KUR-World

Appendix 14

Noise and Vibration Impact Assessment

Environmental Impact Statement

APPENDIX_ASK 2017B

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KUR-World Integrated Eco Resort

Barnwell Road, Myola, Queensland

Noise and Vibration Impact Assessment

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1. Introduction

ASK Consulting Engineers Pty Ltd (ASK) was commissioned by NRA Natural Resource Assessments to provide acoustic consultancy services for the KUR-World Integrated Eco Resort development proposed to be located at Barnwell Road, Myola, Queensland. The development is to include residential, educational, sporting, leisure, accommodation, medical and retail uses.

This report presents an assessment of the noise impacts associated with existing uses as well as the development. It is to form an appendix to the Environmental Impact Statement (EIS) being submitted to the Queensland Coordinator-General for consideration by stakeholders such as Mareeba Shire Council and the Department of Environment and Heritage Protection (EHP).

The proposed development includes the following land uses:

- Residential lots
- Education campus
- Sporting facilities
- Equestrian centre
- Golf course
- Retail village
- Hotels
- Medical retreat
- Rainforest education centre
- Adventure park

The purpose of this report is as follows:

- Outline the relevant project noise criteria.
- Present the results of noise monitoring.
- Predict and assess the noise emissions from the development.
- Predict and assess the noise impacts onto the development.
- Describe noise mitigation requirements, if any.

To aid in the understanding of the terms in this report a glossary is included in **Appendix A**.

2. Study Area Description

2.1 Overview

The proposed KUR-World location is on the Atherton Tablelands approximately 3 kilometres to the west of the centre of Kuranda as shown in **Figure 2.1** and **Figure 2.2**.

