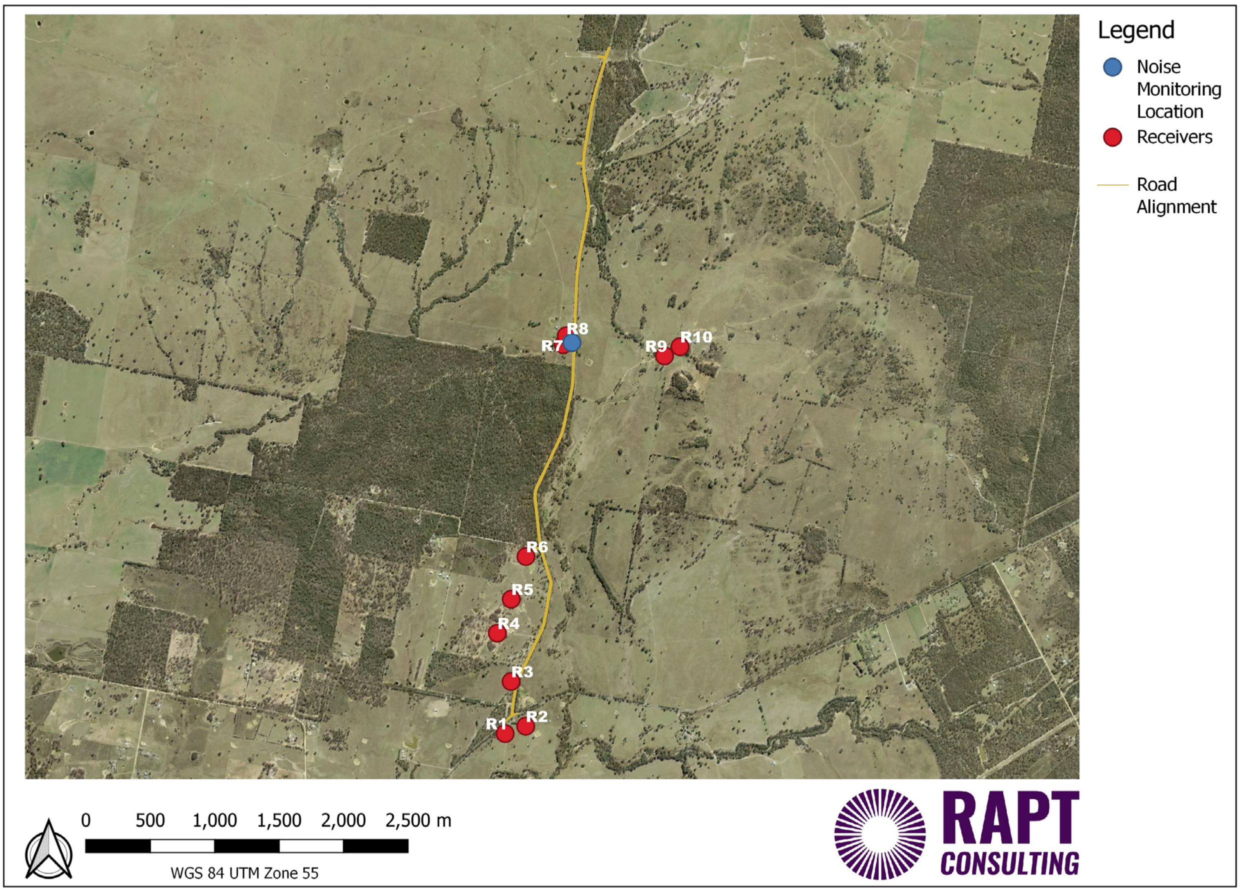


Figure 2-2 Monitoring Location.

Figure 2-3 Noise Monitoring Location

Monitoring was undertaken using a RION NL-42 noise logger with Type 2 Precision. The measurements were undertaken with consideration to AS 1055-1997, “Acoustics – Description and measurement of Environmental Noise” and the NPfI. The acoustic instrumentation employed during the monitoring complies with the requirements of AS 1259.2 – 1990, “Sound Level Metres” and is within current calibration. The acoustic instrumentation used carries current NATA calibration and complies with AS/NZS IEC 61672.1-2019- Electroacoustics – Sound level meters – Specifications. The attended monitoring was undertaken during calm conditions. Calibration was checked before and after the measurements with no significant drift.

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 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 was sourced from The Bureau of Meteorology's weather station located at Mudgee. Logged data was reviewed and filtered to exclude any extraneous data during the monitoring period.

The noise monitoring results are provided in Table 2-2 below. Noise monitoring charts are provided in Appendix A.

Table 2-2 Summary of Measured Noise Levels

Descriptor	R7	Time Interval
$L_{A90\ Day}$	35[1] (25) dB(A)	7:00am - 6:00pm
$L_{A90\ Evening}$	30[1] (22) dB(A)	6:00pm - 10:00pm
$L_{A90\ Night}$	30[1,2] (23) dB(A)	10:00pm - 7:00am
$L_{Aeq(15hr)}$	51dB(A)	7:00am - 10:00pm
$L_{Aeq(9hr)}$	45dB(A)	10:00pm – 7:00am
$L_{A10(18hr)}$	40dB(A)	6:00am – 12:00am

Note 1 Table 2.1 of the NPfI specifies a minimum assumed rating background noise level of 35dB(A) for day and 30 dB(A) for evening and night-time. Number in brackets (XX) represents actual measured RBL determined for assessment period.

Note 2 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.

The noise descriptors used by most countries to define noise criteria are L_{Aeq} or L_{A10} . For continuous high volume traffic, L_{Aeq} and L_{A10} are strongly correlated when assessed over the same period, L_{A10} being approximately 3 dB(A) higher than L_{Aeq}. As can be seen from the results in Table 2-2, the L_{A10} results are significantly less than the L_{Aeq} results which indicates traffic noise is not a prominent feature in the vicinity of Blue Springs Road.

Attended noise monitoring results are provided in Table 2-3.

Table 2-3 Attended Noise Monitoring Results

Noise Period	Noise Level dB(A)		Noise Sources dB(A) / Observations
	L_{Aeq}	L_{A90}	
17/05/2021 11:30am – 11:45am	47	38	Truck Passby 64 Birds 40–55 3 automobiles passed by during the monitoring

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)
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.

It is understood construction is planned for standard hours. Based on the above and the RBL's determined from site monitoring, construction noise management levels (NML's) have been derived, as shown in Table 3-3.

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

Receiver	Within Recommended Standard Hours
Residential	45

3.2 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.

3.3 Vibration Guidelines

3.3.1 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 3-4 for the applicable receivers.

Table 3-4 Preferred and Maximum Levels for Human Comfort

Location	Assessment Period[3]	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 3 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 3-5 for the applicable receiver type.

Table 3-5 Acceptable Vibration Dose Values for Intermittent Vibration (m/s1.75)

Location	Daytime [4]		Night-time [4]	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas[5]	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 4 Daytime is 7:00 to 22:00 and night-time is 22:00 to 7:00: and
Note 5 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.

3.3.2 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 3-6 for DIN 4150-3: 1999-02 and Table 3-7 for BS7385.2 – 1993.

Table 3-6 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 6 At frequencies above 100Hz, the values given in this column may be used as minimum values

Table 3-7 BS7385.2 Transient Vibration Guideline Values for Potential building - Cosmetic Damage

Building Type[8]	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz[7]	15 Hz and above[7]
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 7 Values referred to are at the base of the building: and
Note 8 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.

3.4 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.
- Roads and Maritime 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 3-8 sets out the applicable road traffic noise target levels recommended by the NCG.

Table 3-8 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)

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'.

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.

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[9]
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[9]
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 9 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 Bruel and Kjaer'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.

Construction noise levels have been predicted based on the potential construction noise levels provided in Table 4-1. The different scenarios will occur from site establishment to site finishes. These noise levels represent different equipment noise levels and give an idea how noise levels may change across the study 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

- 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 5.

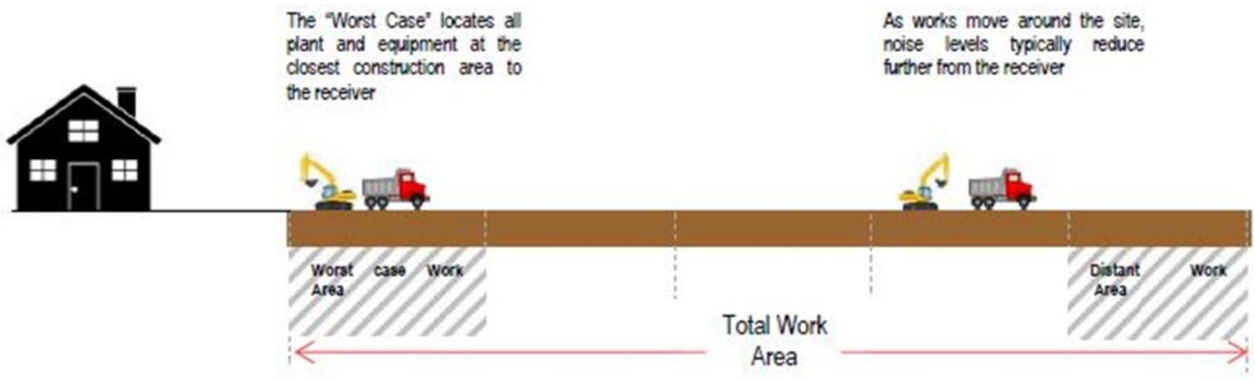


Figure 4-1 Example of Differing Work Areas

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. Seven locations were modelling being in closest proximity to nearest residences as shown in Figure 4-2.

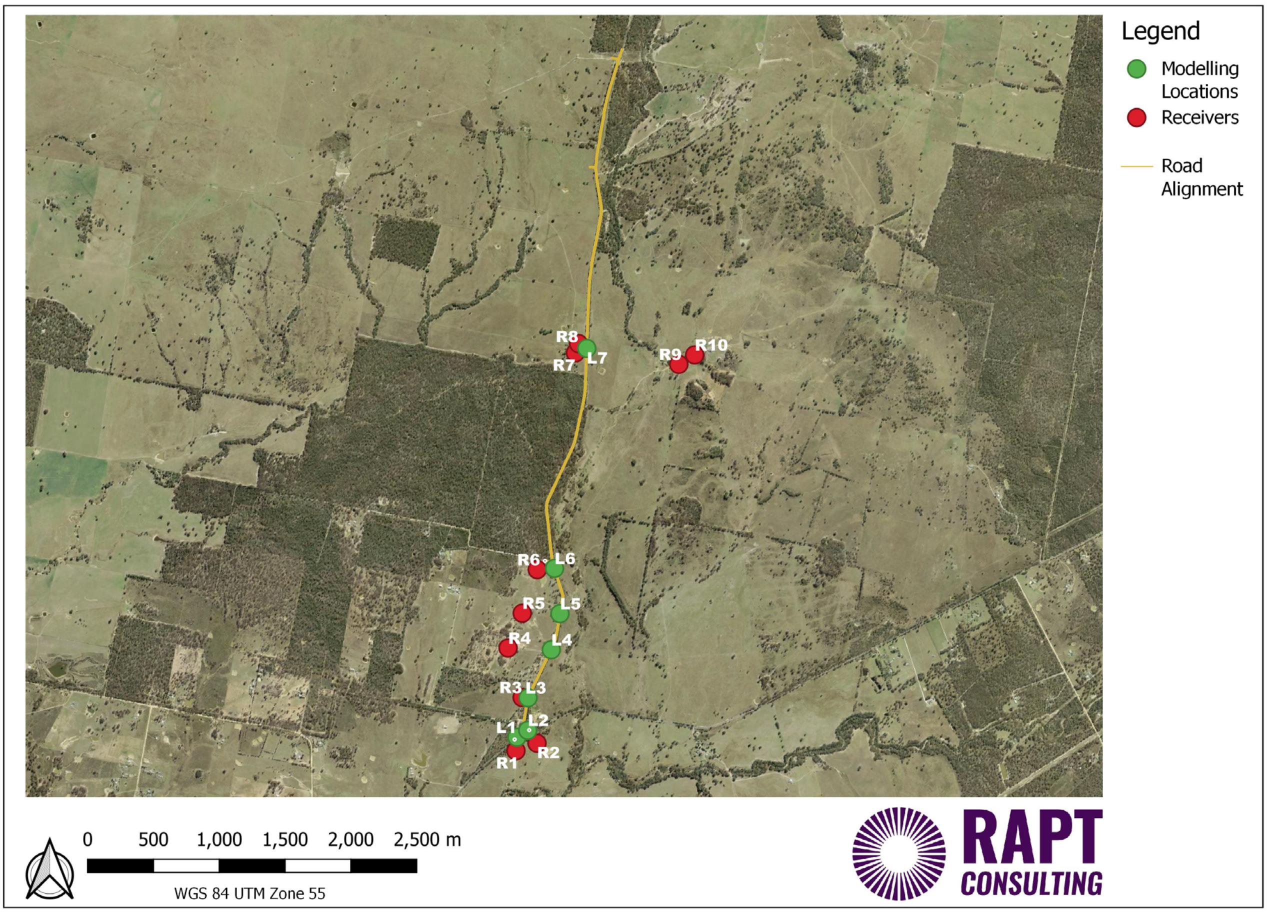


Figure 4-2 Modelling Locations.

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 10 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.

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 residential receptors. Predicted exceedances of NML's are highlighted in RED. Noise modelling contours are provided in Appendix B.

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

Site Preparation									
Receiver	**L1**	**L2**	**L3**	**L4**	**L5**	**L6**	**L7**	**NML**	**Highly Affected Noise Level**
R1	60	57	50	43	35	31	16	45	75
R2	58	59	52	45	36	32	16	45	75
R3	48	50	67	50	40	36	19	45	75
R4	39	40	45	50	49	40	22	45	75
R5	35	36	40	47	52	46	24	45	75
R6	31	31	35	40	46	58	28	45	75
R7	11	12	14	17	19	22	60	45	75
R8	11	11	13	16	18	21	62	45	75
R9	10	11	13	16	18	21	45	45	75
R10	9	10	12	15	17	19	40	45	75

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

Utilities Infrastructure									
Receiver	**L1**	**L2**	**L3**	**L4**	**L5**	**L6**	**L7**	**NML**	**Highly Affected Noise Level**
R1	65	62	55	48	40	36	21	45	75
R2	63	64	57	50	41	37	21	45	75
R3	53	55	72	55	45	41	26	45	75
R4	44	45	50	55	54	45	27	45	75
R5	40	41	45	52	57	51	29	45	75
R6	36	31	40	45	51	63	33	45	75
R7	16	17	19	22	24	27	65	45	75
R8	16	16	18	21	23	26	67	45	75
R9	15	16	18	21	23	26	50	45	75
R10	14	15	17	20	22	24	45	45	75

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

Vegetation Removal									
Receiver	**L1**	**L2**	**L3**	**L4**	**L5**	**L6**	**L7**	**NML**	**Highly Affected Noise Level**
R1	70	67	60	53	45	41	26	45	75
R2	68	69	62	55	46	42	26	45	75
R3	58	60	77	60	50	46	31	45	75
R4	49	50	55	60	59	50	32	45	75
R5	45	42	50	57	62	56	34	45	75
R6	41	36	45	50	56	68	38	45	75
R7	21	22	24	27	29	32	70	45	75
R8	21	21	23	26	28	31	72	45	75
R9	20	21	23	26	28	31	55	45	75
R10	19	20	22	25	27	29	50	45	75

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

Drainage / Paving									
Receiver	**L1**	**L2**	**L3**	**L4**	**L5**	**L6**	**L7**	**NML**	**Highly Affected Noise Level**
R1	66	63	56	49	41	36	22	45	75
R2	64	65	58	51	42	38	22	45	75
R3	54	56	73	56	46	42	27	45	75
R4	45	46	51	56	55	46	28	45	75
R5	41	38	46	53	58	52	30	45	75
R6	37	32	41	46	52	64	34	45	75
R7	17	18	20	23	25	28	65	45	75
R8	17	17	19	22	24	27	68	45	75
R9	16	17	19	22	24	27	51	45	75
R10	15	16	18	21	23	25	45	45	75

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

Finishing Works									
Receiver	**L1**	**L2**	**L3**	**L4**	**L5**	**L6**	**L7**	**NML**	**Highly Affected Noise Level**
R1	62	59	52	45	37	32	18	45	75
R2	60	61	54	47	38	34	18	45	75
R3	50	52	69	52	42	38	23	45	75
R4	41	42	47	52	51	42	24	45	75
R5	37	34	42	49	54	48	26	45	75
R6	33	28	37	42	48	60	30	45	75
R7	13	14	16	19	21	24	61	45	75
R8	13	13	15	18	20	23	64	45	75
R9	12	13	15	18	20	23	47	45	75
R10	11	12	14	17	19	21	41	41	75

The results of the construction assessment indicate exceedances of NML's may occur depending on work location, work activity and proximity to receivers. However the Highly Affected Noise Level is expected to be complied with in all situations with the exception of R3 during vegetation removal when these works are being conducted at L3 which is closest to that receptor. 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. 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 Vibration

The relationship between vibration and the probability of causing human annoyance or damage to structures is complex. This complexity is mostly due to the magnitude of the vibration source, the particular ground conditions between the source and receiver, the foundation-to-footing interaction and the large range of structures that exist in terms of design (e.g. dimensions, materials, type and quality of construction and footing conditions). The intensity, duration, frequency content and number of occurrences of vibration, are all important aspects in both the annoyances caused and the strains induced in structures.

Energy from construction equipment is transmitted into the ground and transformed into vibrations, which attenuates with distance. The magnitude and attenuation of ground vibration is dependent on the following:

- The efficiency of the energy transfer mechanism of the equipment (i.e. impulsive; reciprocating, rolling or rotating equipment)
- The Frequency content
- The impact medium stiffness
- The type of wave (surface or body)
- The ground type and topography.

Due to the above factors, there is inherent variability in ground vibration predictions without site-specific measurement data.

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 4-8. 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. The minimum working distances are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions.

Table 4-8 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
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

Where vibratory rollers are proposed it is recommended <200 kN (4-6 tonne) be utilised particularly if rollers are proposed within 50 metres of residences. Additionally if hydraulic hammering were to occur, it is recommended no larger than medium 900kg (12 to 18 t excavator) be utilised.

4.3 Construction Noise and Vibration Mitigation Measures

It is noted that construction noise emissions are anticipated to satisfy relevant NMLs in most cases, However, depending on work location, activities and distances to receivers NML's have the potential to be exceeded, The project is committed to managing noise emissions within the community and will adopt the following procedures where feasible. Recommendations for consideration during construction activities to reduce emissions to the surrounding community for this project may include:

- Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise.
- Ensure site managers periodically check the site and nearby residences and other sensitive land uses for noise problems so that solutions can be quickly applied.
- Keep truck drivers informed of designated vehicle routes, parking locations, acceptable delivery hours or other relevant practices (for example, minimising the use of engine brakes, and no extended periods of engine idling).
- Maintain good communication between the community and project staff.
- Appoint a community liaison officer where required.
- Provide a readily accessible contact point, for example, through a 24 hour toll-free information and complaints line.
- Regularly inspect and maintain equipment to ensure it is in good working order. Also check the condition of mufflers.
- Place as much distance as possible between the plant or equipment and residences and other sensitive land uses.
- Locate site vehicle entrances away from residences and other sensitive land uses.
- Avoid use of reversing alarms by designing site layout to avoid reversing, such as by including drive through for parking and deliveries.
- Install where feasible and reasonable less annoying alternatives to the typical 'beeper' alarms taking into account the requirements of the Occupational Health and Safety legislation; examples are smart alarms that adjust their volume depending on the ambient level of noise and multifrequency alarms that emit noise over a wide range of frequencies.

The Roads and Maritime Construction Noise and Vibration Guideline (CNVG) also provides guidance for additional mitigation measures and may be used to minimise the impacts on the community from noise and vibration. Appendix B of the CNVG provides guidance for standard mitigation measures and is reproduced as Table4-9.

4.4 Operational Noise

The purpose of the Blue Springs Road upgrade is to improve safety. There will be minimal alignment adjustments associated with the proposal which means road traffic will be travelling along essentially the same pathway as prior to the proposal. Attended observations noted 3 vehicles passed by during a 15-minute measurement and determined traffic noise was not a significant feature of the area. Week-long noise measurements also determined road traffic noise descriptors are well below RNP guidelines. Information provided indicates there are approximately 174 vehicles that travel on Blue Springs road per day. In order to increase traffic noise levels by 2 dB(A) traffic volumes would need to increase by 60% which will not occur as a result of this minor works proposal. Therefore operational traffic noise will meet project operational noise goals.

5. Conclusion

This acoustic assessment has been undertaken for Ramboll to inform a review of environmental factors (REF) for the Blue Springs Road Upgrade. The purpose of the upgrade is to improve safety for the road.

Construction

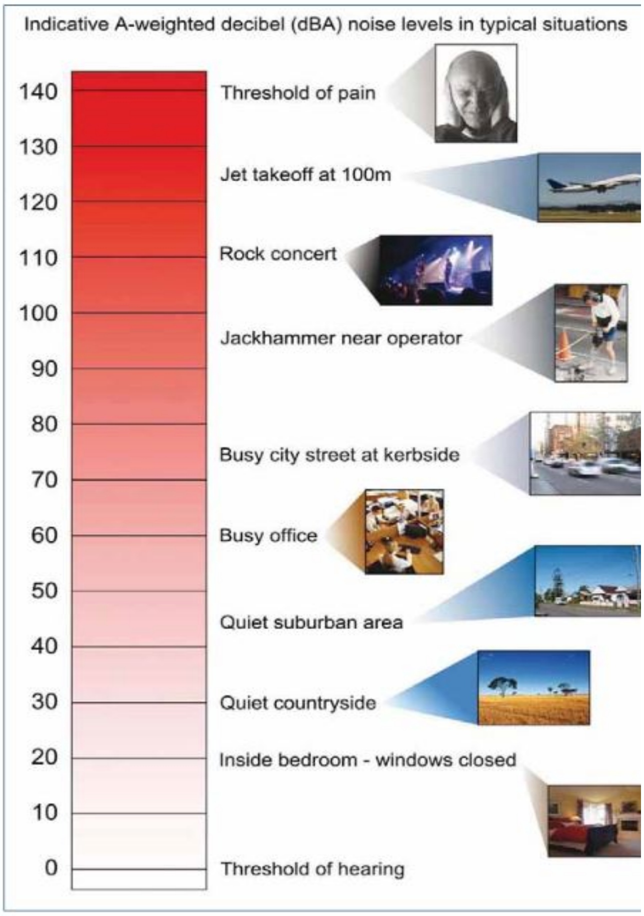
The assessment outlined in this report indicates that construction noise management levels will be complied with in most situations. However, there is the potential for exceedances for some receivers assessed in certain situations. However, the highly noise affected level of 75dB(A) $L_{Aeq(15min)}$ is expected to be complied with. 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

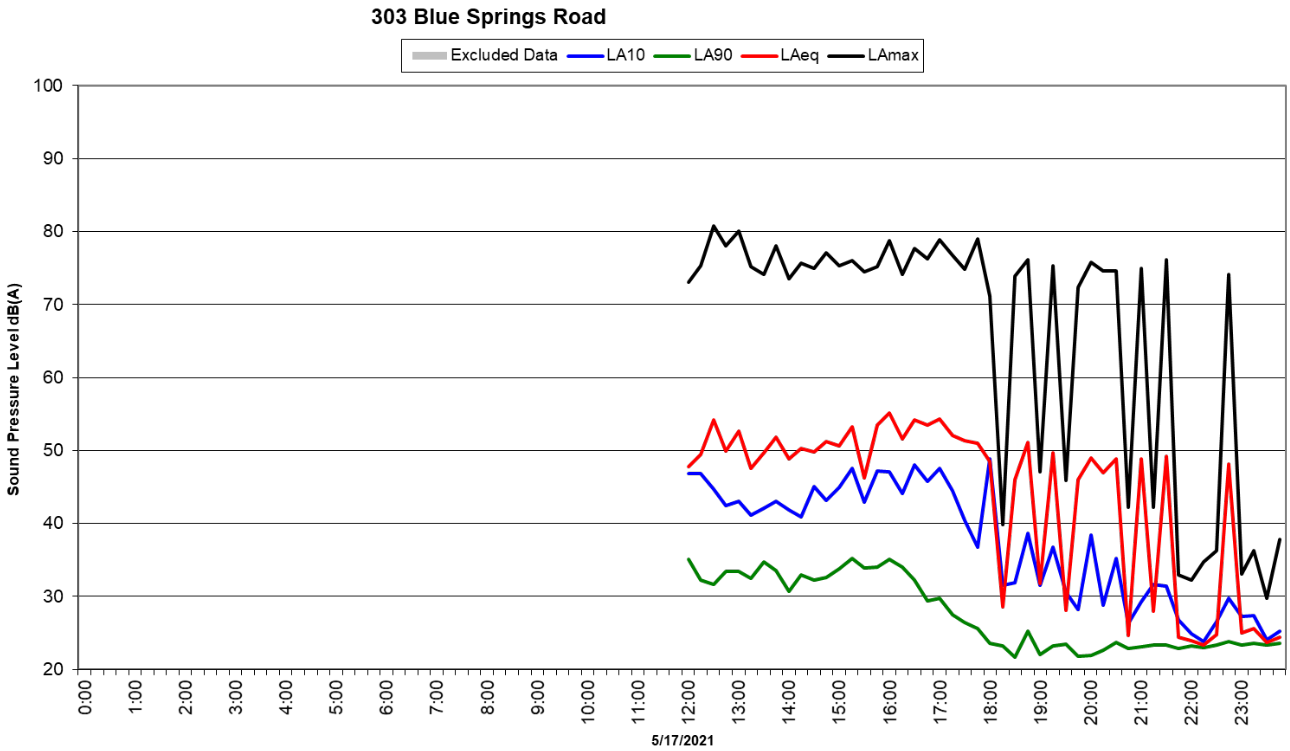
Term	Definition
dB	Decibel is the unit used for expressing the sound pressure level (SPL) or power level (SWL) in acoustics. The picture below indicates typical noise levels from common noise sources.

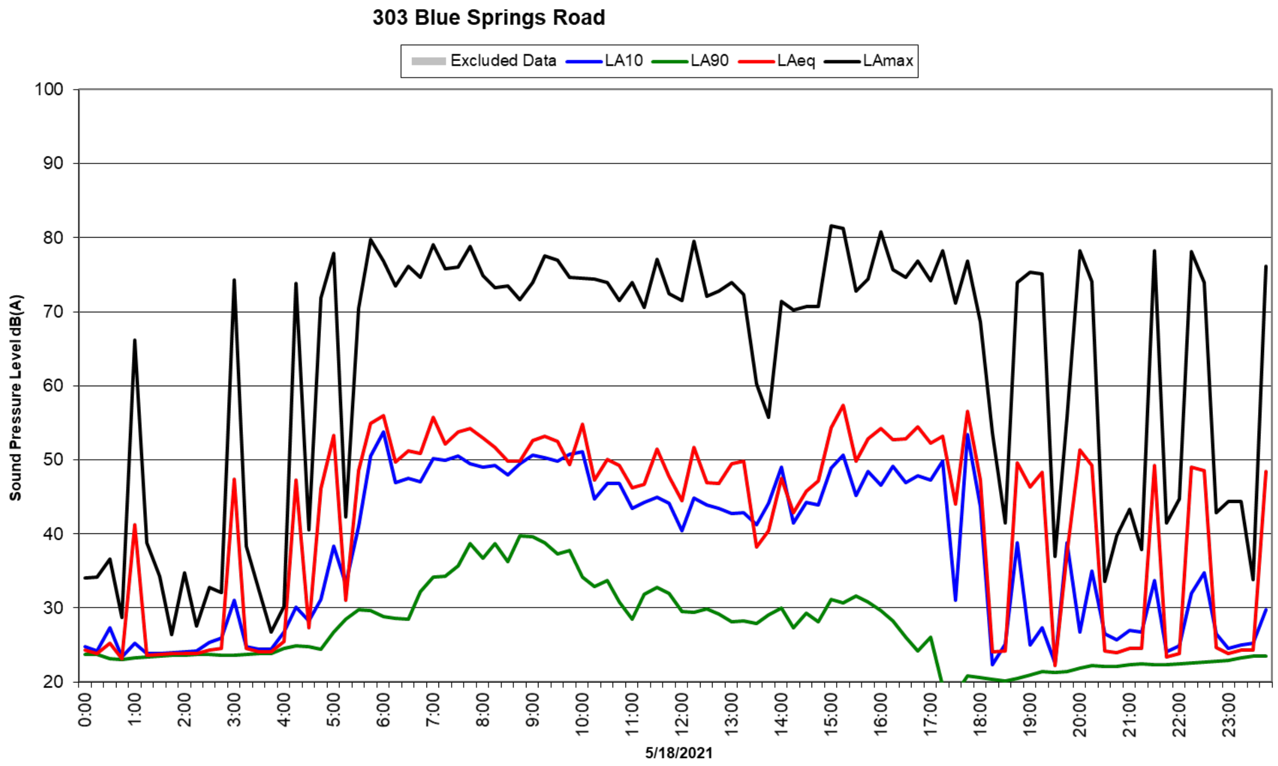


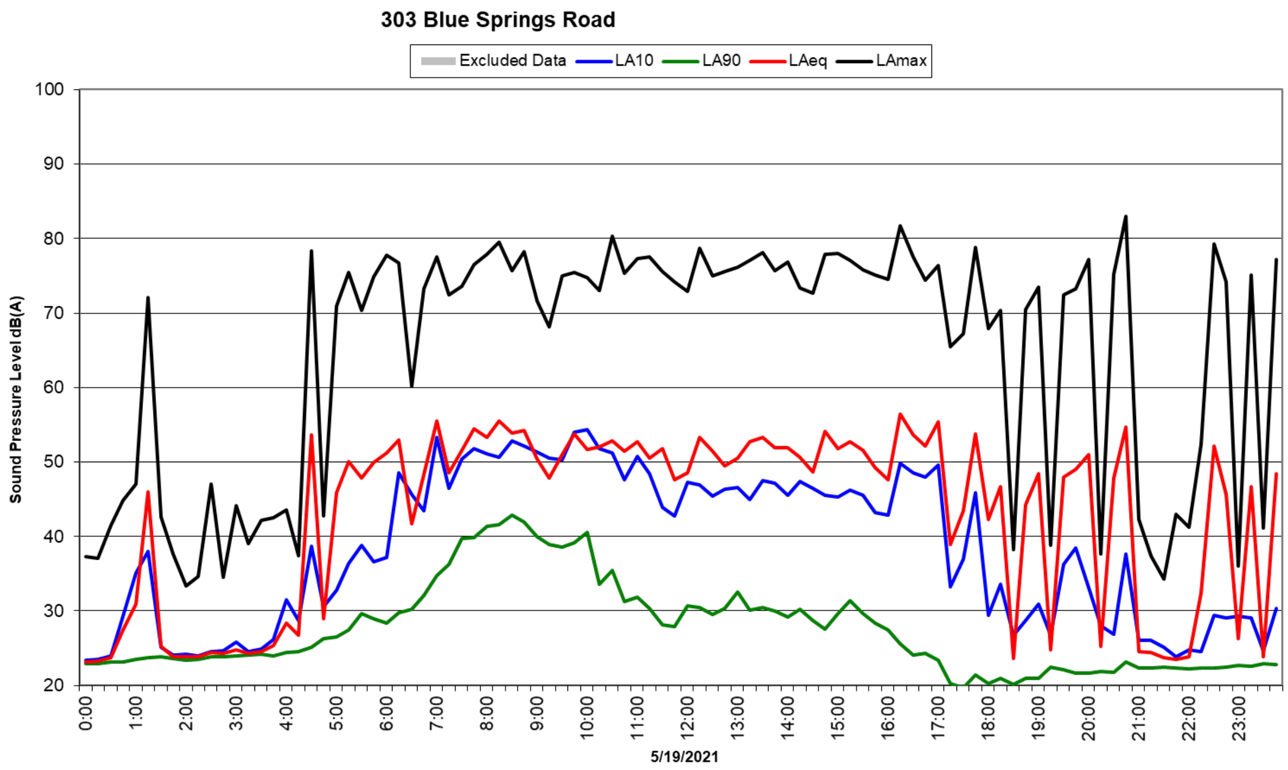
Term	Definition
dB(A)	Frequency weighting filter used to measure 'A-weighted' sound pressure levels, which conforms approximately to the human ear response, as our hearing is less sensitive at very low and very high frequencies.
$L_{Aeq(period)}$	Equivalent sound pressure level: the steady sound level 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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Excluded Data
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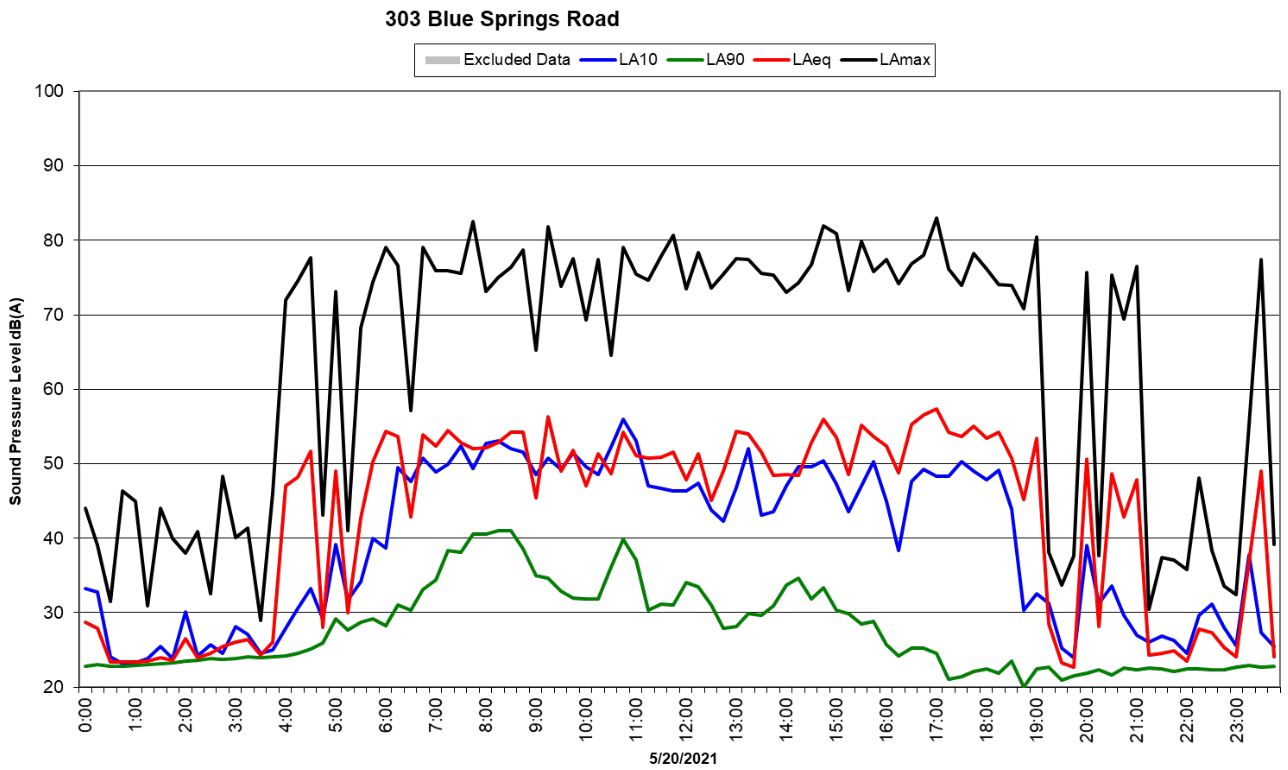
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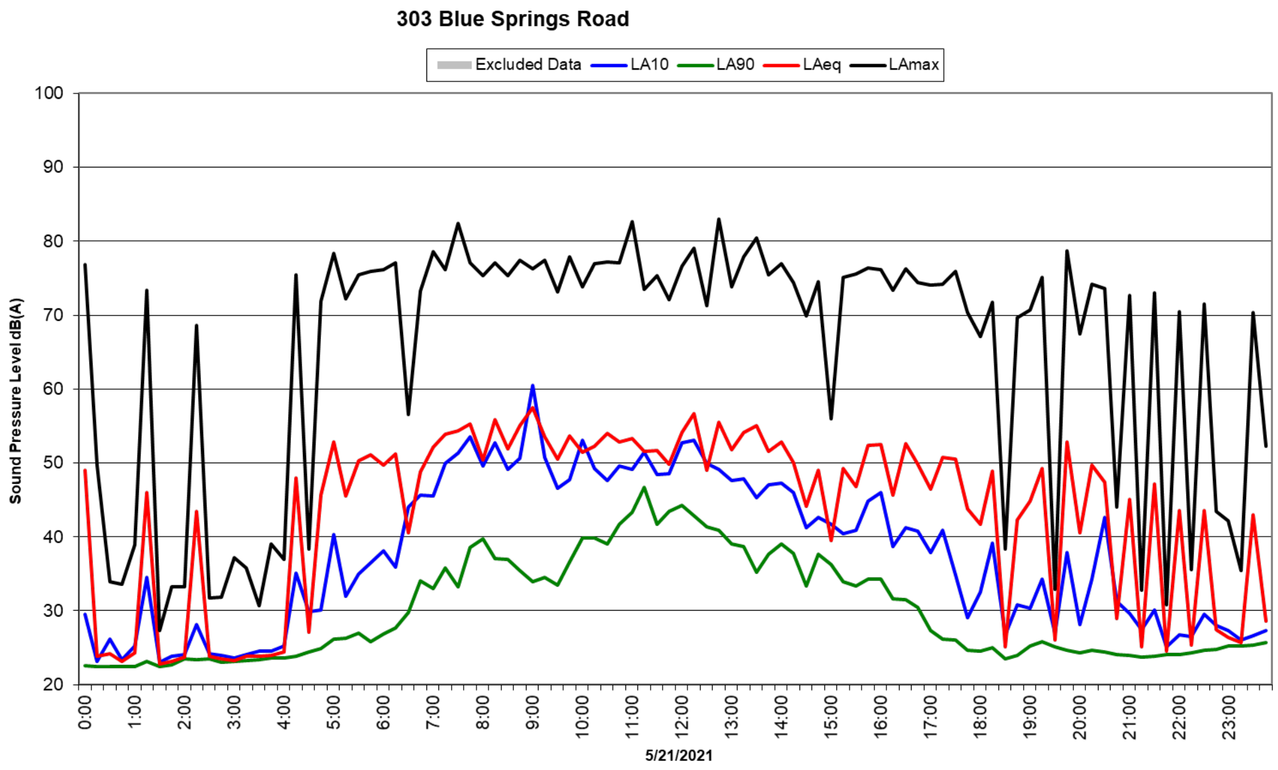
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Sound Pressure Level dB(A)
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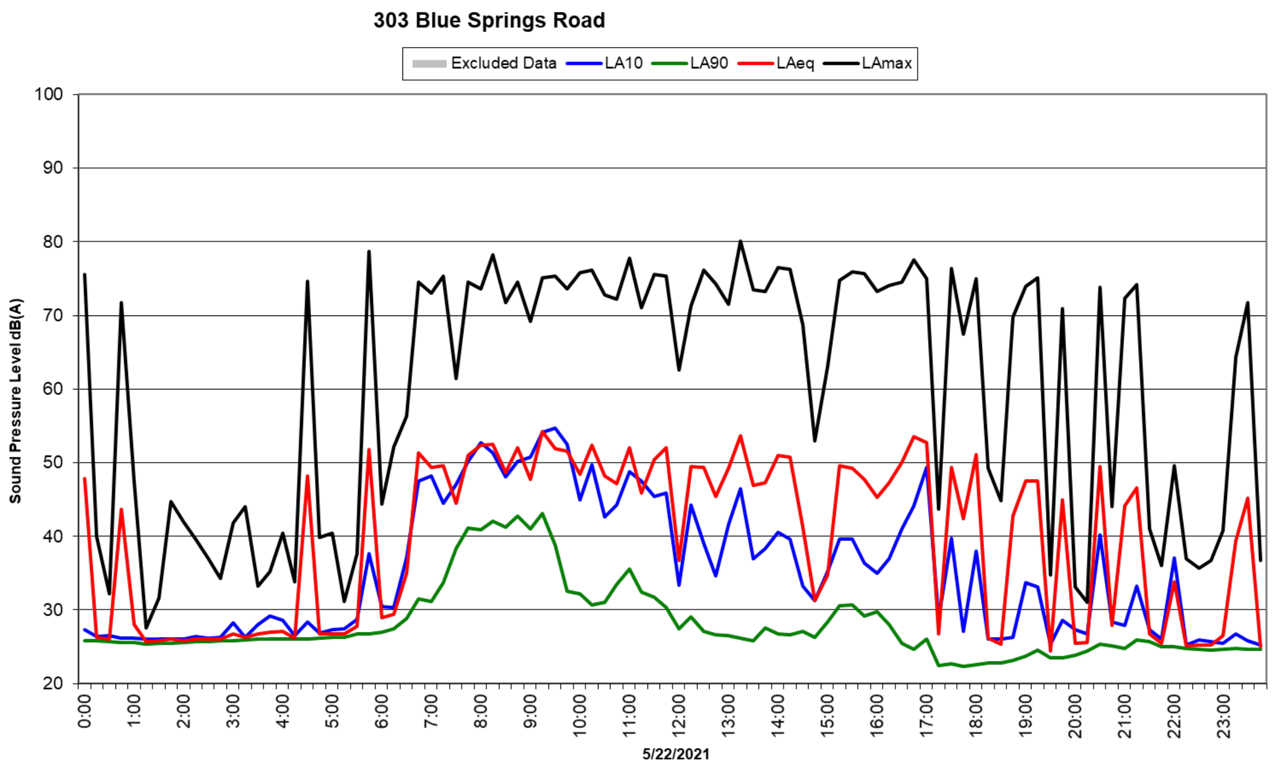
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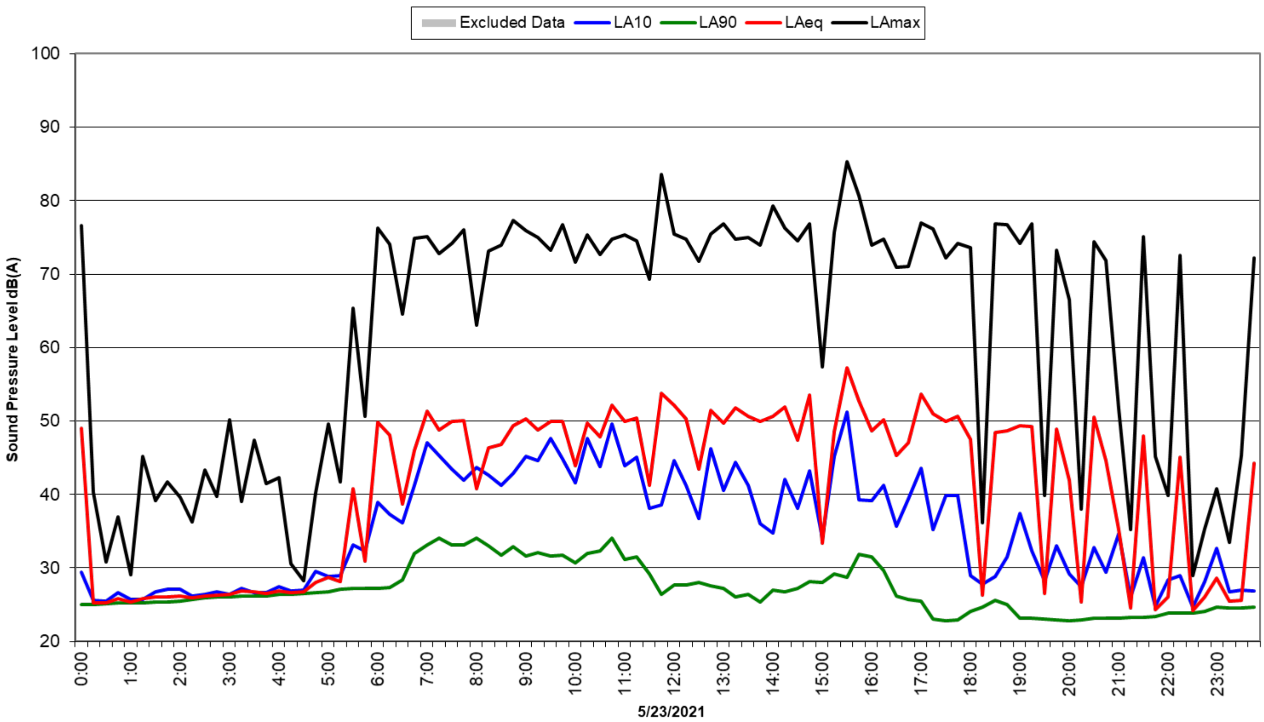
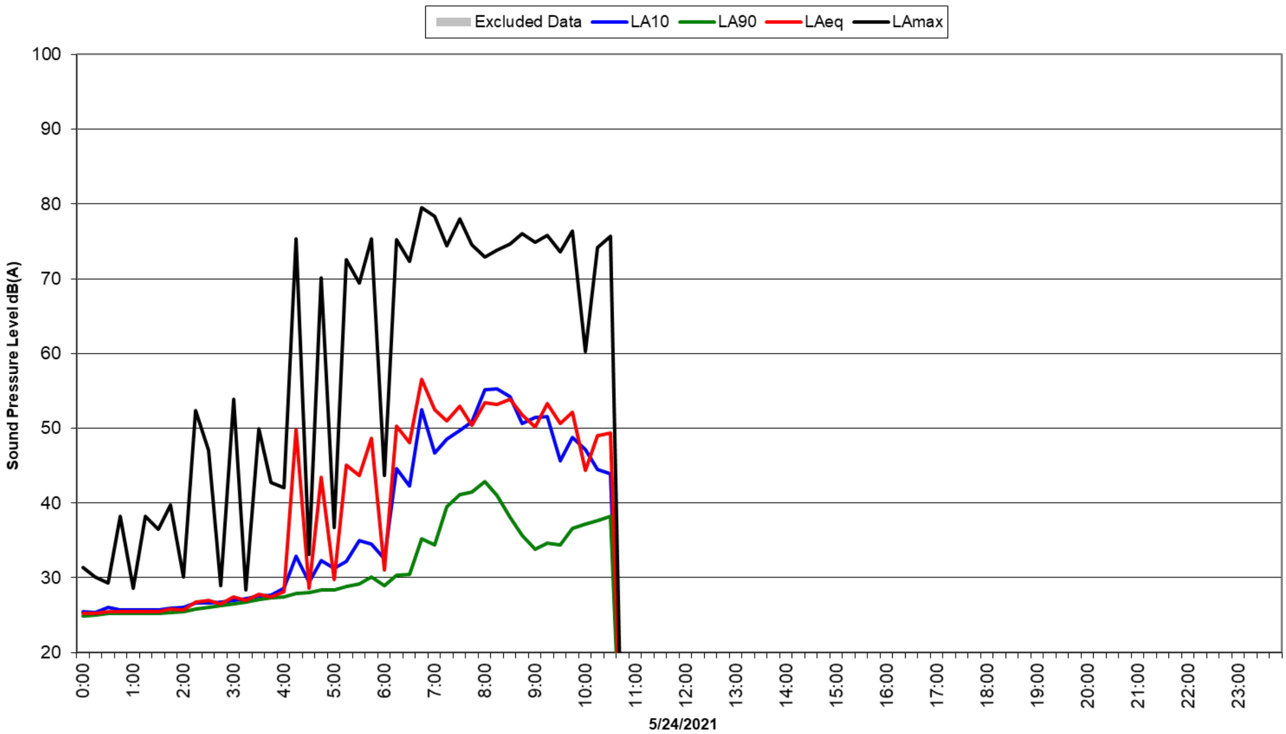
Sound Pressure Level dB(A)
5/22/2021