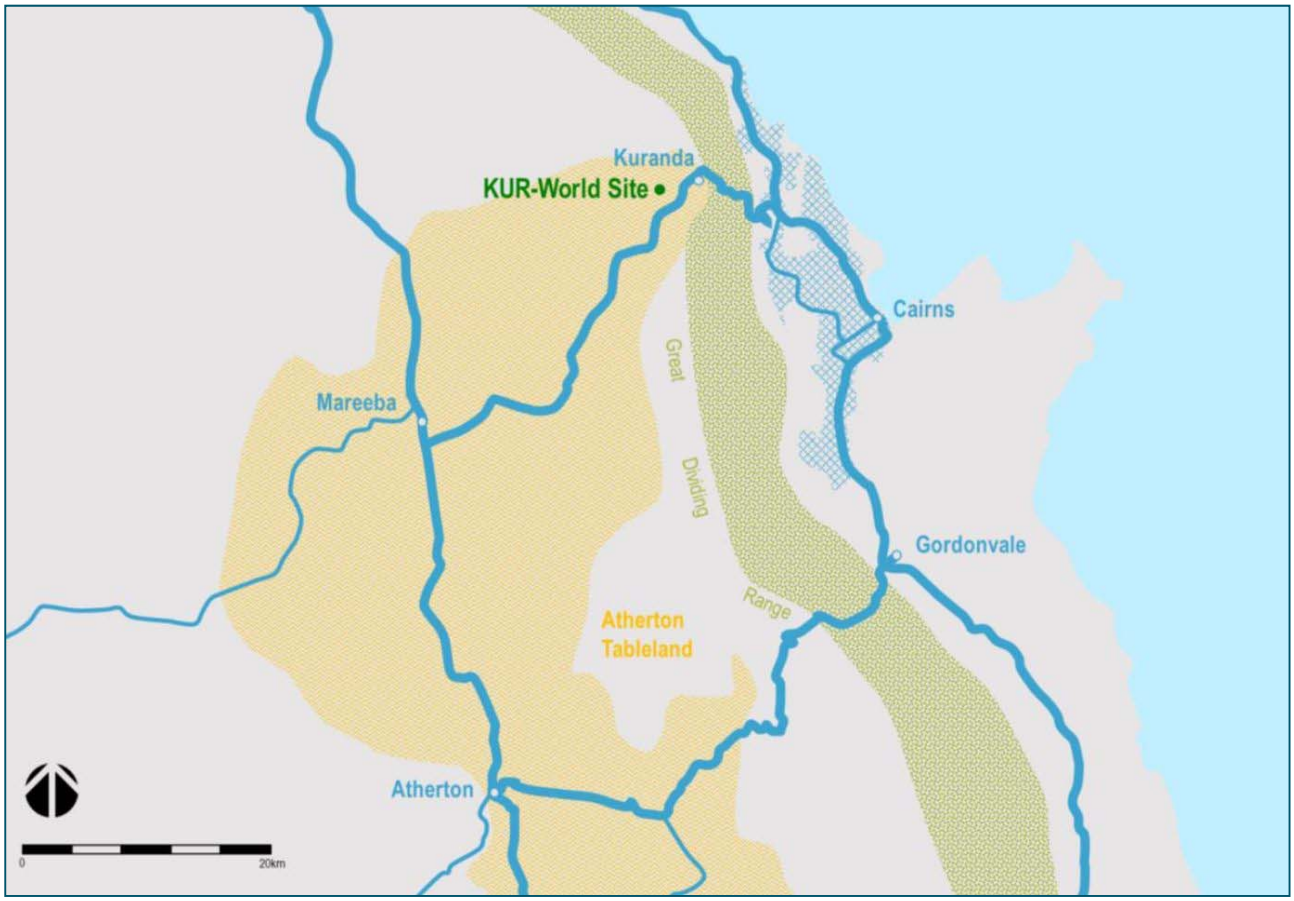


Figure 2.1 Regional Site Location

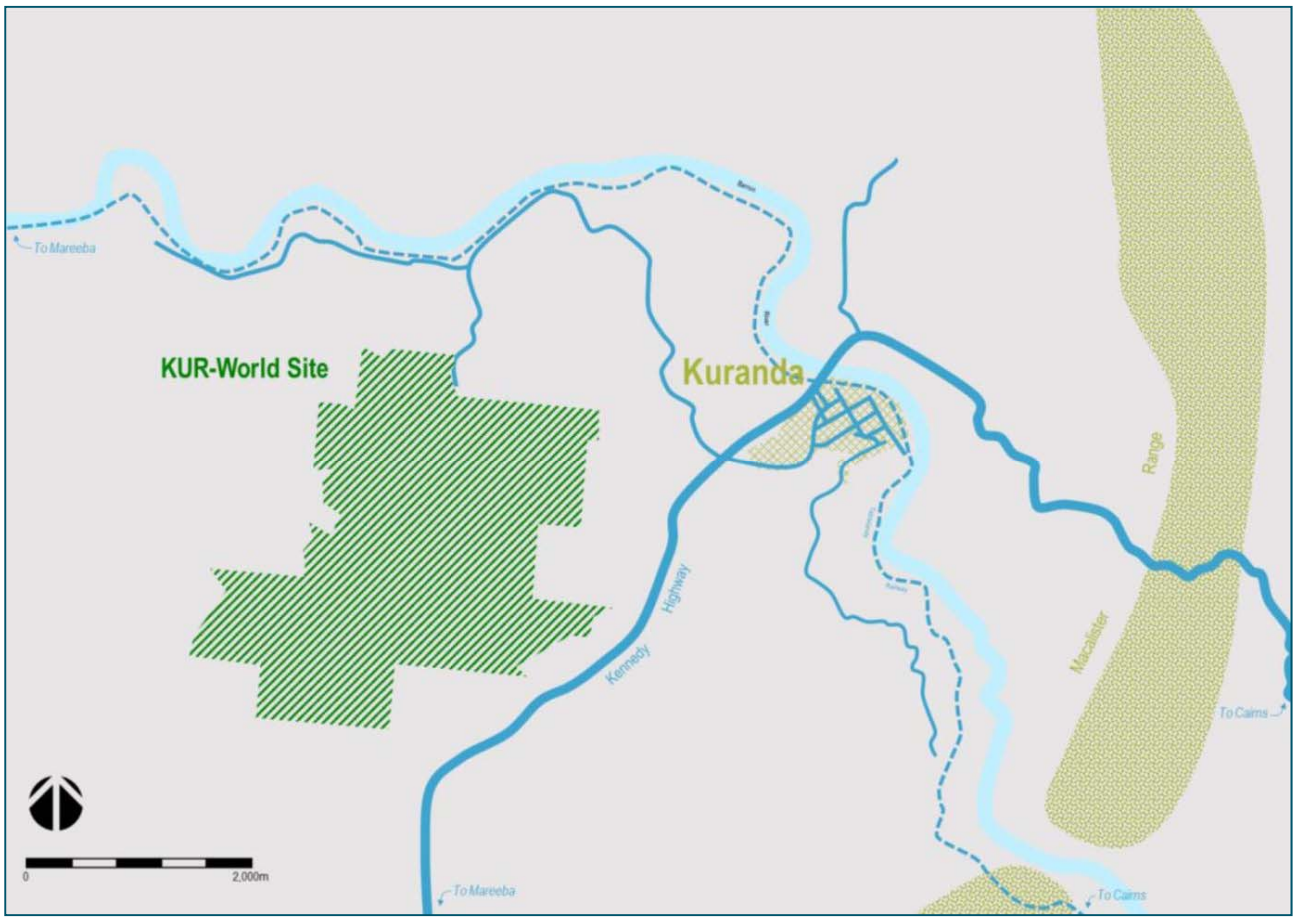


Figure 2.2 Site Location

2.2 Site Location and Nearby Uses

The proposed development is to be located at Barnwell Road, Myola, Queensland. The site location is shown in **Figure 2.3** (source: Google Earth Pro).

The site currently has a farmhouse, dam and animal yards located on the northern section of the property. The southern section generally consists of cleared land for grazing and rainforest.

The immediate surrounding land uses follow:

- Residences and a small orchard off Monaro Close are to the north.
- Residences and a church off Barnwell Road are to the north-east.
- Residences off Warril Drive, Hilltop Close and Punch Close are to the east.
- The Billabong Hotel facility is to the south.
- Residences and the Kuranda Pet Resort dog kennels are to the west.

The zoning of the site is rural. The zoning of surrounding properties is either rural or rural-residential.

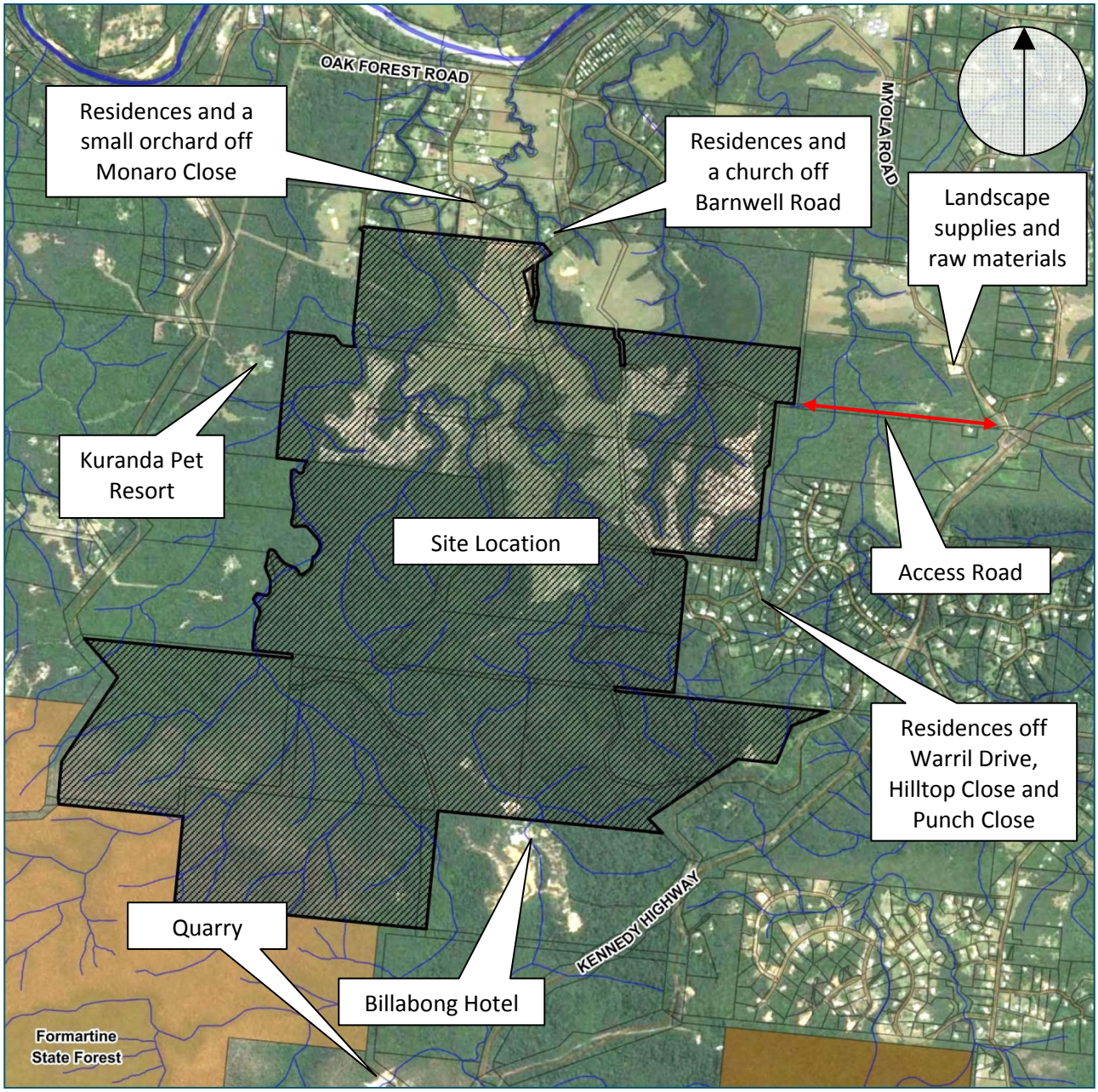


Figure 2.3 Site Location and Nearby Uses

2.3 Sensitive Land Uses and Receptors

Sensitive land uses are defined in Schedule 24 of the Planning Regulation 2017 as:

(a) caretaker's accommodation; or
(b) a childcare centre; or
(c) a community care centre; or
(d) a community residence; or
(e) a detention facility; or
(f) a dual occupancy; or
(g) a dwelling house; or
(h) a dwelling unit; or

(i) an educational establishment; or
(j) a health care service; or
(k) a hospital; or
(l) a hotel, to the extent the hotel provides accommodation for tourists or travellers; or
(m) a multiple dwelling; or
(n) non-resident workforce accommodation; or
(o) a relocatable home park; or
(p) a residential care facility; or
(q) a resort complex; or
(r) a retirement facility; or
(s) rooming accommodation; or
(t) rural workers' accommodation; or
(u) short-term accommodation; or
(v) a supervised accommodation service; or
(w) a tourist park.

Sensitive receptor (or sensitive receiver) means an area or place where noise is measured as defined by Schedule 1 of the Environmental Protection Policy (Noise) 2008.

The nearest sensitive receptors are summarised in **Table 2.1** including their northing and easting locations and are shown in **Figure 2.4** (Image from Google Earth Pro). The closest receptors to the proposed development are approximately 100 metres from the Queenslander lots at the farm-stay accommodation. The receptors listed in **Table 2.1** are residences with the exception of 16 (Church), 24 (Pet Resort), and 28 (Hotel). It is noted that a Church itself is not classified as a sensitive receiver, unless it has components which are considered sensitive (e.g. caretaker's accommodation etc).