303 Blue Springs Road



303 Blue Springs Road



Appendix C – Noise Modelling Contours dB(A) Leq(15min)

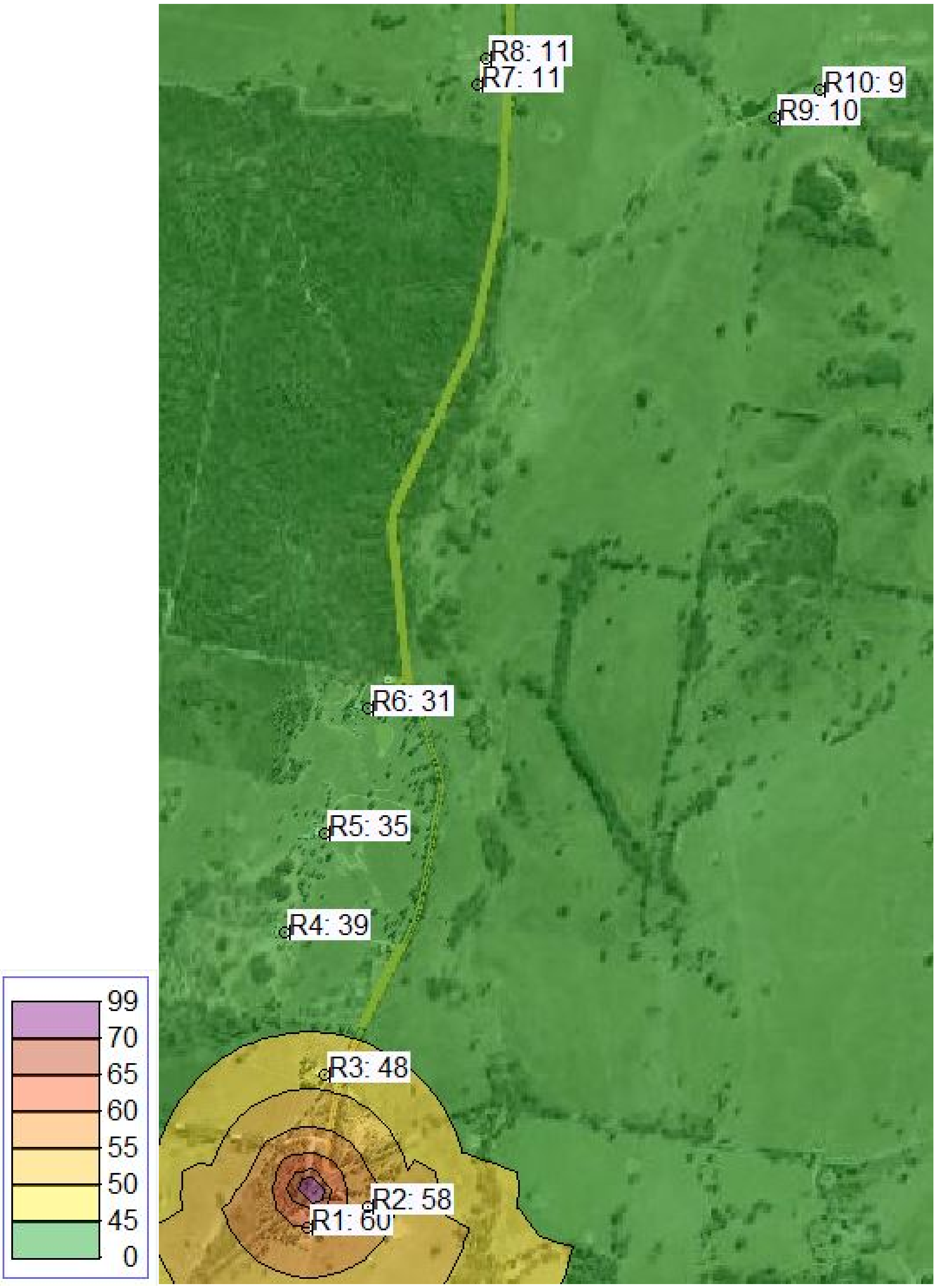


Figure 0-1 L1 Prep

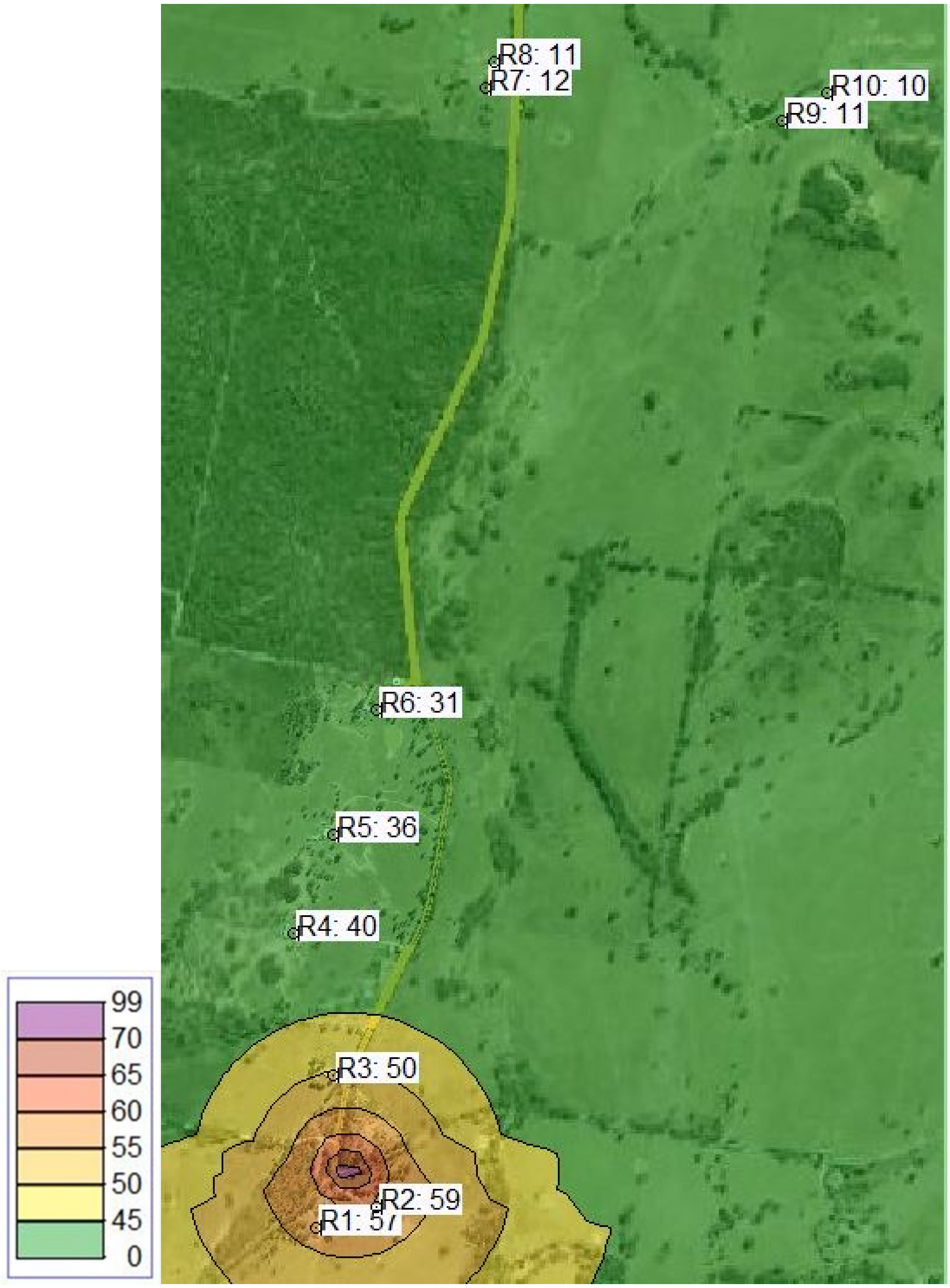


Figure 0-2 L2 Prep

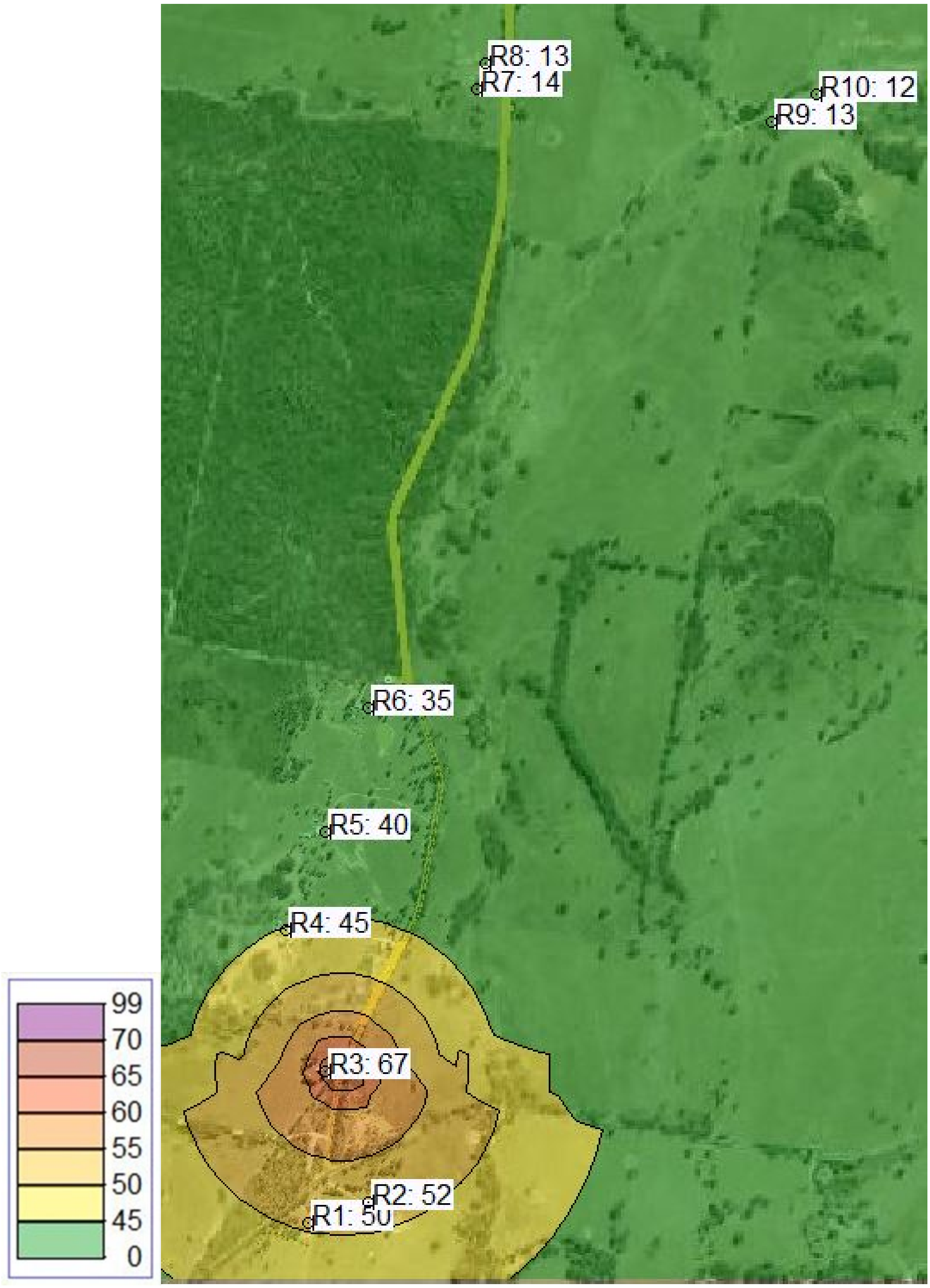
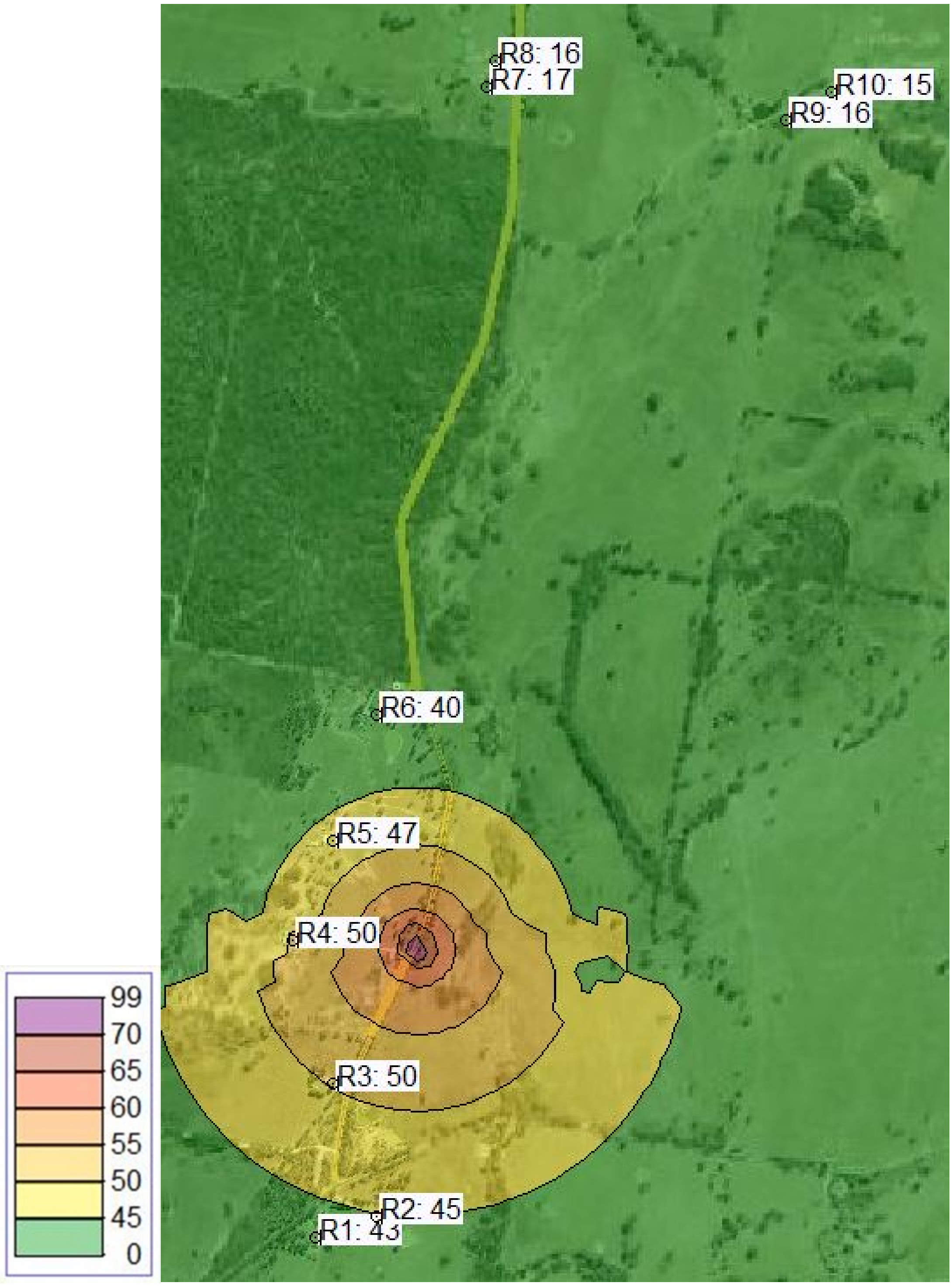


Figure 0-3 L3 Prep



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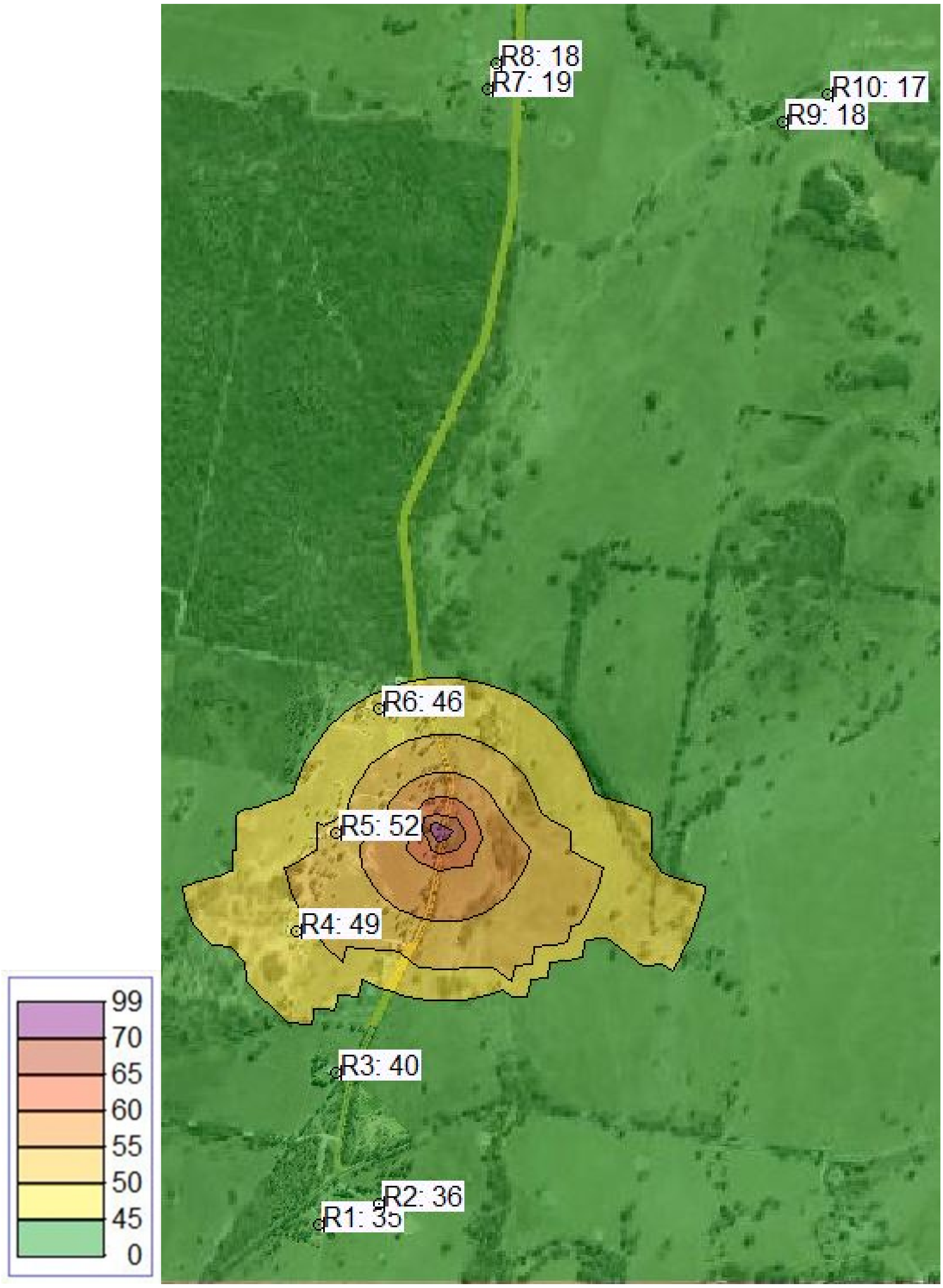