The nearest schools to the site are:

- Cairns Rudolph Steiner School 46 Boyles Rd 1 kilometre to the west of the development.
- Kuranda District State College 260 Myola Rd more than 1.5 kilometres to the north of the development and off the boundary of **Figure 2.4**. The rural residential properties around the development site already have a residence on them.

The receptor locations listed in **Table 2.1** are existing receptors that have the potential to be impacted by the proposed Project. They were selected based on the presence of a sensitive land use and the distance and direction of the receptor from parts of the proposed development site that may include noise emission sources.

Table 2.1 List of Sensitive Receptors with UTM Coordinates (WGS84 Z55)

ID	Address	Real Property Description	Indicative Distance and Direction from Proposed Developments	Easting (m)	Northing (m)
1	7 Hilltop Close	86/RP746616	300m to the south of the villas	351965	8138646
2	10 Hilltop Close	79/RP746616	"	352033	8138670
3	2 Warril Drive	76/RP742969	100m to the south of the villas	351995	8138883
4	4 Warril Drive	75/RP742969	"	352043	8138831
5	6 Warril Drive	74/RP742969	"	352102	8138776
6	8 Warril Drive	73/RP742969	"	352147	8138829

ID	Address	Real Property Description	Indicative Distance and Direction from Proposed Developments	Easting (m)	Northing (m)
7	10 Warril Drive	72/RP742969	"	352184	8138865
8	1 Warril Drive	77/RP742969	"	352301	8138852
9	10 Punch Close	44/RP737515	300m to the east of the villas 5 star resort	352481	8139138
10	8 Punch Close	43/RP737515	"	352512	8139179
11	6 Punch Close	42/RP737515	"	352524	8139218
12	4 Punch Close	41/RP737515	"	352549	8139245
13	Punch Close	40/RP737515	"	352578	8139273
14	77 Barnwell Road	16/N157227	200m to the east of the equestrian centre	351384	8140301
15	78 Barnwell Road	1/RP735374	100m to the north-east of the farm accommodation	351275	8140479
16	62 Barnwell Road (Church)	2/SP218094	300m to the north of the farm accommodation	351272	8140708
17	2 Leilas Way	2/RP748612	300m to the north-east of the farm accommodation	351438	8140530
18	78 Monaro Close	8/RP737018	100m to the north of farm accommodation	350979	8140493
19	68 Monaro Close	9/RP737018	"	350920	8140523
20	77 Monaro Close	7/RP737018	"	351055	8140569
21	64 High Chapparal Road	1/RP748876	500m to the north-west of the equestrian centre	350230	8140570
22	76 High Chapparal Road	3/RP748876	"	350351	8140363
23	73 High Chapparal Road	8/RP728075	"	350437	8140516
24	131 Boyles Road (Pet Resort)	4/RP749637	300m to the north-west of the villas	349941	8139832
25	165 Boyles Road	3/RP749637	600m to the west of the villas	349640	8139572
26	197 Boyles Road	1/RP866988	"	349449	8139375
27	265 Boyles Road	2/RP734821	700m to the south-west of the villas	349765	8138872
28	186 Mount Haren Road (Billabong Hotel)	44/RP851441	100m to the south-east of the small education centre	351217	8137600

The existing receptors in **Table 2.1** are shown in **Figure 2.4** in addition to future proposed sensitive receptors identified later in this report.

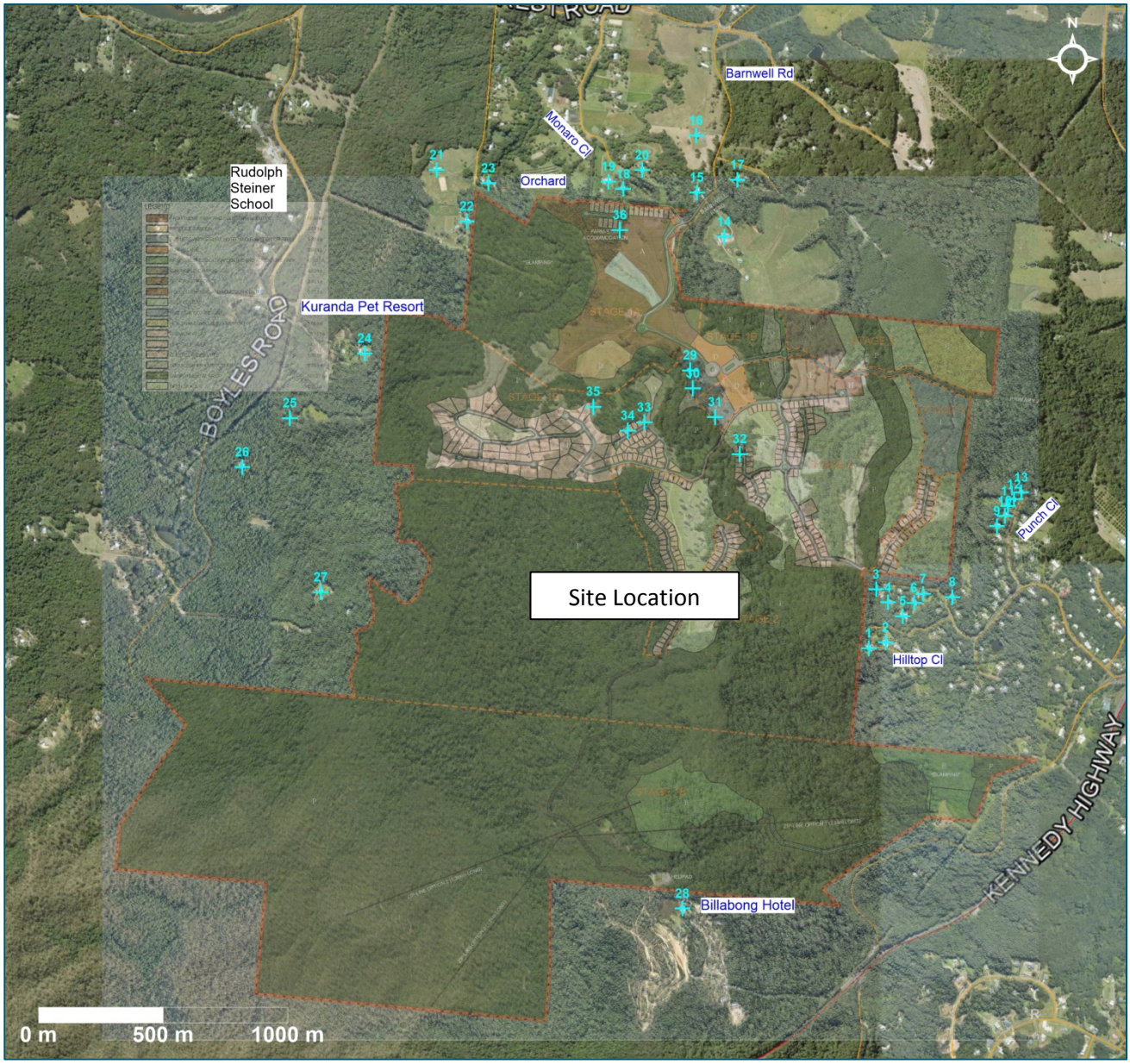


Figure 2.4 Aerial Photo, Site Layout and Location of Existing Offsite Receptors (1 to 28) and Proposed Future Onsite Sensitive Receptors (29 to 36)

2.4 Description of Noise Sources in the Vicinity

A survey of potential noise sources in the surrounding area was conducted on 22nd and 23rd February 2017 and the results are summarised in **Table 2.2**.