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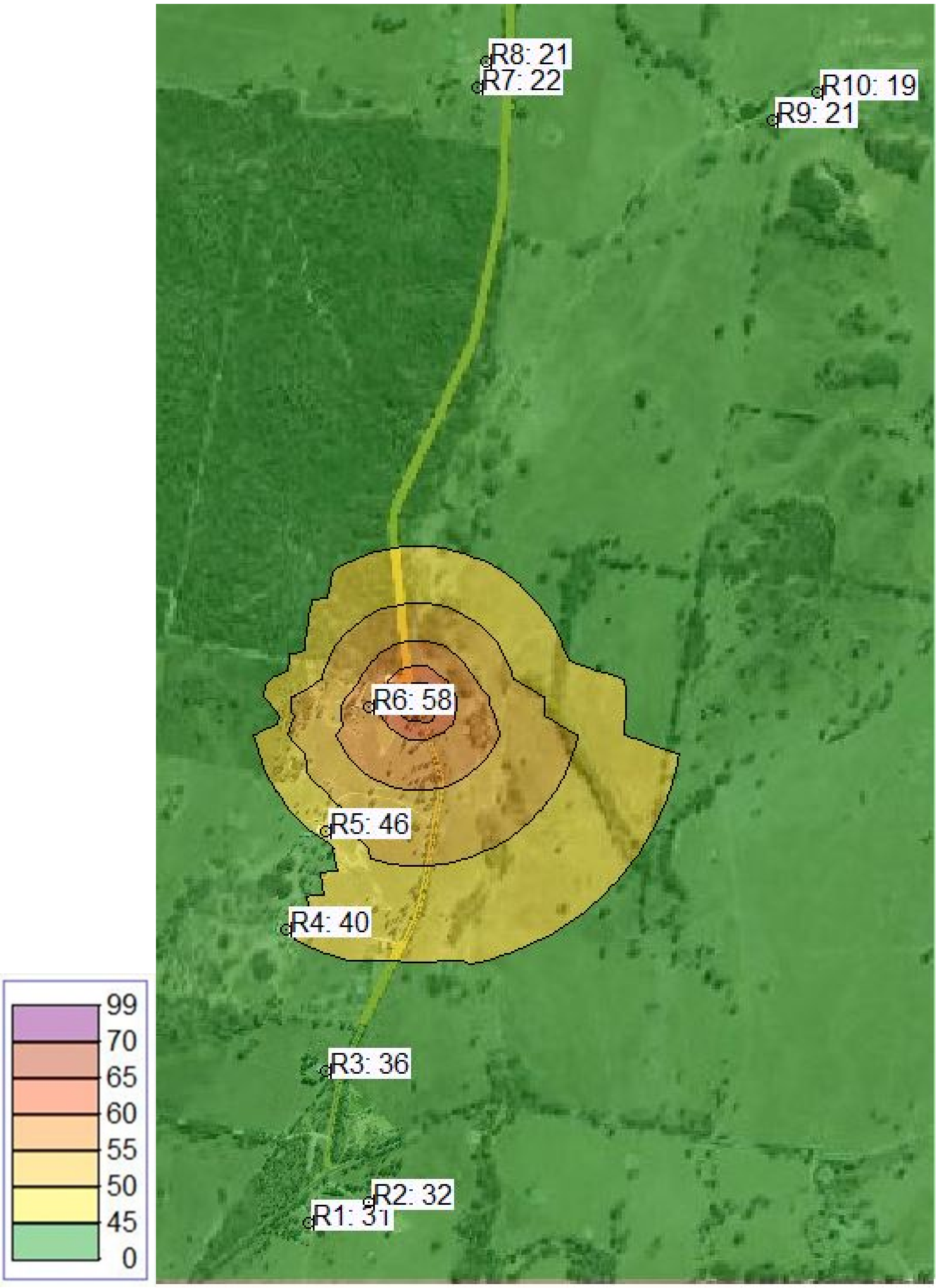

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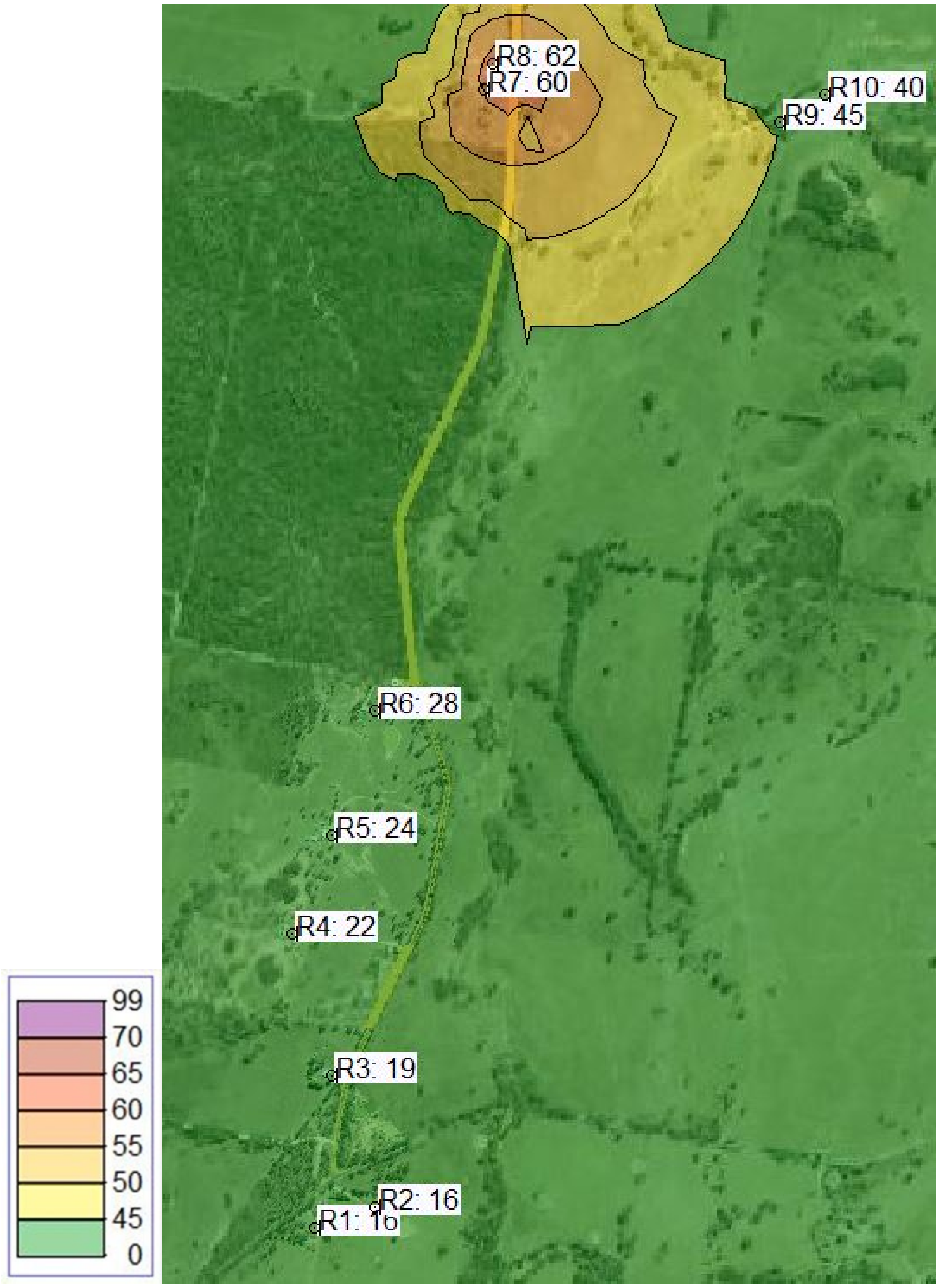

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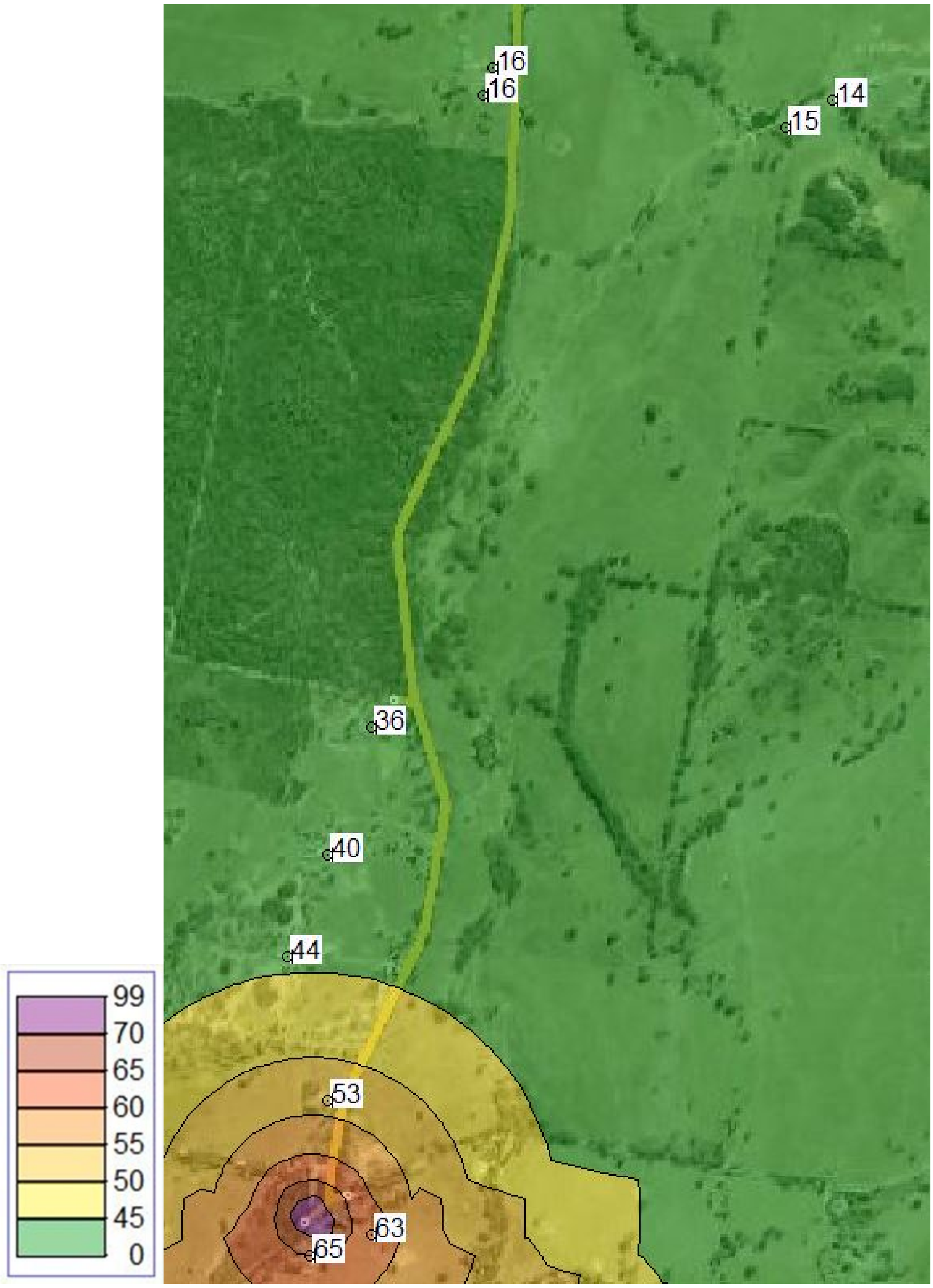