Table 2.2 List of Nearby Noise Sources

Address	Name	Location relative to development (refer Figure 2.3)	Potential Noise Emissions impacting onto Development
45 Myola Rd	Kuranda Landscape Supplies	Approximately 800m east of the development	Equipment and vehicles
47 Myola Rd	Kuranda Raw Materials	Approximately 800m east of the development	Equipment and vehicles
46/RP851443	Quarry on Kennedy Highway opposite Windy Hollow Road	Approximately 1.5km south of the development	Equipment and vehicles
56 Monaro Close	A small orchard	Approximately 75m north of the development	Occasional farm equipment
186 Mount Haren Road	Billabong Hotel	Approximately 75m south of the development	Recreational activities
131 Boyles Road	Kuranda Pet Resort	Approximately 75m west of the development	Dogs

The landscape supplies, material supplies and quarry are all well over 500 metres from the development site. In addition, this quarry is not shown on key resource area mapping under the State Planning Policy. Thus noise emissions from these activities are considered very unlikely to impact on the development site, and they are not considered further in this report.

The closest KUR-World components to the orchard are the proposed farm theme park and equestrian centre, which are not considered sensitive to the potential orchard noise. The proposed farm-stay accommodation is approximately 150 metres south-west of the orchard, which is the same distance as other existing residences near the orchard. The noise from the orchard is not considered further in this report.

The Billabong Hotel is located approximately 75 metres south of the KUR-World site. The Billabong Hotel includes off road motor activities and a licensed venue with amplified music and patrons. The nearby KUR-World activities will include a helipad, zip lines and other adventure activities. Overall, both the Hotel and the KUR-World development will include a variety of noise sources which will be considered further in this report.

The Kuranda Pet Resort is understood to have a history of noise related concerns, but the substance of those concerns is currently unknown. Noise from this operation will be considered further in this report.

3. Proposed Development

3.1 Masterplan

The proposed development site consists of twelve allotments as described below in **Table 3.1** covering approximately 680 hectares[I] in Barnwell Road, Myola, approximately 22 kilometres directly north-west of Cairns. The site is currently used for cattle grazing. Surrounding properties include large rural residential allotments.

The proposed development is to include the following:

- The KUR-World educational campus and sporting facility is to include dining facilities, three storey accommodations, sports fields, swimming pool and training hall.
- An equestrian centre and farm theme park will include an arena, stables, accommodation and animal yards. There will be a cattle paddocks and yard and horse stables.
- 342 accommodation villas are planned over approximately 34 hectares.
- A village will include plaza, restaurant, bar, amphitheatre, convention centre, market area and boutique retail precinct. A 3-star resort in the village will comprise 270 rooms, restaurant, bar, pool and children's adventure park.
- A medical retreat will include accommodation and facilities for 60 guests and a herbal laboratory.
- A 5-star eco-resort will include 200 two-storey villas, restaurant, pools, and function centre.
- A small education centre in the southern zone will include 14 boarding cabins, kitchens, function spaces and laboratories.
- An adventure park in the southern zone will include a high ropes course, suspended bridges, zip lines and rope ladders.
- Other facilities include a golf course, horse riding and walking trails.

Table 3.1 Lot and Plan Details

Lot and Plan Details	Area (hectares)	Lot and Plan Details	Area (hectares)
Lot 22 on N157227	37.26	Lot 20 on N157423	70.62
Lot 17 on N157227	57.71	Lot 95 on N157452	34.05
Lot 18 on N157227	63.01	Lot 43 on N157359	64.51
Lot 2 on RP703984	48.31	Lot 129 on NR456	65.89
Lot 1 on RP703984	16.19	Lot 131 on N157491	64.75
Lot 19 on N157452	39.60	Lot 290 on N157480	64.75

Electricity is to be provided via high voltage extensions along the Kennedy Highway. All refuse and waste will be disposed of at Mareeba and/or Cairns waste transfer facility. An Environmental Management Plan, Operational Plan, and Waste Management Plan will form part of the EIS.

The concept master plan shows the two main zones: the north zone and the south zone as shown in **Figures 3.1** and **3.2**. Most of the facilities will be in the northern zone.

The proposed plans are also included in **Appendix B**.

[I] This is the total property area, including proposed access road area.