Figure 0-8 L1 Utilities

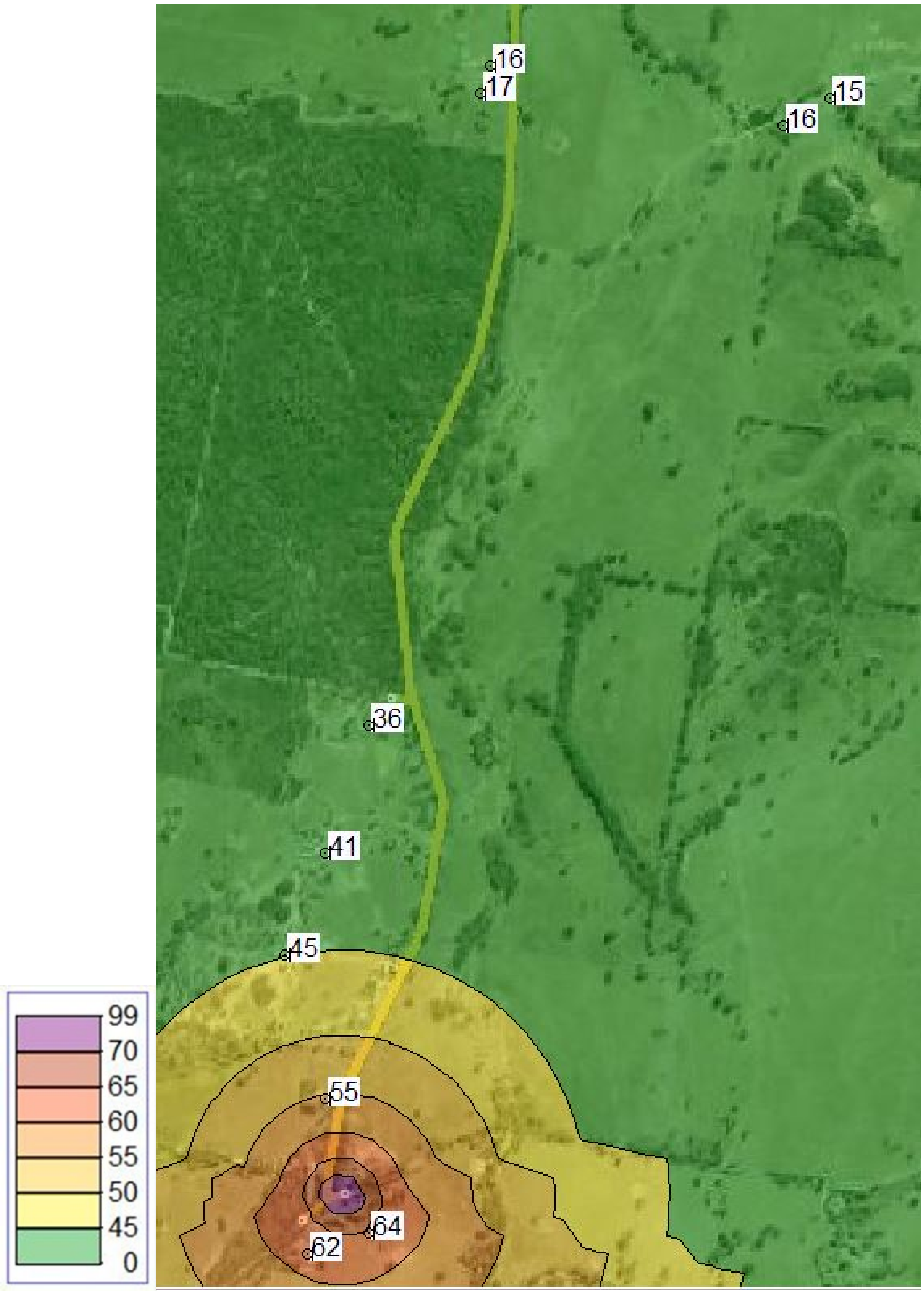

Figure 0-9 L2 Utilities

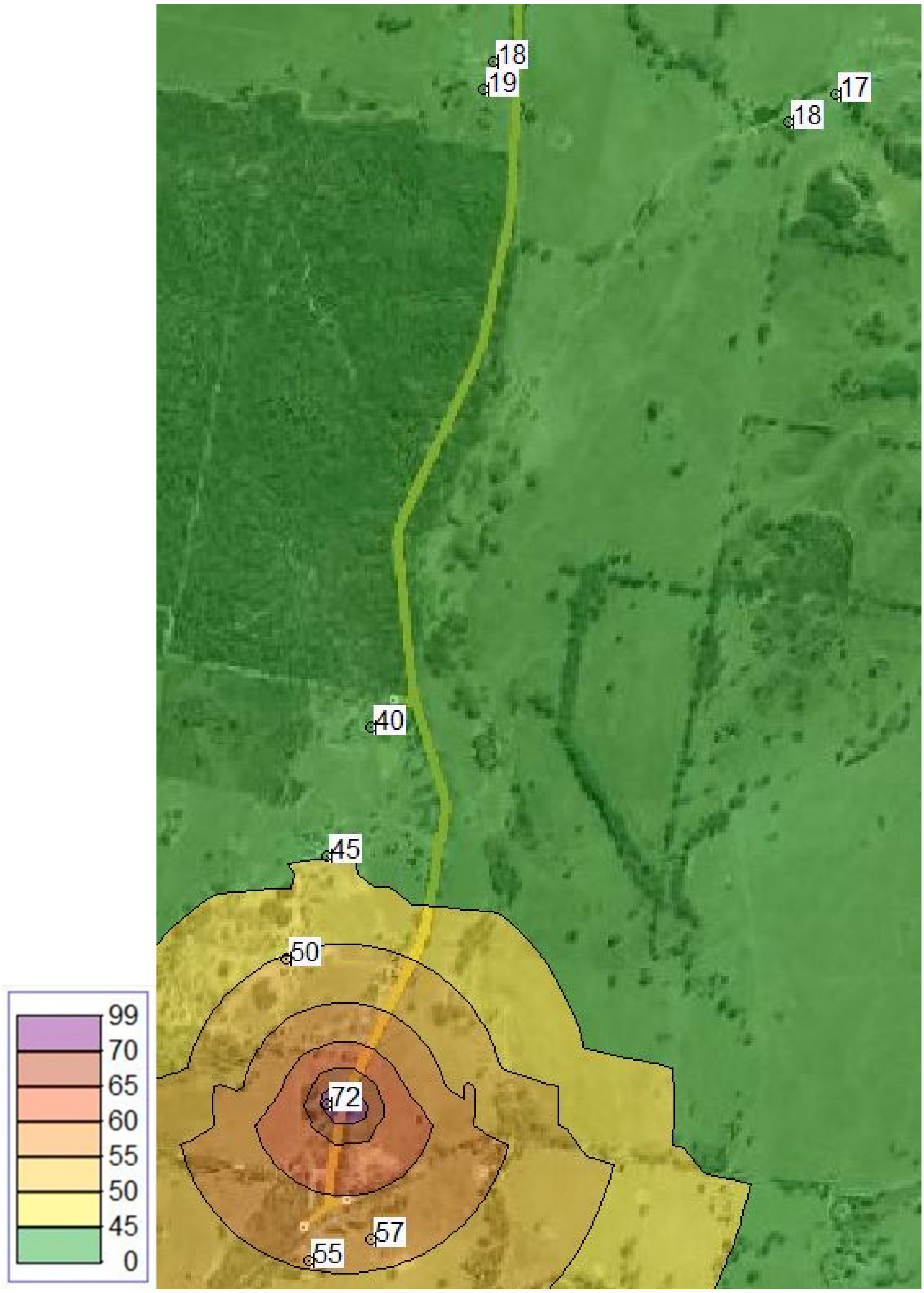

Figure 0-10 L3 Utilities

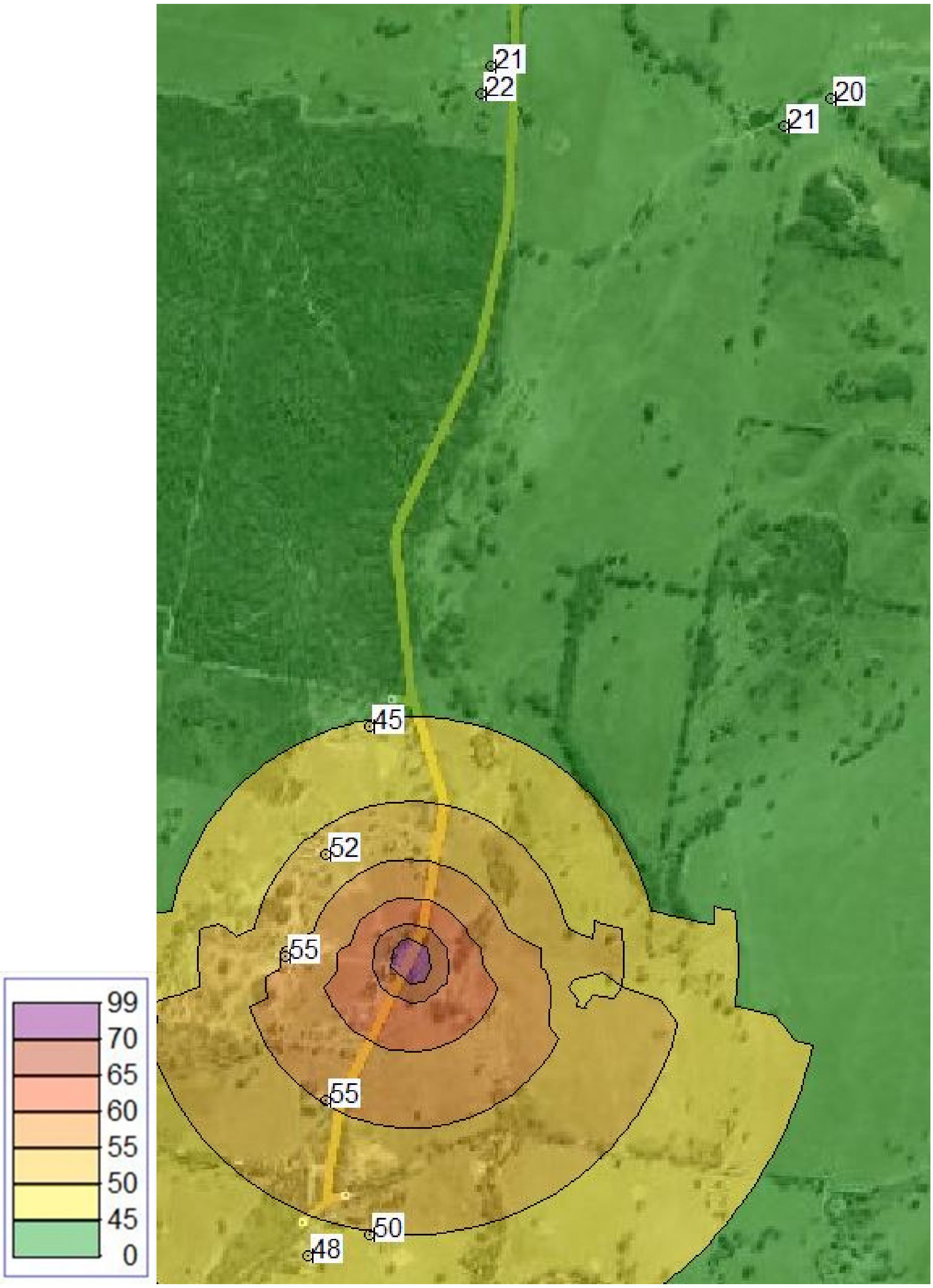

Figure 0-11 L4 Utilities

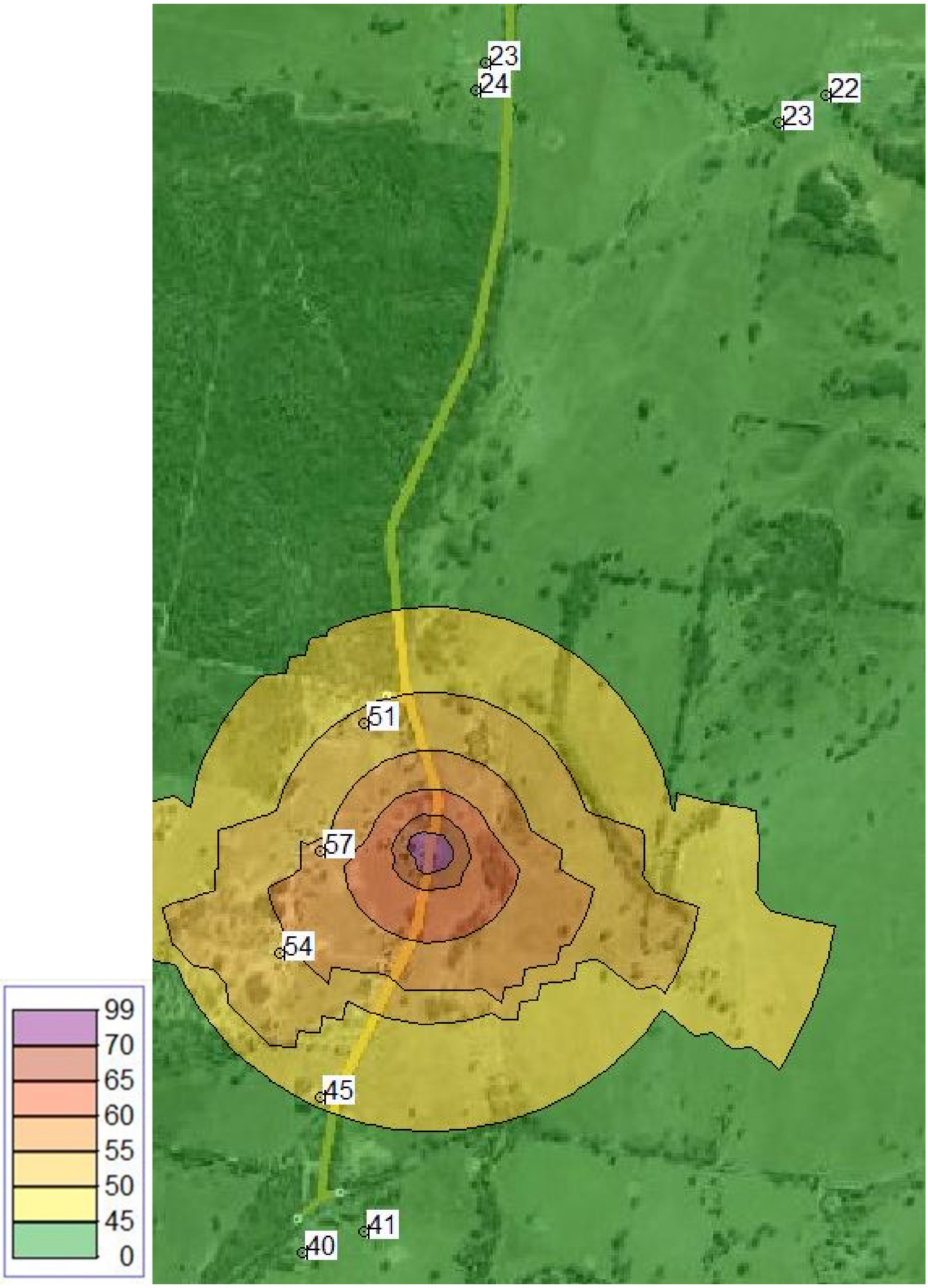

Figure 0-12 L5 Utilities

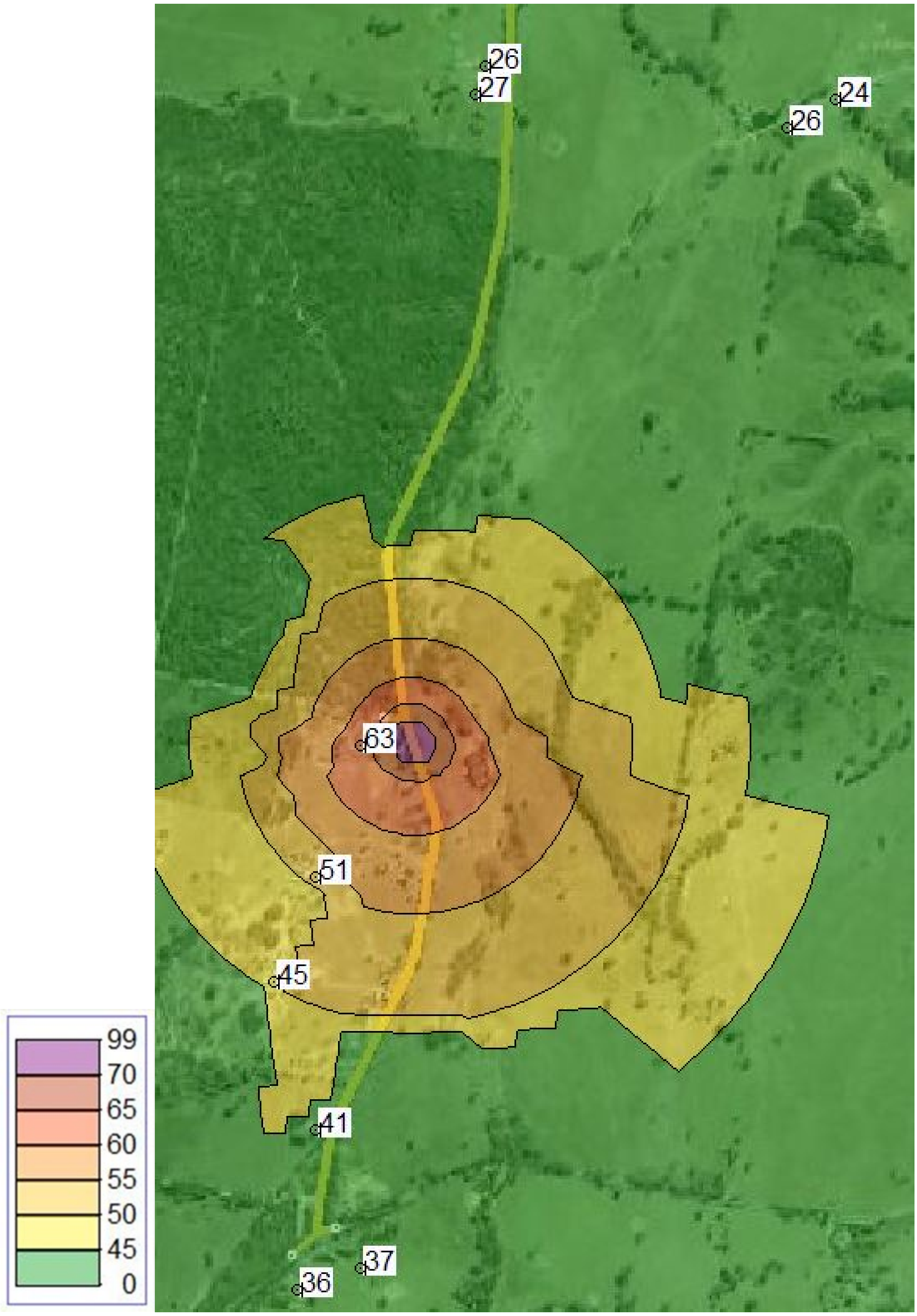

Figure 0-13 L6 Utilities

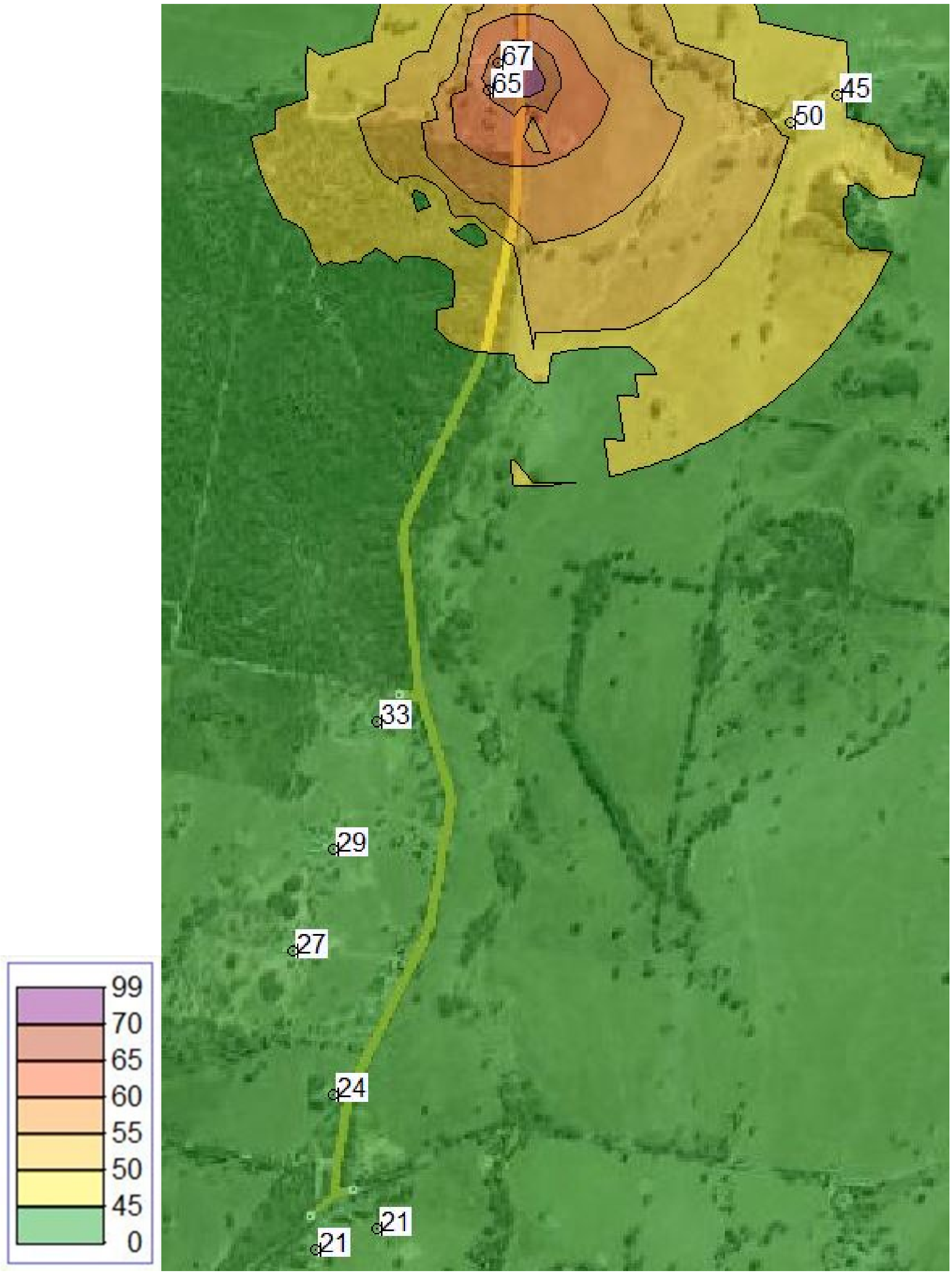

Figure 0-14 L7 Utilities

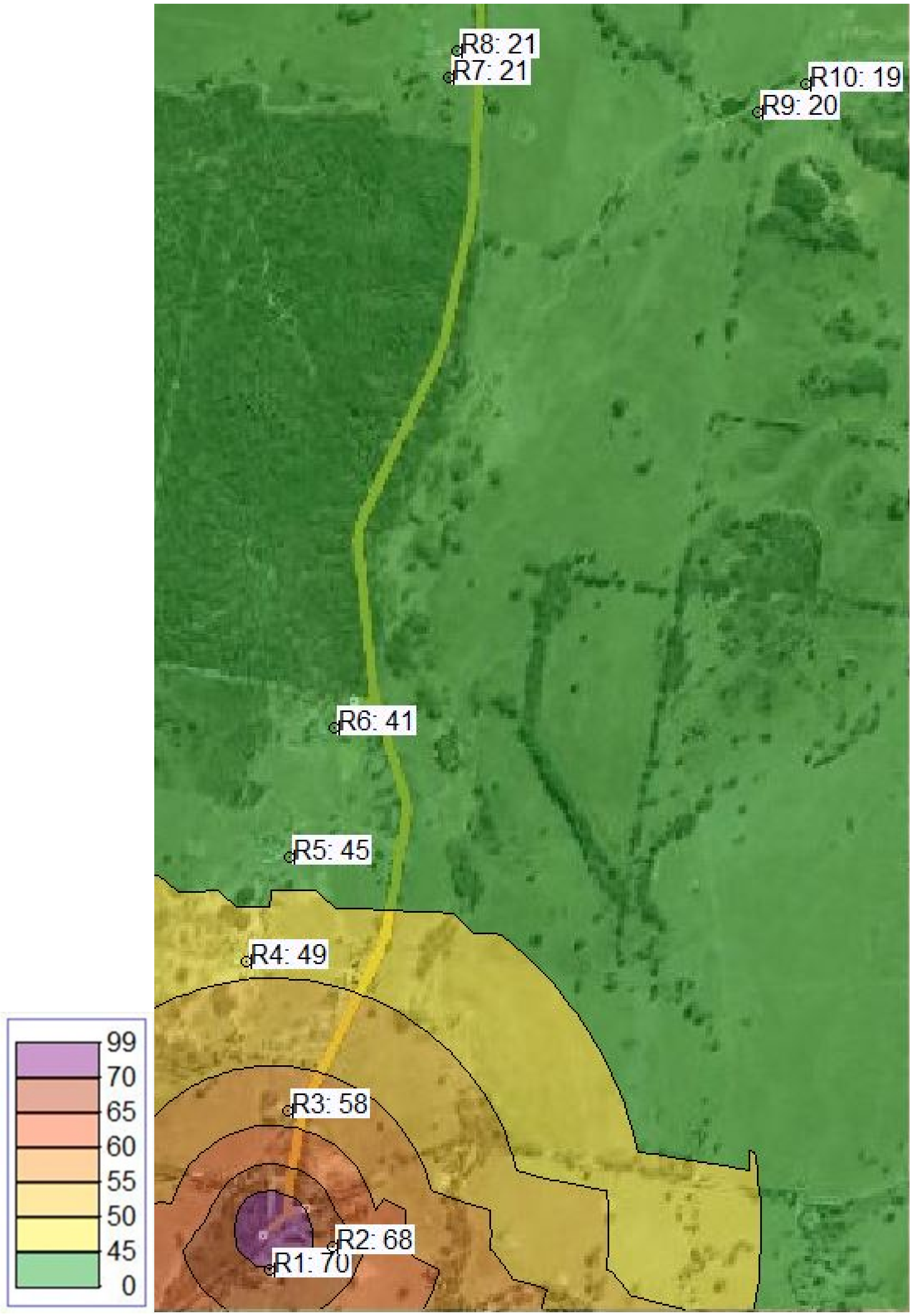