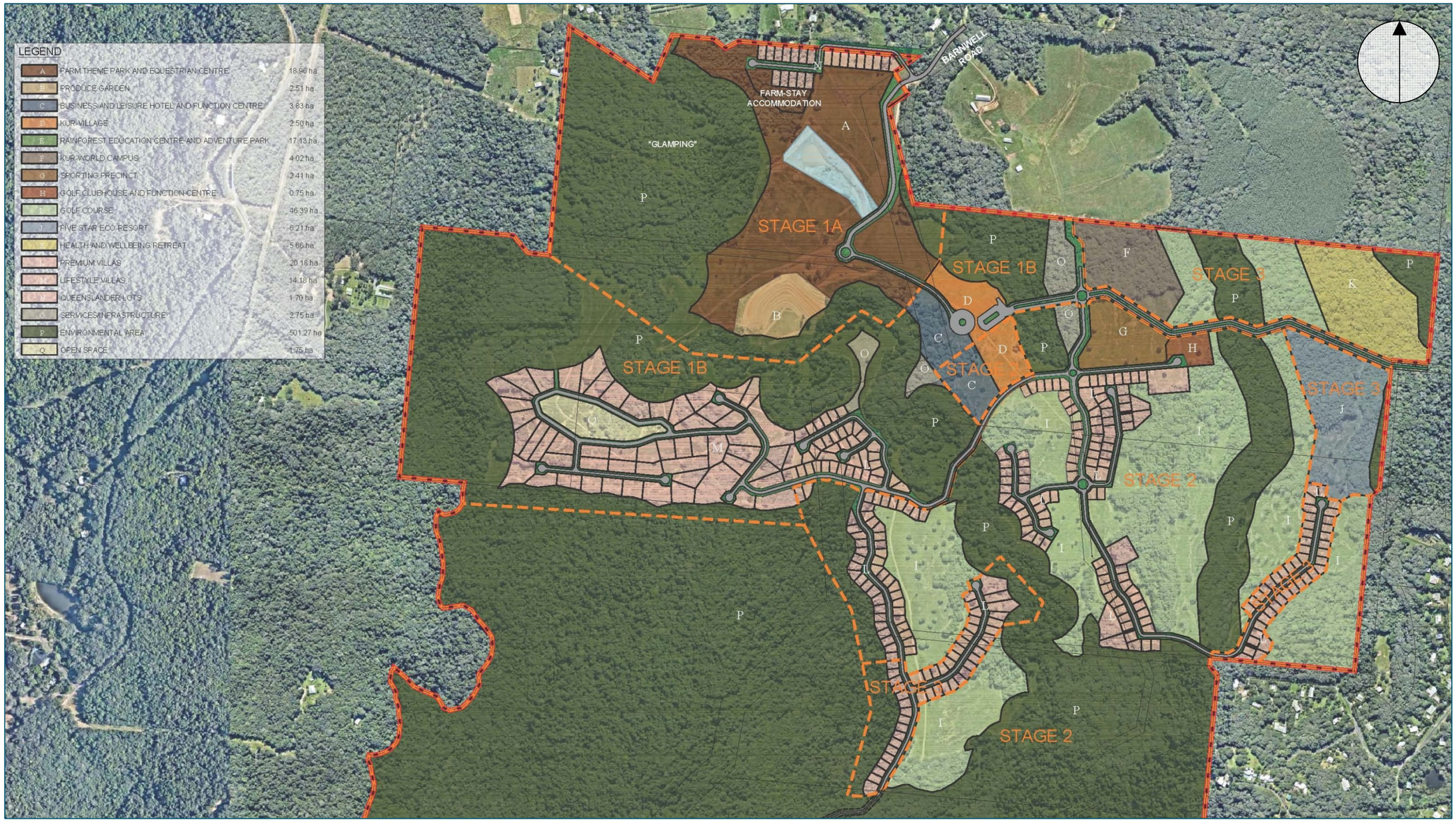


Figure 3.1 **North Zone Master Plan**

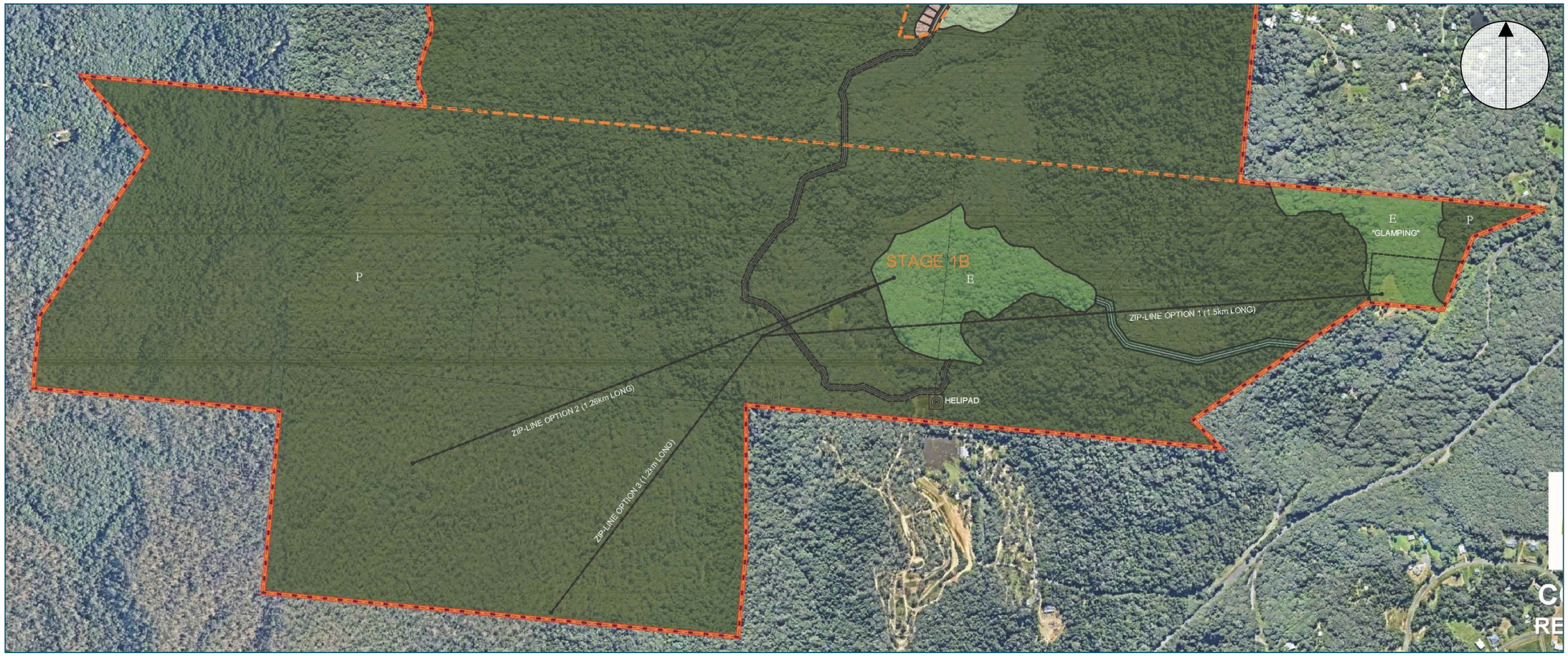


Figure 3.2 South Zone Master Plan

3.2 Construction Activities

Construction activities onsite will have the potential to generate noise and, to a lesser degree of impact, vibration.

Typical plant equipment used for construction include the following:

- Excavators
- Dozers
- Haul trucks
- Loaders
- Cranes

Construction activities in the southern zone will be minimal in comparison to those in the northern zone.

3.3 Operational Noise Emissions

Potential noise emissions due to the operation of the Project are presented in **Table 3.2**.

Table 3.2 Operational Noise Emissions

Noise Source/s	Location
Air conditioning, refrigeration, fans, backup power generators	Various
Vehicles moving around internal roads and carparking	Various
Helipad	Stage 1B – adjacent southern boundary of site
Farm theme park and equestrian centre – noise from recreational activities	Part A in Stage 1A – northern zone
Business and leisure hotel and function centre – noise from amplified music and patrons at functions	Part C in Stage 1B – northern zone
Zip lines	Part E in Stage 1B - southern zone
Glamping – noise from people and vehicles	Part E in Stage 1B and Part P in Stage 1A - south-east and north-west corners of the site
Sporting precinct – noise from outdoor sports activities	Part G in Stage 2 – northern zone
Golf course – noise from lawn maintenance, people, workshop and clubhouse	Parts H & I in Stage 2 – northern zone
Five star eco-resort – noise from restaurant and function spaces	Parts J in Stage 2 – northern zone
Health & well being retreat – noise from people and music, and vehicles.	Part K in Stage 3 – northern zone
Two sewage treatment plants	Part O in Stage 1B in northern zone and one in southern zone

Some of the noise sources listed in **Table 3.2** are relatively minor and/or able to be readily controlled through the design stages (e.g. indoor facilities) and via specifying noise limits (e.g. mechanical plant). Other items require more detailed review to understand the potential impacts prior to more detailed design being undertaken (e.g. zip lines).

4. Noise and Vibration Criteria

4.1 Overview

The Project is located within the Mareeba Shire Council area and therefore is required to comply with the requirements of Mareeba Shire Council in addition to state legislation.

The relevant policies, guidelines and criteria to be considered include:

- Mareeba Shire Council planning scheme QPP version 4.0 (8 January 2016).
- Department of Environment and Heritage Protection (EHP) – Environmental Protection Policy (Noise), Environmental Protection Act and relevant guidelines.
- Relevant noise standards and guidelines.

4.2 Terms of Reference

The October 2016 Terms of Reference (ToR) for the Project includes the noise related items in **Table 4.1**.

Table 4.1 Noise Requirements of the Terms of Reference (ToR)

ToR Section	Description	Relevant Sections of this Report
Noise & Vibration	Objective - Development is planned, designed, constructed and operated to protect the environmental values of the acoustic environment.	All
12.18	Fully describe the characteristics of the noise and vibration sources that would be emitted when carrying out the activity (point source and general emissions). Describe noise and vibration emissions (including fugitive sources) that may occur during construction, commissioning, upset conditions, and operation.	Section 6 (operational) & Section 8 (construction)
12.19	Predict the impacts of the noise emissions from the construction and operation of the project on the environmental values of the receiving environment, with reference to sensitive receptors, using recognised quality assured methods. Discuss separately the key project components likely to present an impact on noise and vibration for the construction and operation phases of the project.	Section 6 (operational) & Section 8 (construction)
12.20	Taking into account the practices and procedures that would be used to avoid or minimise impacts, the impact prediction must address the: (a) activity's consistency with the objectives (b) cumulative impact of the noise with other known emissions of noise associated with existing development and possible future development (as described by approved plans) (c) potential impacts of any low-frequency (<200 Hz) noise emissions.	Section 6 (operational)
12.21	Describe how the proposed activity, and in particular, the key project components described above, would be managed to be consistent with best practice environmental management for the activity. Where a government plan is relevant to the activity, or the site where the activity is proposed, describe the activity's consistency with that plan.	Section 6 (operational)
12.22	Describe how the achievement of the objectives would be monitored and audited, and how corrective actions would be managed.	Section 6 (operational)

4.3 Mareeba Shire Planning Scheme

The Mareeba Shire Council planning scheme QPP version 4.0 (8 January 2016) includes the following general requirements for noise:

Part 3 Strategic Framework

3.4 Natural resources and environment

3.4.8 Element – Air and noise quality

3.4.8.1 Specific outcomes

(1) The health, well-being, amenity and safety of the community and the environment is protected from the impacts of air emissions, noise and odour through appropriate management and adequate separation distances.

(2) Mareeba's major industry area accommodates uses with the potential to impact on air and acoustic qualities.

(3) Land uses which emit high level of noise, including for example motor sports, gun clubs and the like will be appropriately located and managed to mitigate acoustic impacts.

(4) Sensitive land uses are appropriately separated from areas containing or designated for activities that generate noise and air emissions.

There are other references to noise, but they appear limited to maintaining (or not detracting from) general noise amenity.

In terms of specific noise criteria, it is proposed to reference other documents including state legislation.

4.4 Environmental Protection Act

In Queensland, the environment is protected under the *Environmental Protection Act 1994*. The object of the Act is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development).

The Act describes a number of offences relating to noise standards, including building work, regulated devices (e.g. power tools), pumps, air-conditioning equipment, refrigeration equipment, indoor venues, outdoor events, amplifier devices other than at indoor venue or open-air event, power boat sports in waterway, operating power boat engine at premises, blasting, and outdoor shooting ranges.

The requirement for construction activity are as follows:

440R Building work

(1) A person must not carry out building work in a way that makes an audible noise—

(a) on a business day or Saturday, before 6.30a.m. or after 6.30p.m; or

(b) on any other day, at any time.

(2) The reference in subsection (1) to a person carrying out building work—

(a) includes a person carrying out building work under an owner-builder permit; and

(b) otherwise does not include a person carrying out building work at premises used by the person only for residential purposes.

4.5 Environmental Protection (Noise) Policy

4.5.1 Overview

In respect of the acoustic environment, the object of the Act is achieved by the Environmental Protection (Noise) Policy 2008 (EPP (Noise)). This policy identifies environmental values to be enhanced or protected, states acoustic quality objectives, and provides a framework for making decisions about the acoustic environment.

4.5.2 Background Creep

The EPP(Noise) contains noise criteria for controlling background creep, which are to be applied "for an activity involving noise". The criteria are as follows:

To the extent that it is reasonable to do so, noise from an activity must not be—

(a) for noise that is continuous noise measured by $L_{A90,T}$—more than nil dBA greater than the existing acoustic environment measured by $L_{A90,T}$; or

(b) for noise that varies over time measured by $L_{Aeq,adj,T}$—more than 5dBA greater than the existing acoustic environment measured by $L_{A90,T}$.

The EPP(Noise) does not define "continuous noise", but by definition, the "continuous noise" would be required to occur for at least 90% of a measurement period (typically 15 minutes or 60 minutes). Thus this criterion could apply for equipment such as mechanical plant.

The criterion for "noise that varies over time" is appropriate for noise sources operating for less than 90% of a measurement period, and could apply to intermittent events (e.g. vehicles) or mechanical plant that does not run continuously (e.g. air-conditioning).

4.5.3 Acoustic Quality Objectives

The EPP (Noise) contains a range of acoustic quality objectives for a range of receptors. The objectives are in the form of noise levels, and are defined for various periods of the day, and use a number of acoustic parameters.

Schedule 1 of the EPP(Noise) includes the following acoustic quality objectives to be met at residential dwellings:

- Outdoors
  - Daytime and Evening: 50 dBA $L_{Aeq,adj,1hr}$, 55 dBA $L_{A10,adj,1hr}$ and 65 dBA $L_{A1,adj,1hr}$
- Indoors
  - Daytime and Evening: 35 dBA $L_{Aeq,adj,1hr}$, 40 dBA $L_{A10,adj,1hr}$ and 45 dBA $L_{A1,adj,1hr}$
  - Night: 30 dBA $L_{Aeq,adj,1hr}$, 35 dBA $L_{A10,adj,1hr}$ and 40 dBA $L_{A1,adj,1hr}$

In the DEHP EcoAccess Guideline "Planning For Noise Control" documentation it is proposed that the noise reduction provided by a typical residential building façade is 7 dBA assuming open windows. That is, with an external noise source, a 7 dBA reduction in noise levels from outside a house to inside a house is expected when windows are fully open. Thus the indoor noise objectives noted above could be converted to the following external objectives (with windows open):

- Daytime and Evening: 42 dBA $L_{Aeq,adj,1hr}$, 47 dBA $L_{A10,adj,1hr}$ and 52 dBA $L_{A1,adj,1hr}$
- Night: 37 dBA $L_{Aeq,adj,1hr}$, 42 dBA $L_{A10,adj,1hr}$ and 47 dBA $L_{A1,adj,1hr}$

A sensitive receptor is defined as "an area or place where noise is measured".

The EPP(Noise) states that the objectives are intended to be progressively achieved over the long term. However, as this project involves the introduction of new noise sources it would seem reasonable that the

acoustic quality objectives are achieved upon commencement of operation of the project, and this may be the intent of the policy. Therefore, consideration to achieving these acoustic quality objectives will be included in the design noise limits for the project.

The acoustic quality objectives do not take into consideration the existing noise environment and therefore may not be applicable for areas that are particularly quiet or particularly noisy (e.g. near a road). Therefore, it is considered that the objectives should not be used as the sole noise limits for a development, and reference should also be made to noise limits which are determined with consideration for the existing noise environment.

4.6 EcoAccess Guidelines

DEHP has a number of EcoAccess guidelines relevant to the assessment of noise and vibration. These are summarised as follows.

4.6.1 EcoAccess – Planning for Noise Control

DEHP EcoAccess Guideline "Planning For Noise Control" contains procedures and methods that are applicable for setting conditions relating to noise emitted from industrial premises for planning purposes. The guideline is applicable to noise from all sources, individually and in combination, which contribute to the total noise from a site.

4.6.2 Control and Prevention of Background Creep

The procedure takes into account three factors: firstly, the control and prevention of background noise creep in the case of a steady noise level from equipment such as caused by ventilation fans and other continuously operating machinery; secondly, the containment of variable noise levels and short-term noise events such as those caused by forklifts and isolated hand tools to an acceptable level above the background noise level; thirdly, the setting of noise limits that should not be exceeded to avoid sleep disturbance.

4.6.3 Sleep Disturbance Criteria

The World Health Organization (WHO) issued its "Guidelines for Community Noise" in April 1999. The WHO guideline states the following in regard to sleep disturbance from continuous noise from activities such as mining operations:

> "Where noise is continuous, the equivalent sound pressure level should not exceed 30 dBA indoors, if negative effects on sleep are to be avoided. When noise is composed of a large proportion of low-frequency sounds a still lower guideline value is recommended, because low-frequency noise (eg from a ventilation system) can disturb rest and sleep even at low sound pressure levels."

The EcoAccess Guideline "Planning for Noise Control", in referring to the World Health Organisation guidelines, makes the following general recommendation regarding short term transient noise events:

> "As a rule in planning for short-term or transient noise events, for good sleep over eight hours, the indoor sound pressure level measured as a maximum instantaneous value should not exceed approximately 45 dBA maxLpA more than 10 to 15 times per night."

For less regular night events, the allowable internal noise level is higher, as follows:

- Approximately 3 events per night: 50 dBA L_{max}.
- Approximately 1 event per night: 65 dBA L_{max}.

Note: For the purpose of this assessment the maxL_{pA} level is defined using the L_{max} descriptor.