Figure 0-15 L1 Veg Removal

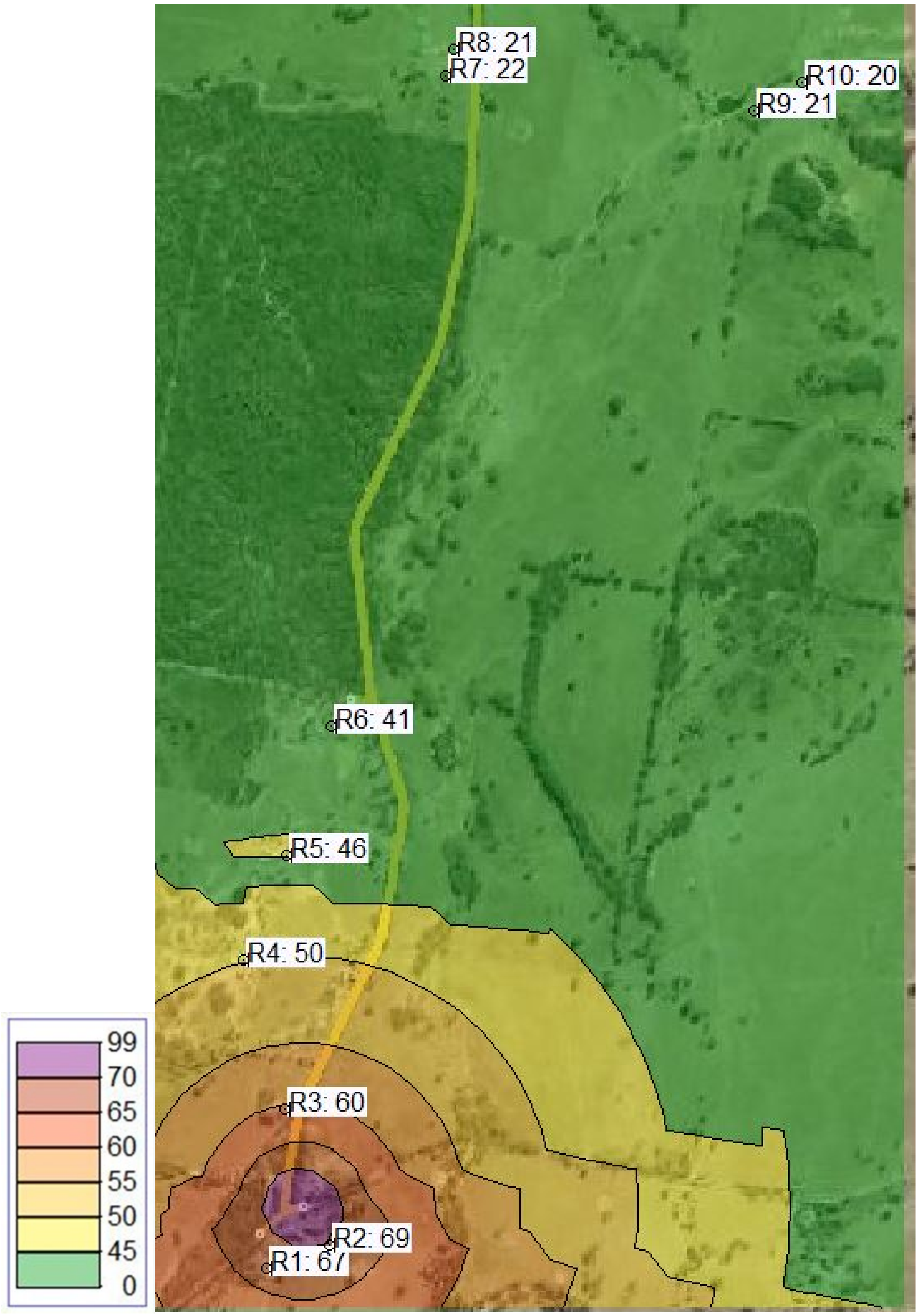

Figure 0-16 L2 Veg Removal

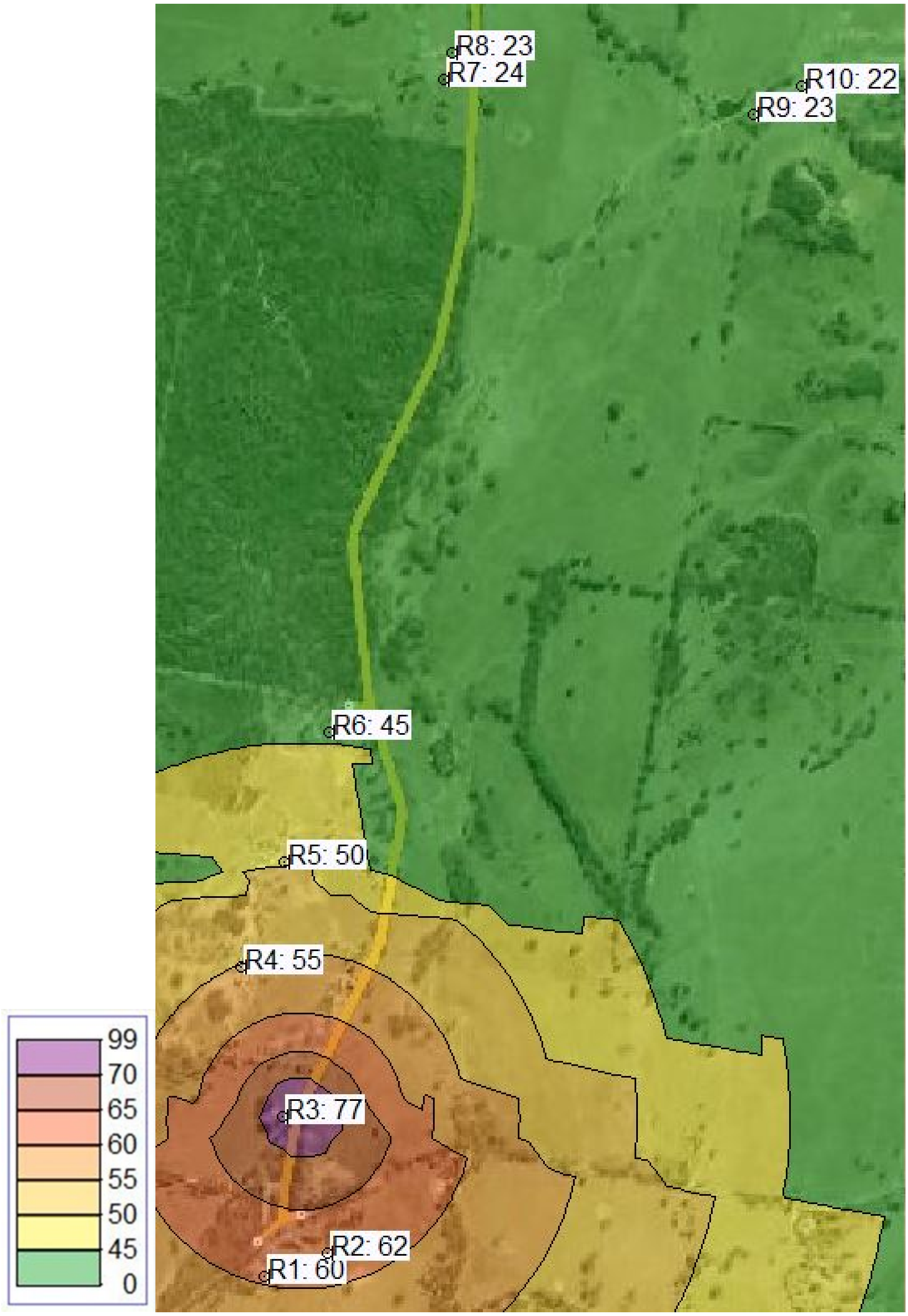

Figure 0-17 L3 Veg Removal

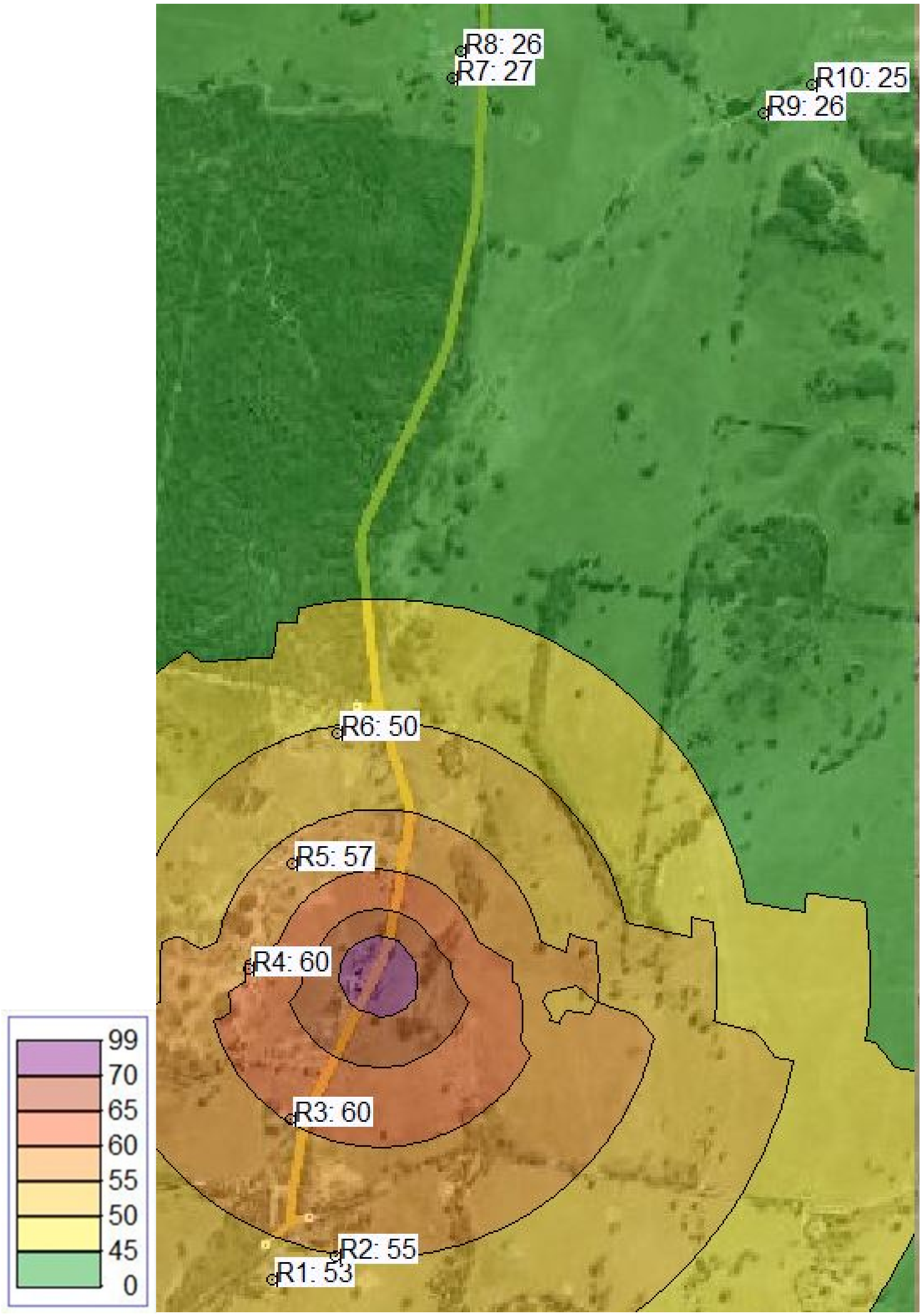

Figure 0-18 L4 Veg Removal

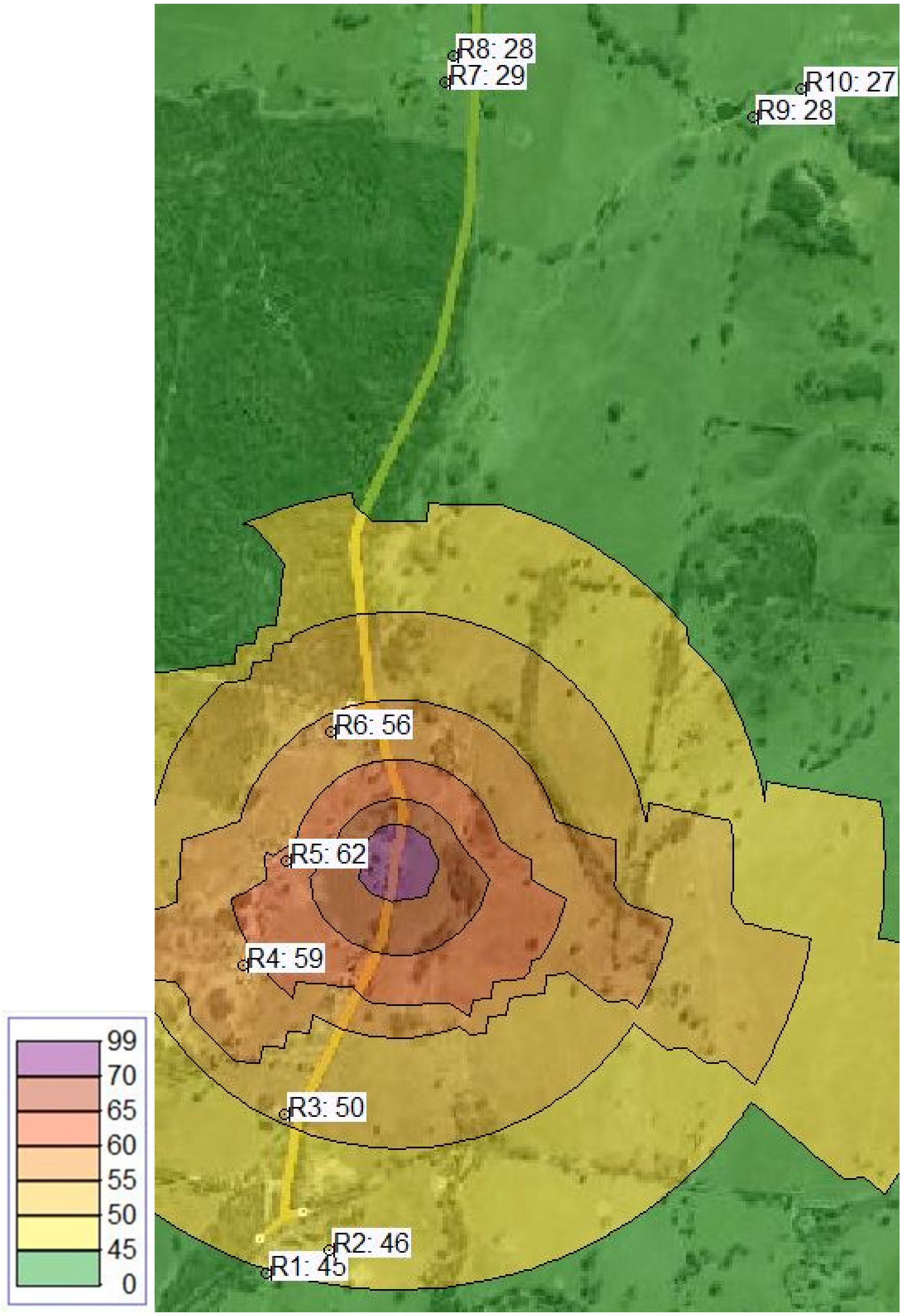

Figure 0-19 L5 Veg Removal

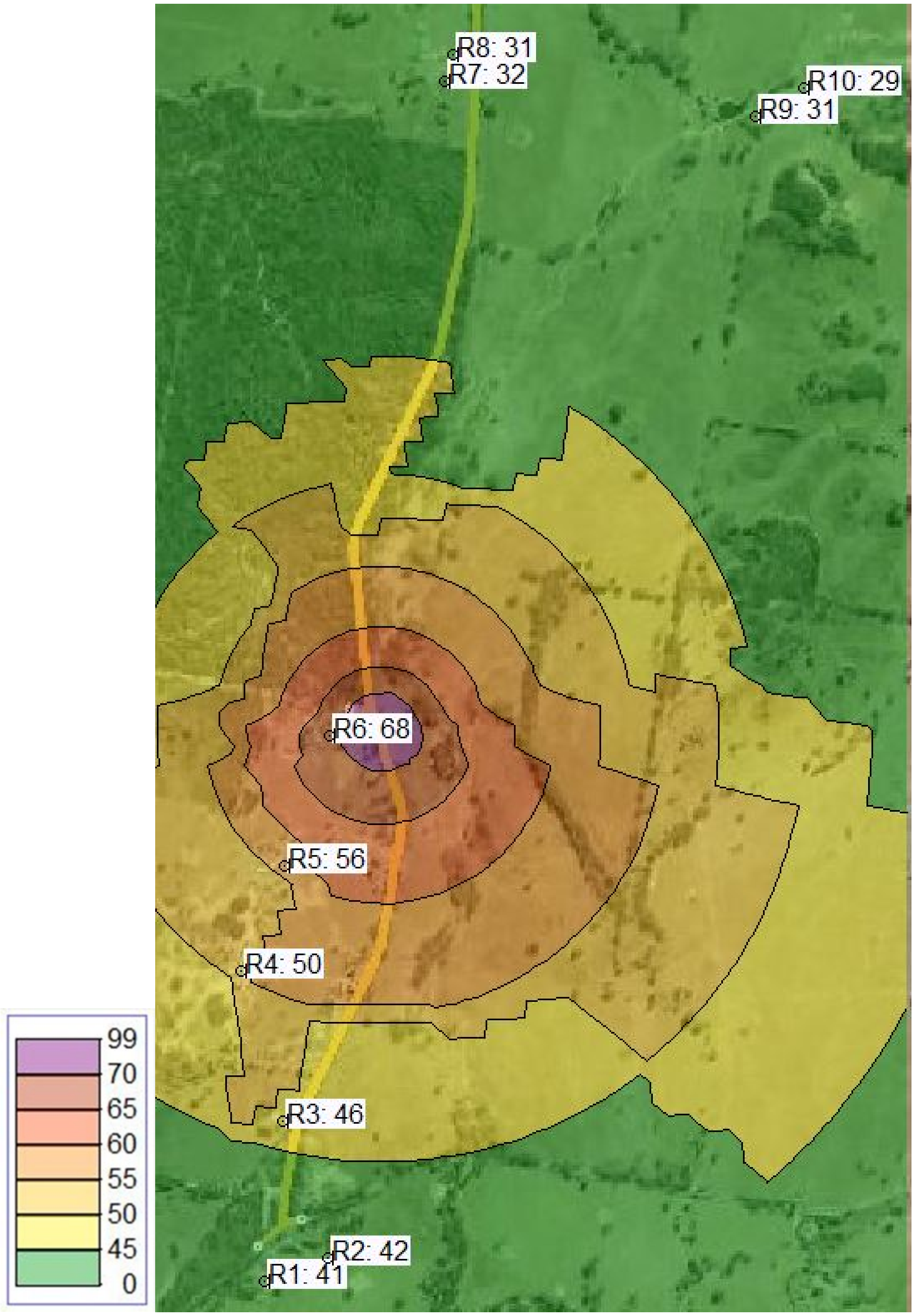

Figure 0-20 L6 Veg Removal

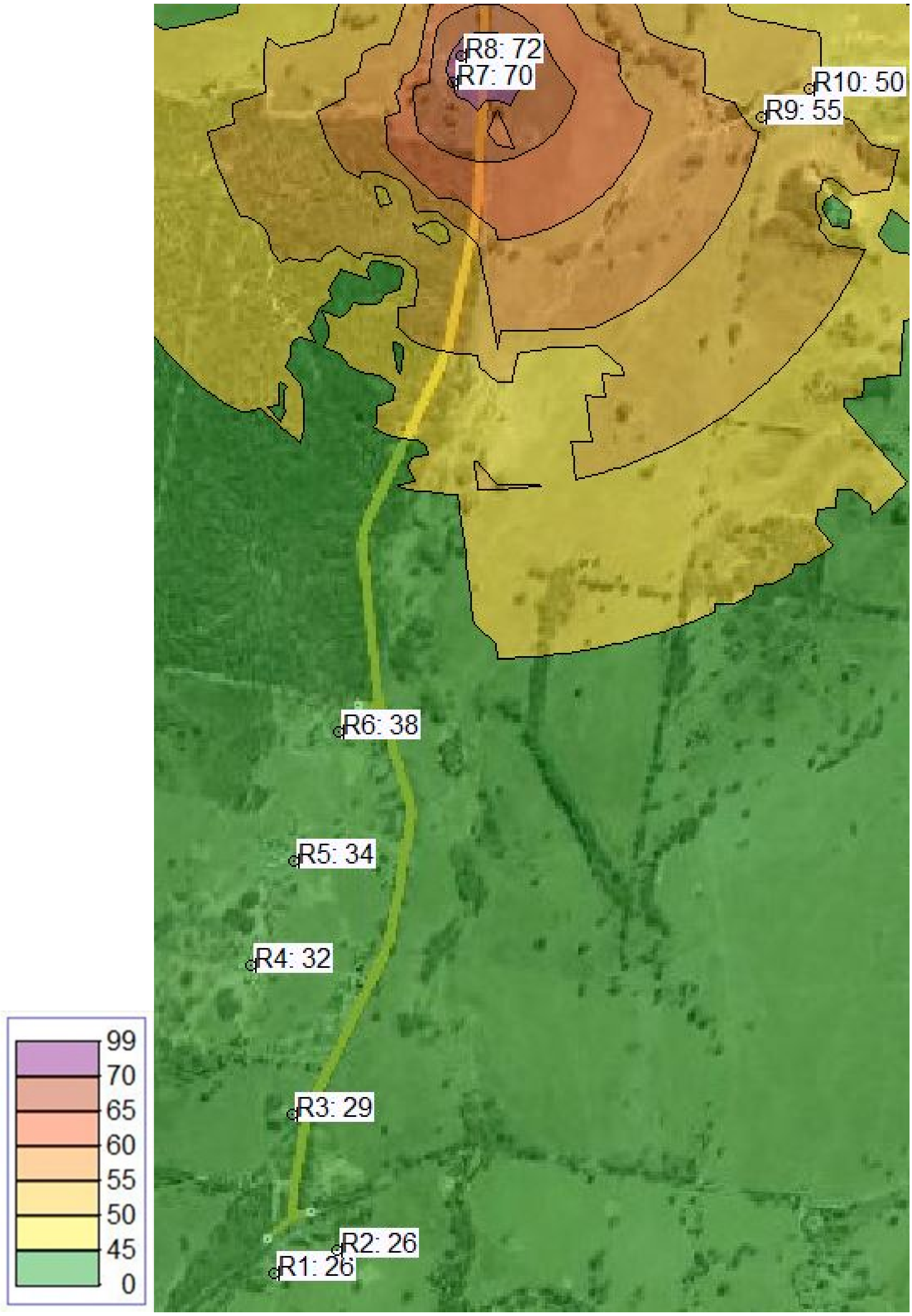

Figure 0-21 L7 Veg Removal

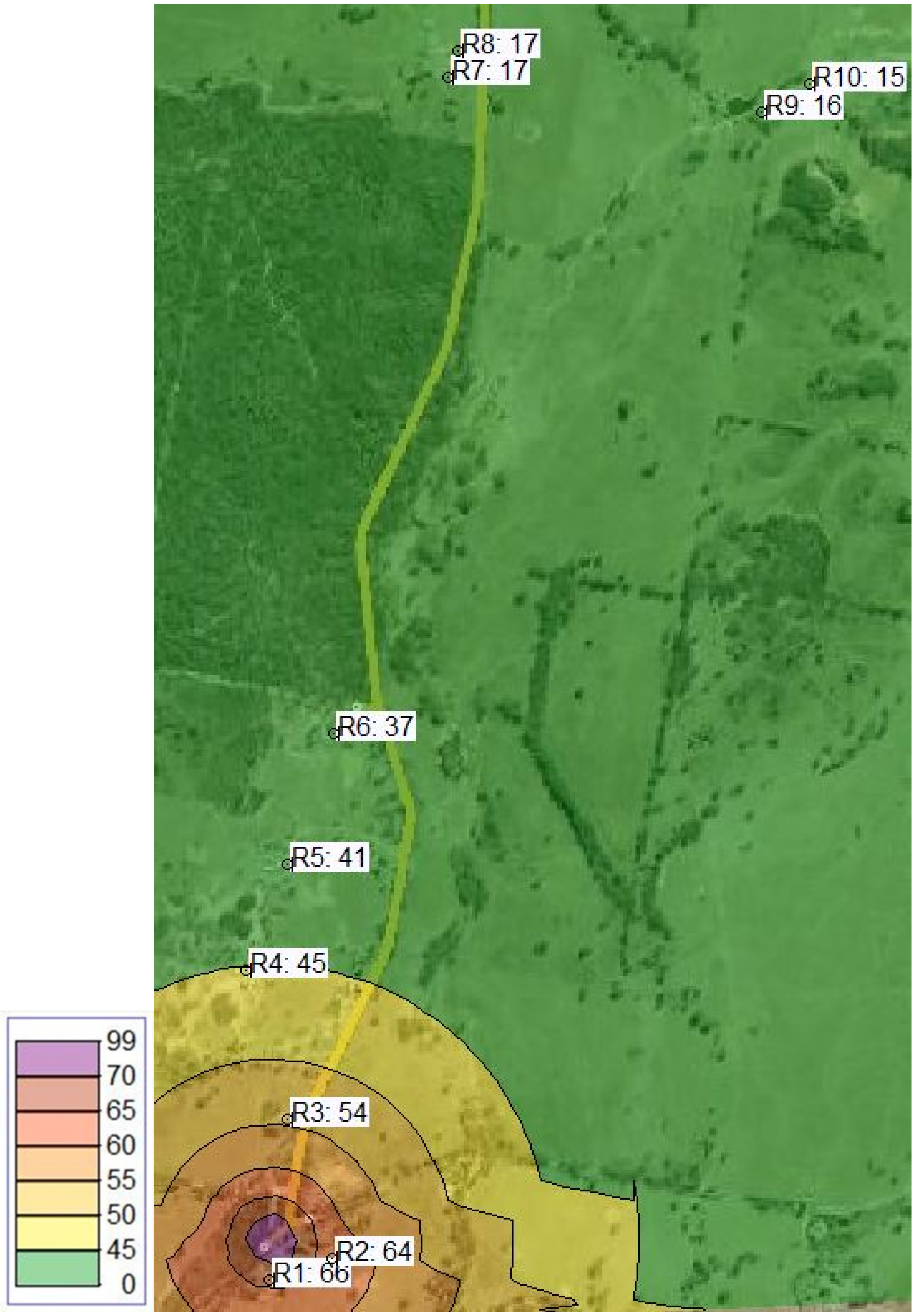