The WHO guideline states the following in regard to annoyance response to community noise:

"Annoyance to community noise varies with the type of activity producing the noise. During the daytime few people are seriously annoyed by activities with L_{Aeq} levels below 55 dBA; or moderately annoyed by L_{Aeq} levels below 50 dBA. Sound pressure levels during the evening and night should be 5 – 10 dBA lower than during the day. Noise with low frequency components requires even lower levels."

DEHP propose that the noise reduction provided by a typical residential building façade is 7 dBA assuming open windows. Thus the indoor noise objectives noted above could be considered external objectives (with windows open) with the appropriate correction.

The criteria are summarised in **Table 4.2**.

Table 4.2 Summary of WHO Sleep Disturbance and Annoyance Criteria

Descriptor	Number of Noise Events	Indoor Criterion dBA	Outdoor Criterion dBA
Sleep Disturbance (Short Duration Events)	10 – 15	L_{max} 45	L_{max} 52
	3	L_{max} 50	L_{max} 57
	1	L_{max} 55	L_{max} 62
Sleep Disturbance (Continuous Noise)	Continuous	L_{eq} 30	L_{eq} 37
Annoyance (Night Time)	Continuous	L_{eq} 35	L_{eq} 42

Note: The outdoor criteria are based on a DEHP EcoAccess nominated outdoor-to-indoor noise reduction of 7 dBA for open windows.

4.6.4 EcoAccess – Assessment of Low Frequency Noise

DEHP EcoAccess Guideline "Assessment of Low Frequency Noise" contains methods and procedures that are applicable to low frequency noise emitted from industrial premises and mining operations for planning purposes. Items such as boilers, pumps, transformers, cooling fans, compressors, oil and gas burners, foundries, wind farms, electrical installations, diesel engines, ventilation and air-conditioning equipment, wind turbulence and large chimney resonance may comprise sources of high level noise having frequency content less than 200 Hz.

These sources may exhibit a spectrum that characteristically shows a general increase in sound pressure level with decrease in frequency. Annoyance due to low frequency noise can be high even though the dBA level measured is relatively low. Typically, annoyance is experienced in the otherwise quiet environments of residences, offices and factories adjacent to or near low frequency noise sources. Generally, low level/low frequency noises become annoying when the masking effect of higher frequencies is absent. This loss of high frequency components may occur as a result of transmission through the fabric of a building, or in propagation over long distances.

Where a noise immission occurs exhibiting an unbalanced frequency spectrum, the overall sound pressure level inside residences should not exceed 50 dB(Linear) to avoid complaints of low frequency noise annoyance. A spectrum is considered unbalanced when the un-weighted overall noise level is more than 15 dB higher than the A-weighted overall noise level.

4.7 Helipad and Helicopters

The development includes a helipad adjacent the southern boundary of the site. Several criteria are presented below:

- Victorian EPA Noise Control Guideline 2008 includes noise criteria and proposes that the noise criteria can be met by a separation distance between the landing site and the residential premises of

150 m for helicopters of less than two tonnes all-up-weight, and 250 m for helicopters of less than 15 tonnes all-up-weight.

- Victorian Department of Planning and Community Development Practice Note 75 June 2015, Planning requirements for heliports and helicopter landing sites states that a permit is not required when the landing point is more than 500 metres from a sensitive use (residential premises), the number of flight movements does not exceed eight in a 30 day period, and four in a 24 hour period, and the flight movements do not take place before 7am or after sunset on a weekday, or before 8am or after sunset on a weekend or holiday.
- Air Services Australia (ASA) Environmental Principles and Procedures for Minimising the Impact of Aircraft Noise (2002) includes a noise limit of 40 dBA $L_{eq,24hours}$ in rural residential areas.
- In accordance with Schedule 3, Part 1 of the NSW Environmental Planning and Assessment Regulations, helicopter facilities are defined as Designated Development, where they have an intended use of more than 7 helicopter flight movements per week (including taking-off or landing), and are located within 1 kilometre of a dwelling not associated with the facilities.

4.8 Construction Noise and Vibration

4.8.1 Overview

As discussed in **Section 4.4**, legislative requirements with respect to construction noise impacts in Queensland only relate to the restriction of the hours of work for construction sites which produce audible noise at a noise sensitive receptor.

For a major project consideration of noise criteria may be required to evaluate long term project construction noise, or to consider construction activities during the restricted hours, which may be necessary for reasons of public safety or to minimise disruption to essential services.

Accordingly, it is proposed to adopt a procedure for managing noise impacts from construction both during standard construction hours and outside standard hours.

In the absence of State noise criteria, the NSW Interim Construction Noise Guideline (ICNG) (NSW DECC, 2009) has been adopted as noise level targets, however, they are not considered prescriptive.

4.8.2 NSW Interim Construction Noise Guideline (ICNG)

The noise level targets adopted for the assessment of noise impacts from construction have been taken from the NSW Interim Construction Noise Guideline (ICNG) (NSW DECC, 2009). These noise level targets were adopted as legislative requirements in Queensland and are based on limiting hours of construction rather than nominating discrete noise limits.

The ICNG provides recommended noise levels for airborne construction noise at sensitive land uses. The guideline provides construction managers with noise levels above which all feasible and reasonable work practices should be applied to minimise the construction noise impact.

The ICNG sets out management levels for noise at sensitive receptors, and how they are to be applied. Management levels are based on the existing background noise levels in the absence of construction activity (represented by the Rating Background Level (RBL) parameter).

The management levels from the ICNG for residences are presented in **Table 4.4**.

For out-of-hours work, the ICNG nominates a noise level 5 dB above the rating background level (RBL) as the noise affected level to represent a threshold where the proponent should negotiate with the community.

It is important to note that the ICNG targets are not noise limits as such, but screening criteria for assessing whether construction noise is likely to have adverse impacts and hence whether "feasible and reasonable" work practices should be implemented during the construction process in order to reduce noise levels.

Table 4.3 ICNG Management Level for Airborne Construction Noise at Residences

Time of Day	Management Level L_{eq}(15 minute) dBA	How to Apply
Recommended standard hours: Monday to Saturday 6:30 am to 6:30 pm No work on Sundays or Public Holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured L_{Aeq} (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noise activities can occur, taking into account: Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or 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.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dBA above the noise affected level, the proponent should negotiate with the community.

For schools and office buildings the protection of outdoor amenity is considered less important. The ICNG includes noise targets for educational and commercial facilities, as follows:

- Classrooms at education facilities: Internal noise level - 45 dBA L_{eq}(15minute)
- Commercial facilities: External noise level - 70 dBA L_{eq}(15minute)

Based on typical modern educational building construction with closed windows, a minimum facade noise reduction of 20 dBA would be expected, and thus an internal design level of 45 dBA L_{eq} corresponds to an external (outdoor) target level of 65 dBA L_{eq}.

5. Existing Noise Environment

5.1 Overview

Noise measurements have been undertaken to determine the existing noise environment at and around areas that could be affected by the project activities. The measurements have consisted of long-term noise logging at four (4) sites over a period of approximately one week, and short-term attended noise measurements. Attended noise measurements were conducted at the four logging sites and at an additional monitoring site.

The noise measurement Locations A to E are shown in **Figure 5.1**.