Figure 0-22 L1 Drainage / Paving

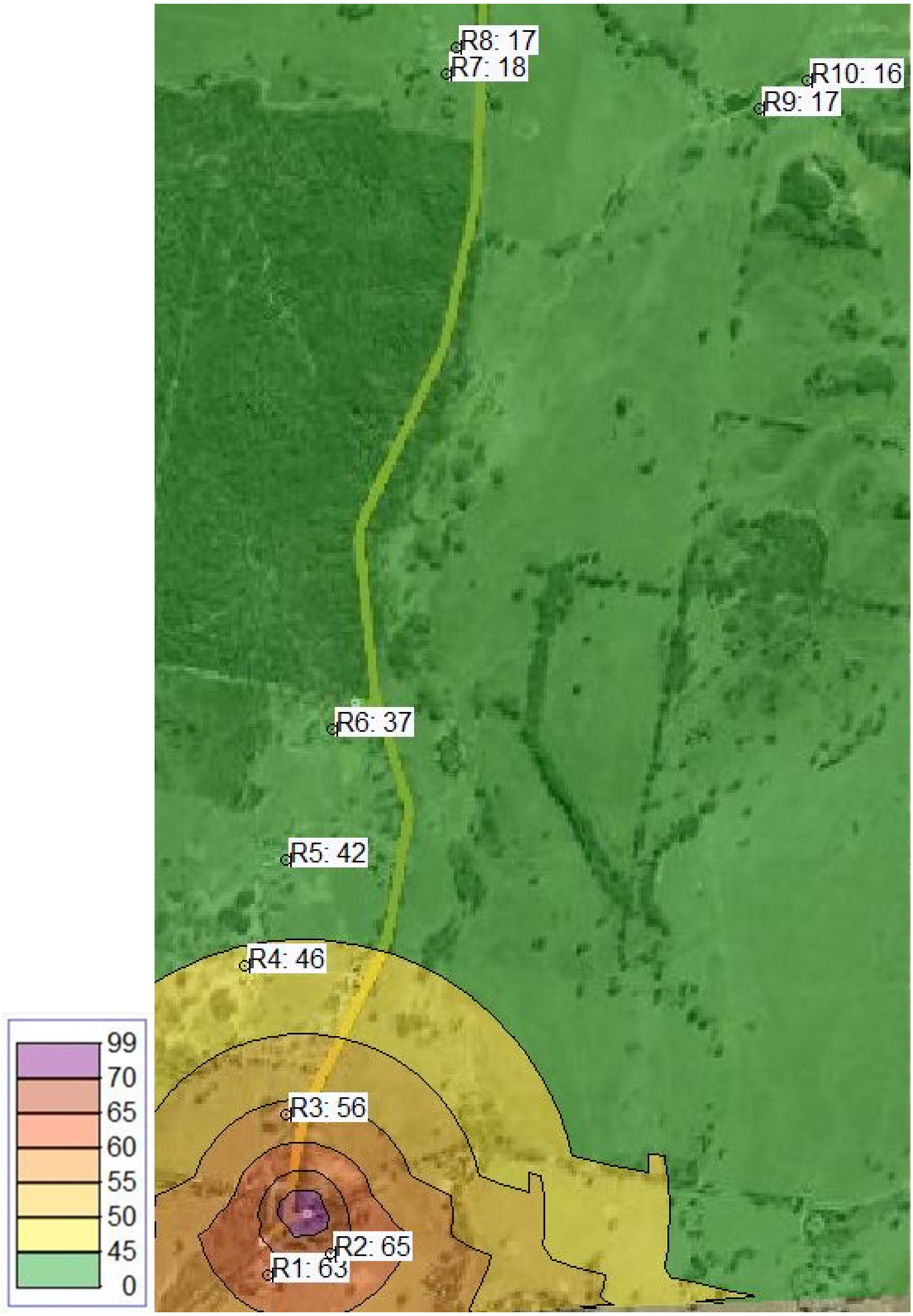

Figure 0-23 L2 Drainage / Paving

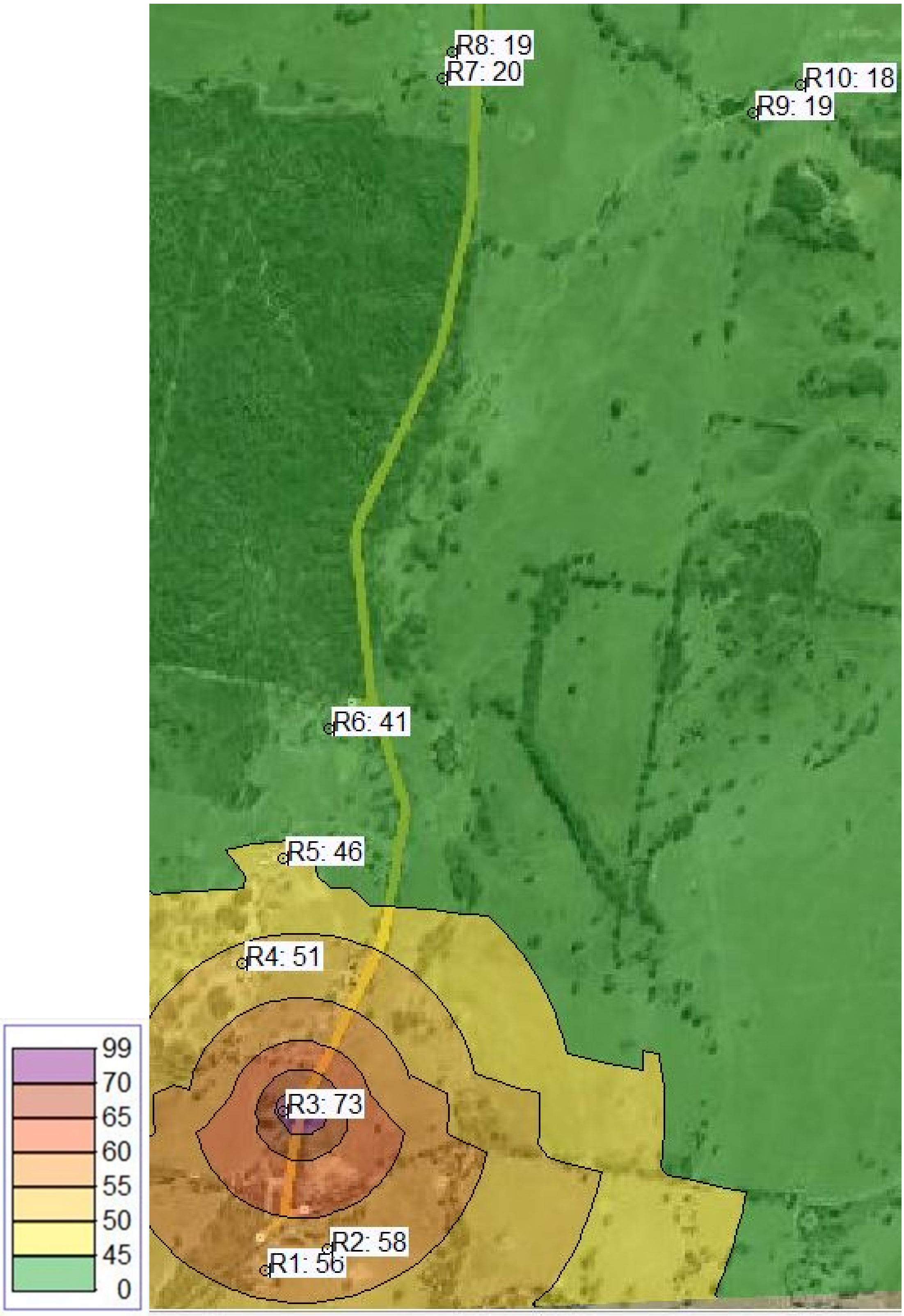

Figure 0-24 L3 Drainage / Paving

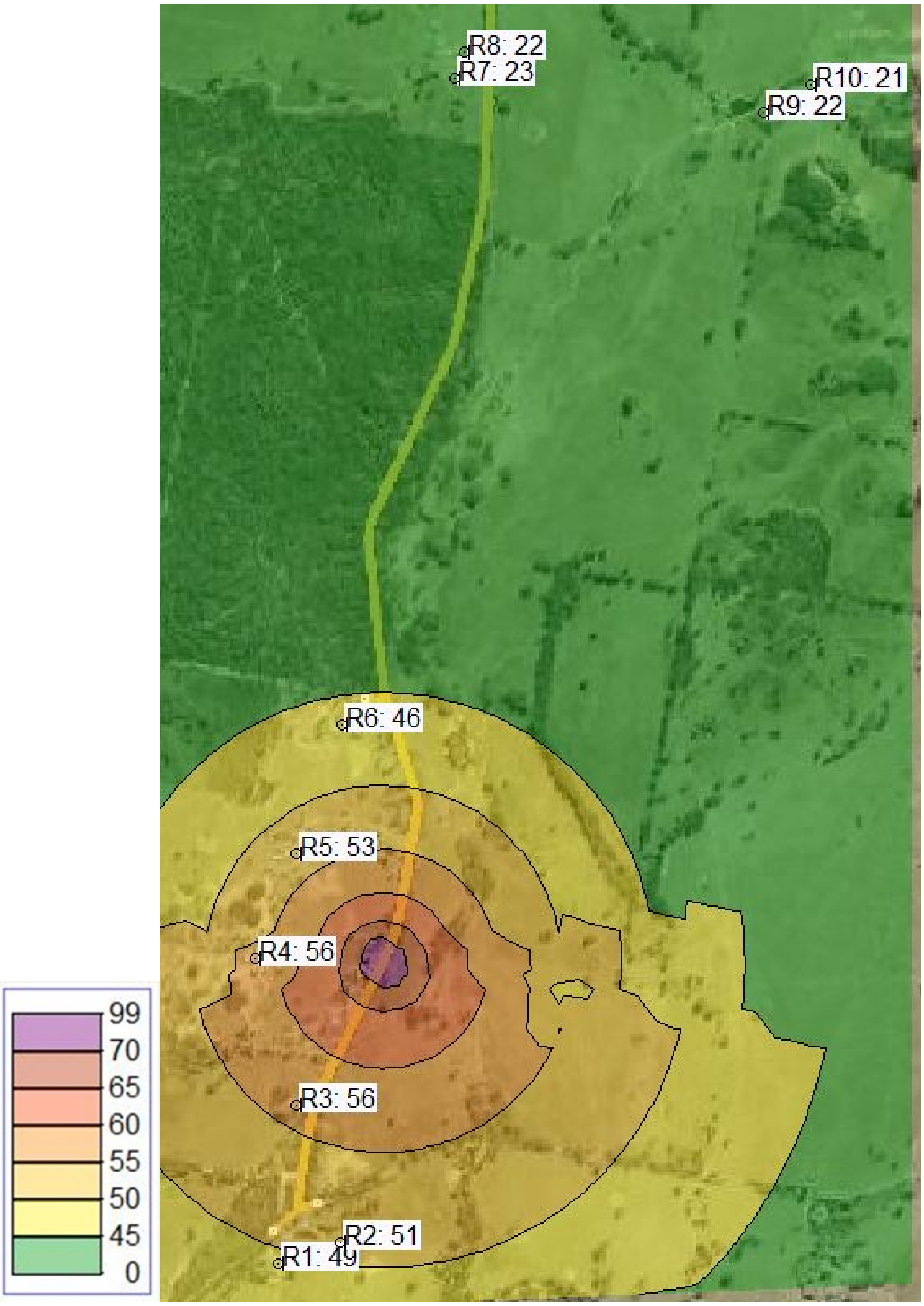

Figure 0-25 L4 Drainage / Paving

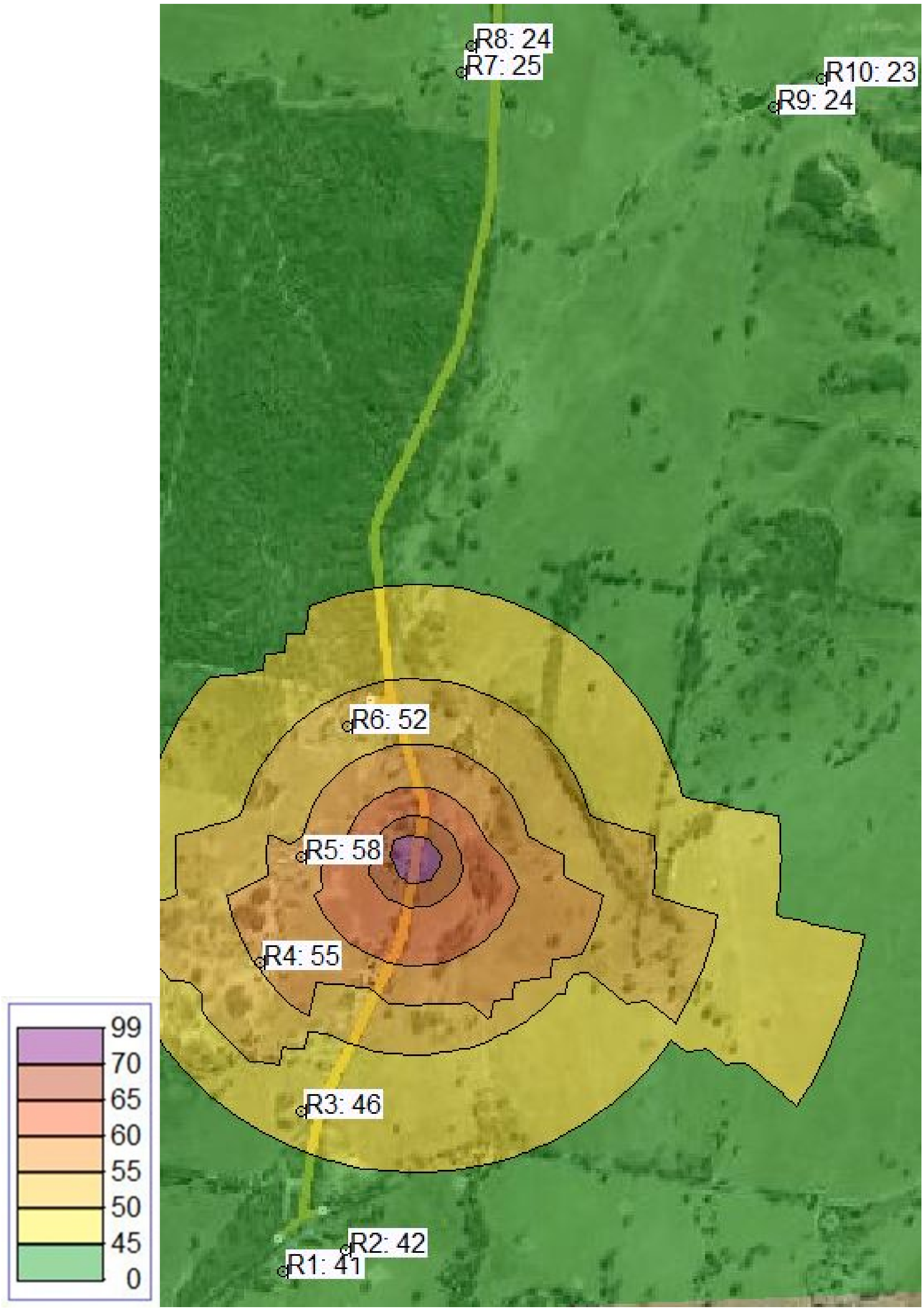

Figure 0-26 L5 Drainage / Paving

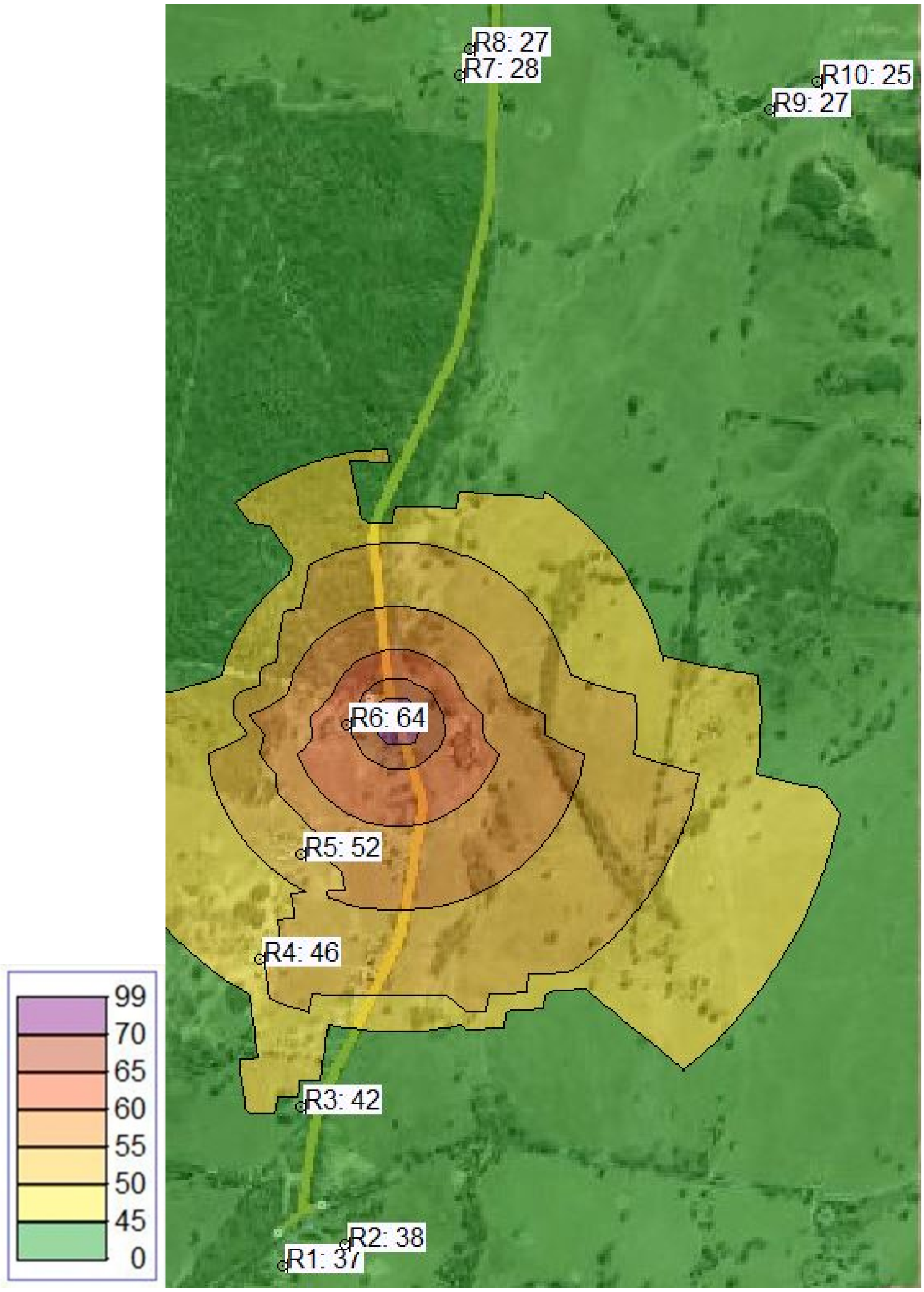

Figure 0-27 L6 Drainage / Paving

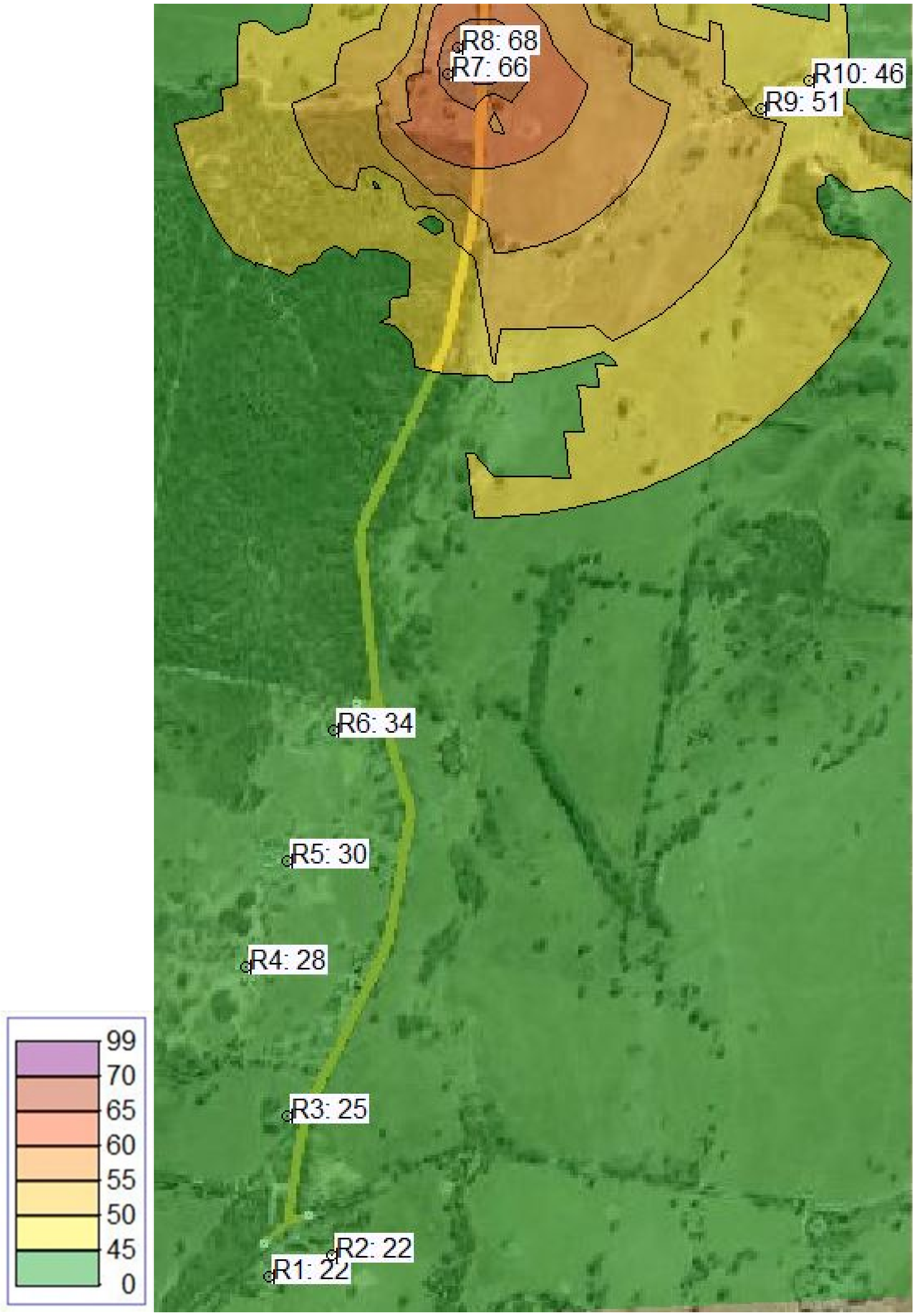

Figure 0-28 L7 Drainage / Paving

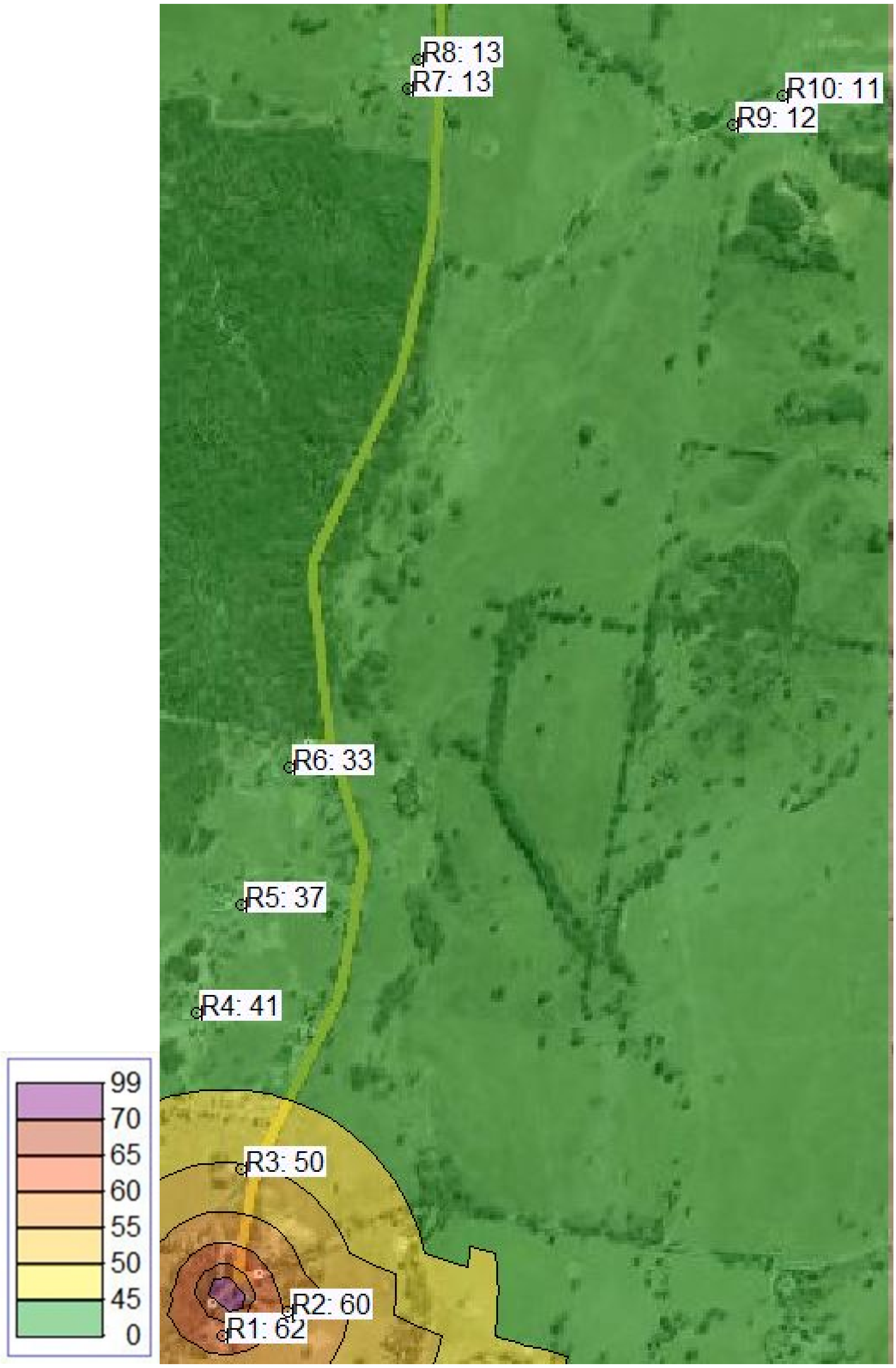

Figure 0-29 L1 Finish

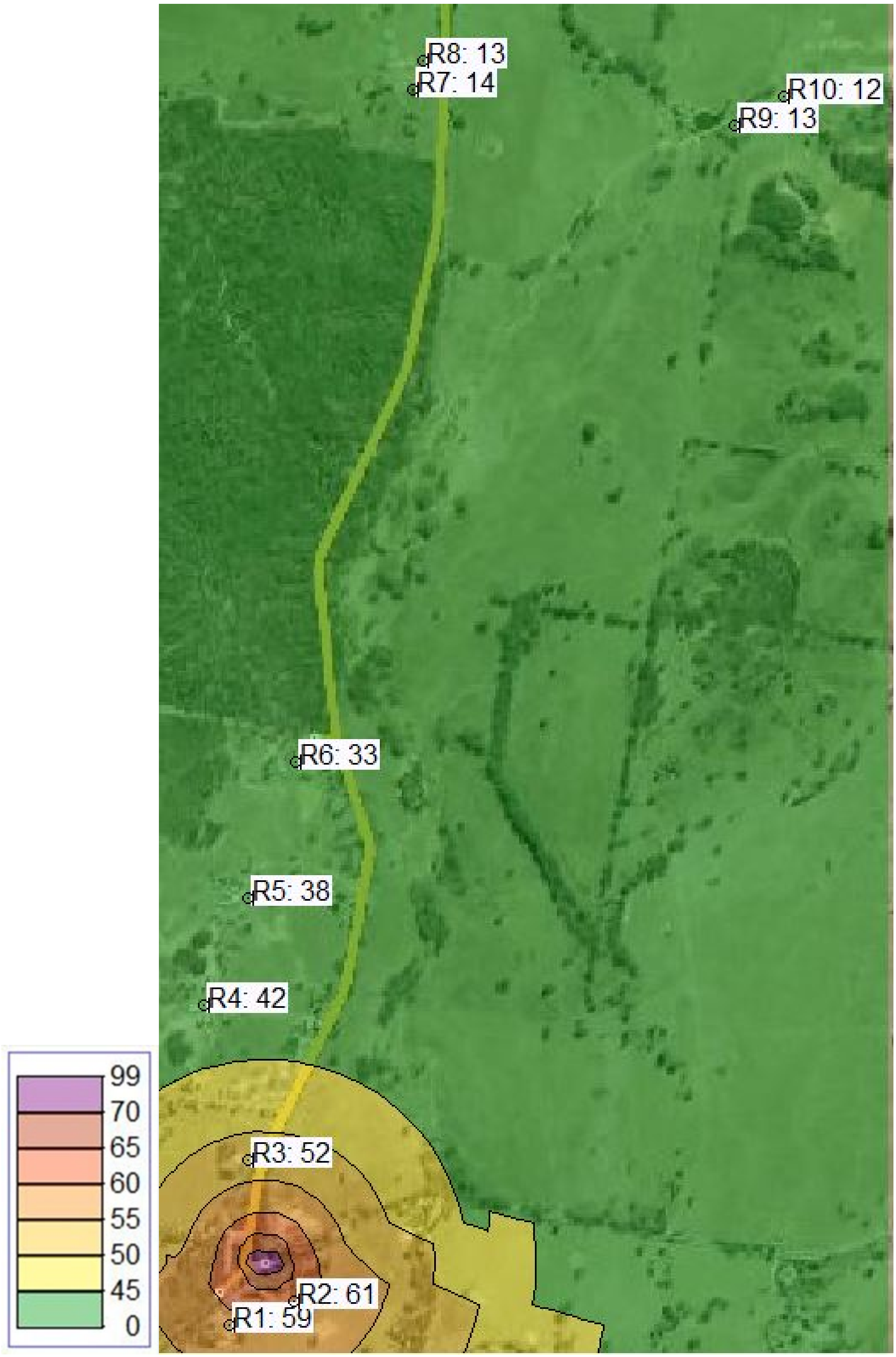

Figure 0-30 L2 Finish

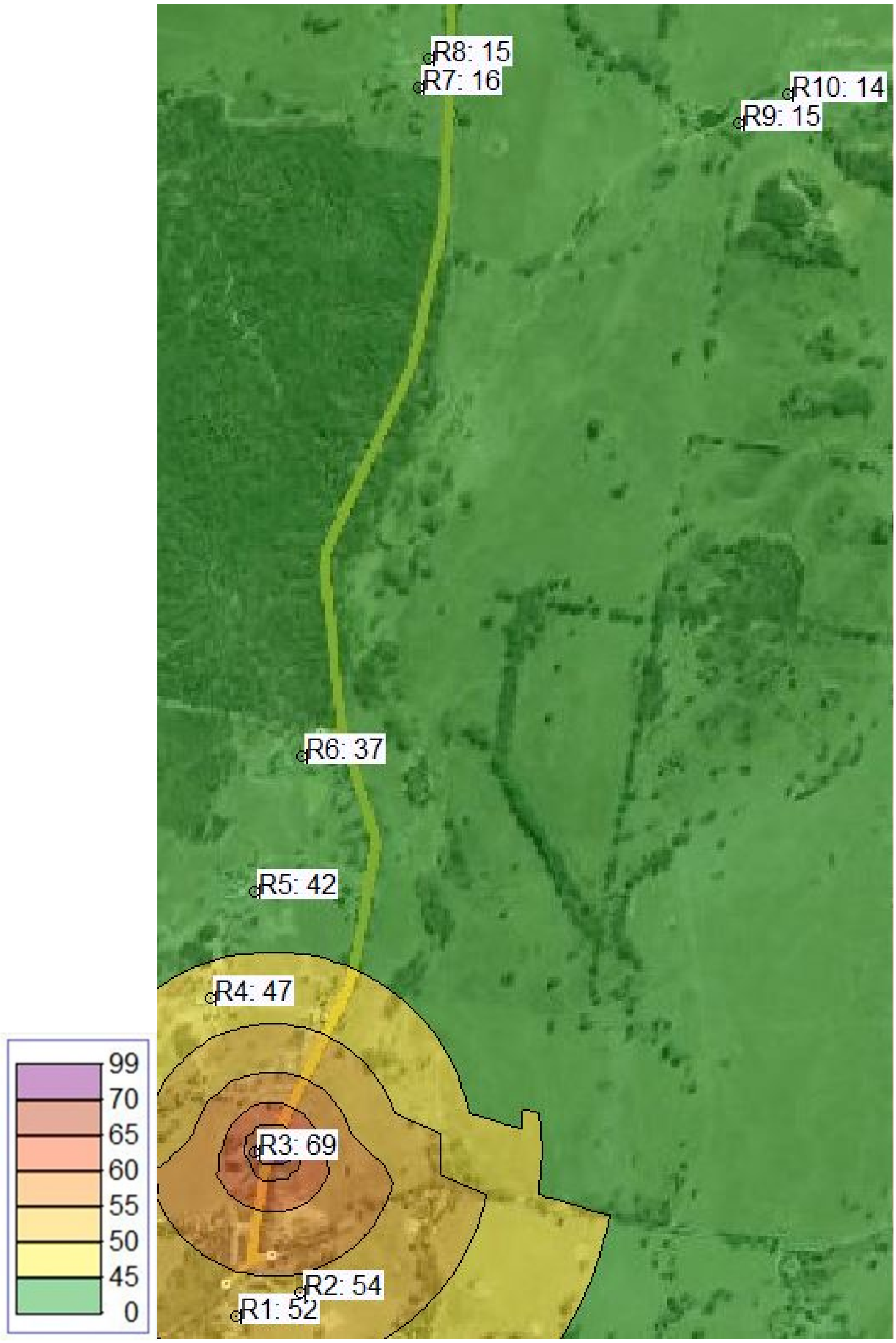

Figure 0-31 L3 Finish

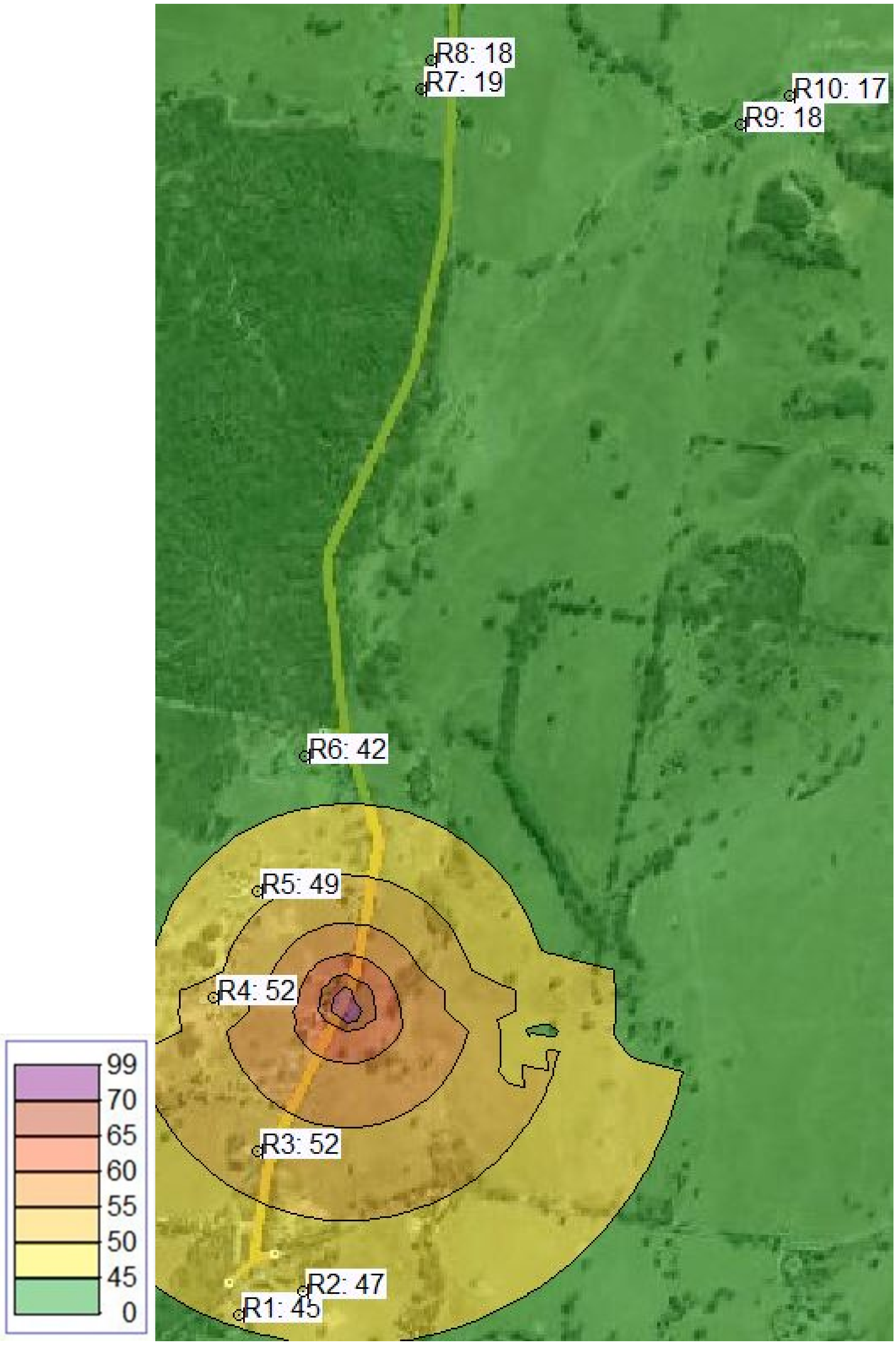

Figure 0-32 L4 Finish

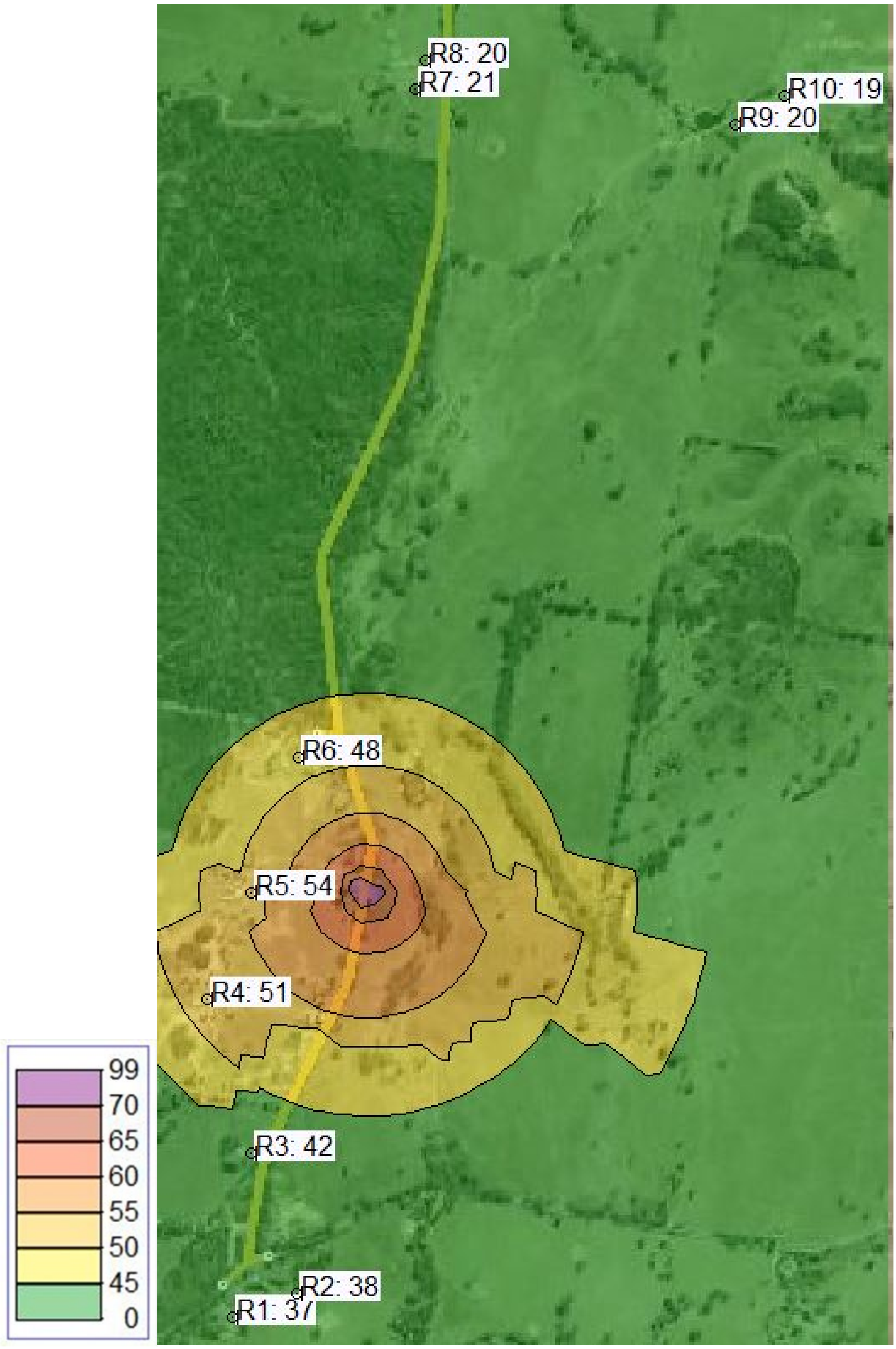

Figure 0-33 L5 Finish

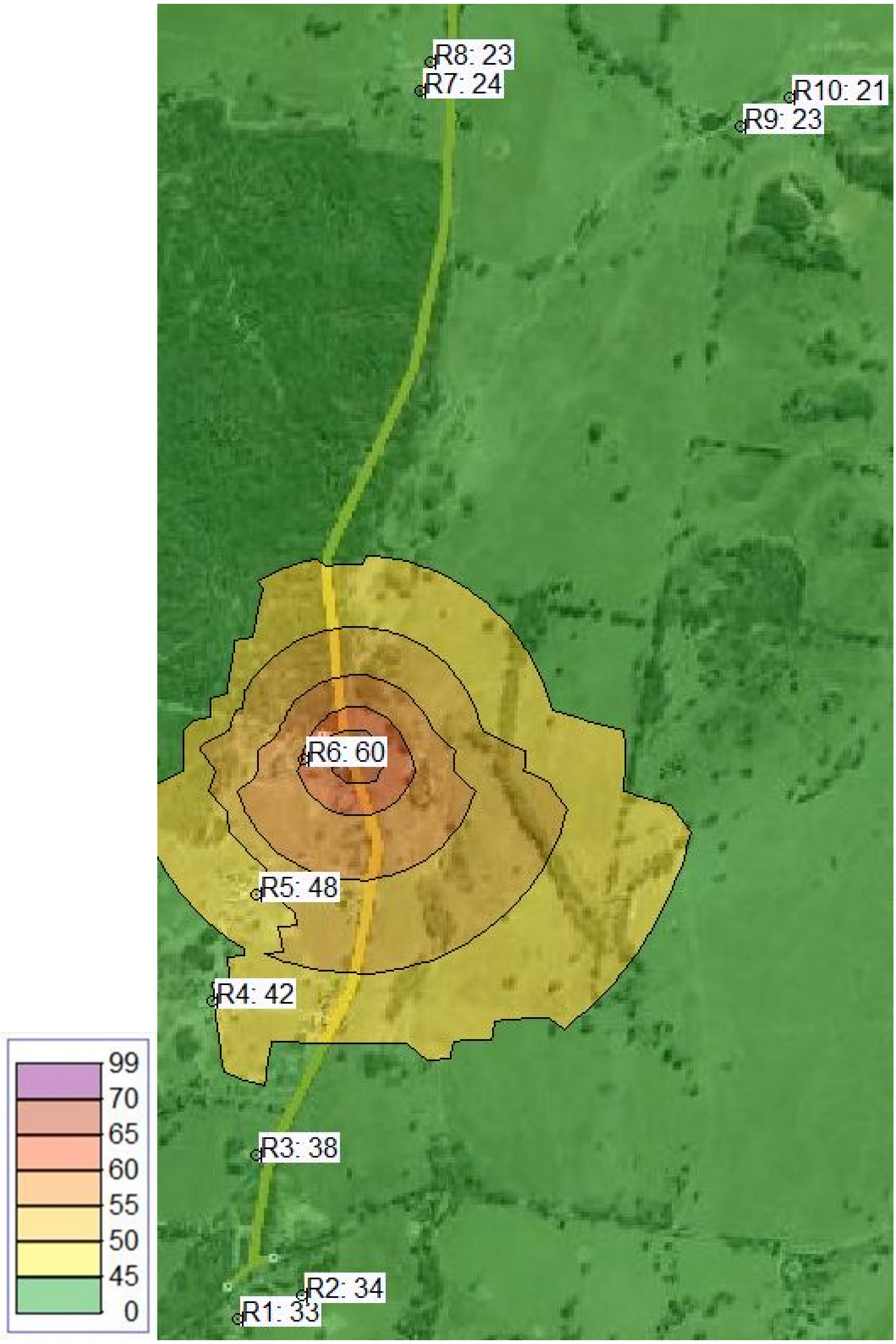

Figure 0-34 L6 Finish

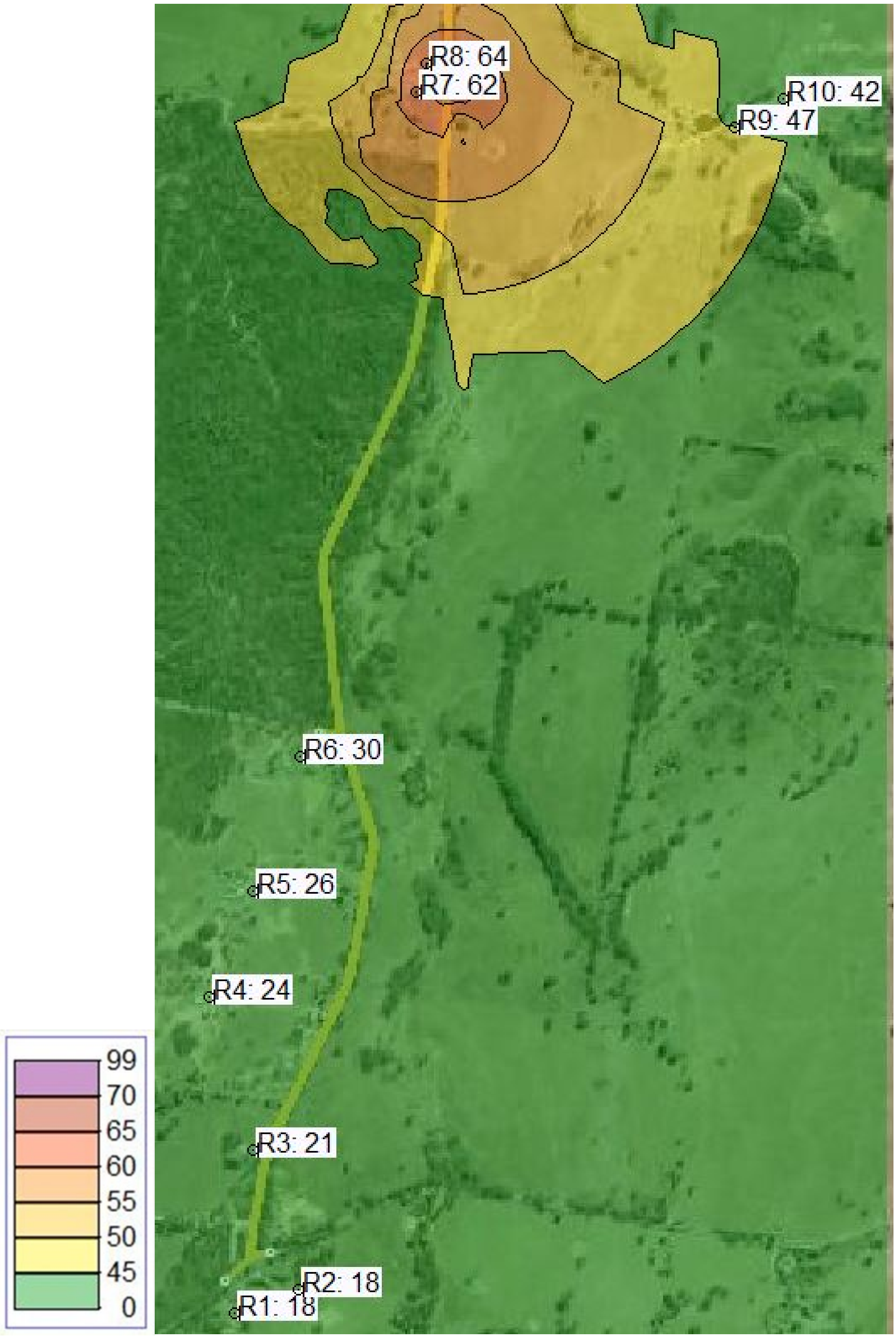

Figure 0-35 L7 Finish