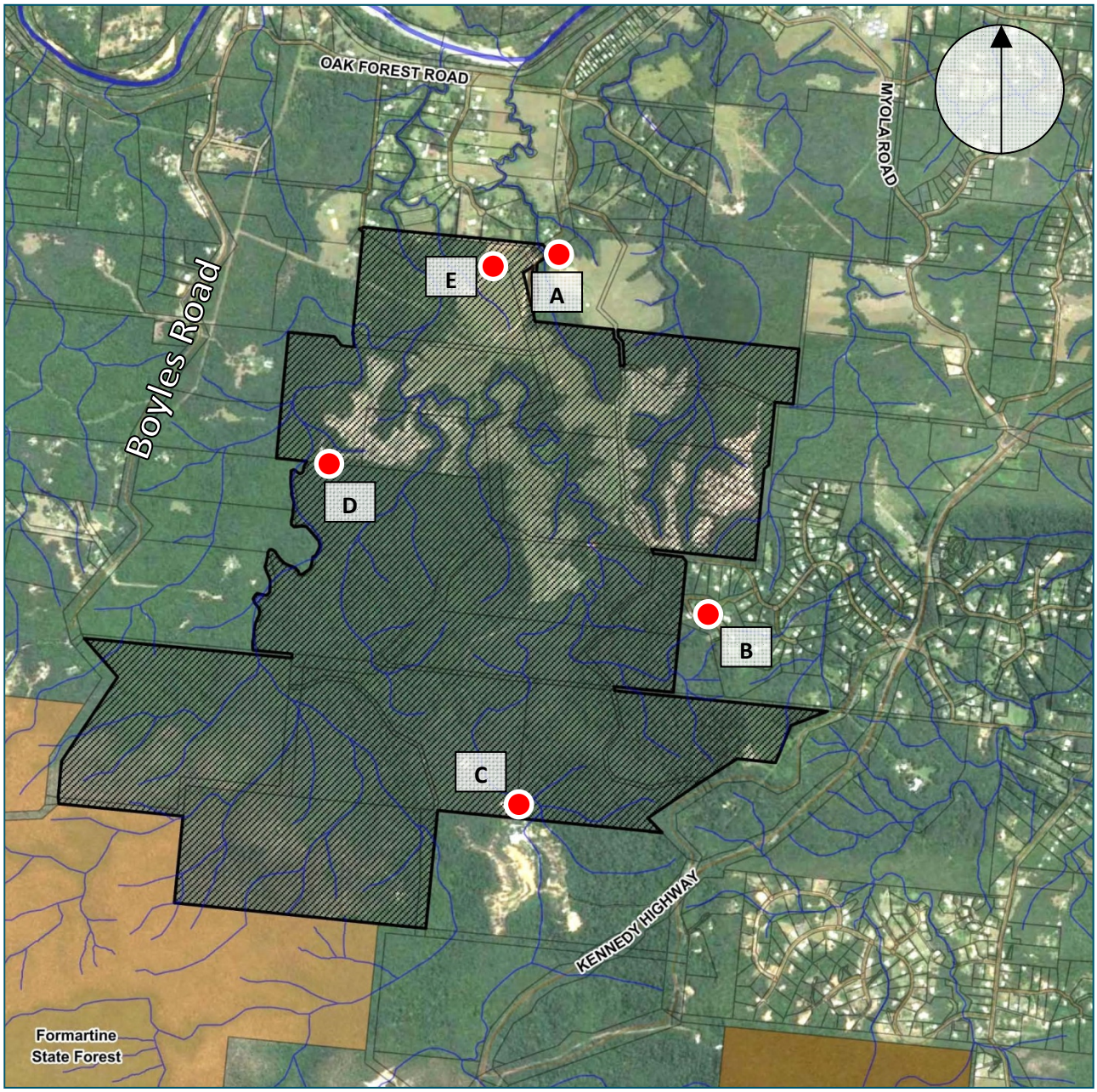


Figure 5.1 Noise Monitoring Locations A to E

The long-term noise logging measurement results assist in understanding the variation in the ambient noise environment noise level by time of day and at different locations. The attended measurements provide additional information on the sources contributing to the noise levels as an ASK engineer was present during the measurement period. The short period of the attended measurements allowed an additional measurement position to be considered.

The noise monitoring locations are described as follows:

- Location A was located near the northern boundary of the subject site, next to the drive way of the property located at 77 Barnwell Road.
- Location B was located near the eastern boundary of the subject site, in the front yard of 10 Hilltop Close.
- Location C was located near the southern boundary of the subject site, near the closest commercial premises (Billabong Hotel).
- Location D was located near the western boundary of the subject site, near the closest neighbouring residences.
- Location E was located near the northern boundary of the subject site, near closest neighbouring residences.

The noise monitoring was undertaken in general accordance with Australian Standard AS1055 Acoustics – Description and measurement of environmental noise and the EHP Noise Measurement Manual.

5.2 Attended Noise Measurements

Attended noise measurements were undertaken at Locations A, B, C, D and E as shown on **Figure 5.1**.

The measurements were undertaken between 1:40pm 22/02/2017 and 1:40pm 23/02/2017 over 15 minute periods using a field and laboratory calibrated Rion NA27 sound level meter. The microphone height was approximately 1.3m above natural ground level and was located in the free field. Weather during the time of monitoring was fine, 10% to 50% cloud cover and at times a slight breeze from the south-east at approximately 0 to 2 m/s was present.

The measured noise levels are summarised in **Table 5.1**.

Table 5.1 Attended Noise Measurement Results

Location	Date & Time	Period (Minutes)	Results & Notes
B	1:41pm 22/02/17	15	Statistical noise levels: L_{10} 58 dBA, L_{eq} 55 dBA, L_{90} 51 dBA Noise from insects dominant around 2 to 2.5 kHz and 8 to 10kHz Insect noise 50 to 60 dBA Birds 56, 57, 60 dBA Distant traffic audible Lull in insects, birds and traffic 47 to 48 dBA
B	10:02pm 22/02/17	15	Statistical noise levels: L_{10} 46 dBA, L_{eq} 44 dBA, L_{90} 42 dBA Noise from insects dominant 40 to 47 dBA (4kHz) Traffic noise audible occasionally Cicadas 40 to 42 dBA (6kHz)

Location	Date & Time	Period (Minutes)	Results & Notes
A	10:32pm 22/02/17	15	Statistical noise levels: L_{10} 52 dBA, L_{eq} 49 dBA, L_{90} 45 dBA Noise from insects dominant 45 to 50 dBA (4 to 8kHz) Loud insects in bursts 50 to 52 dBA Passing car on Barnwell Road 55 to 58 dBA
E	10:56pm 22/02/17	15	Statistical noise levels: L_{10} 56 dBA, L_{eq} 51 dBA, L_{90} 43 dBA Noise from insects dominant 41 to 44 dBA (4kHz) Loud insects in bursts 50 dBA (2 to 2.5kHz) Distant traffic audible
D	11:32pm 22/02/17	15	Statistical noise levels: L_{10} 53 dBA, L_{eq} 50 dBA, L_{90} 46 dBA Noise from insects dominant 45 to 47 dBA (4 to 10kHz) Loud insects in bursts 50 to 52 dBA (4kHz) Distant traffic audible Operator sniff and cough 55 dBA
C	9:24am 23/02/17	15	Statistical noise levels: L_{10} 68 dBA, L_{eq} 65 dBA, L_{90} 60 dBA Noise from insects dominant, very loud 65 to 68 dBA (2 to 10kHz) Traffic noise from Kennedy Highway audible, no effect on measurement
A	11:42am 23/02/17	15	Statistical noise levels: L_{10} 65 dBA, L_{eq} 61 dBA, L_{90} 45 dBA Noise from insects and birds dominant 47 to 49 dBA (4 to 10kHz) Loud birds 53 to 55 dBA Loud Cicadas 65 to 66 dBA Distant traffic audible
D	12:31pm 23/02/17	15	Statistical noise levels: L_{10} 72 dBA, L_{eq} 69 dBA, L_{90} 65 dBA Noise from insects dominant, very loud 65 to 67 dBA (3.15 to 8kHz) Dog kennels audible in distance, no effect on measurement
E	1:33pm 23/02/17	15	Statistical noise levels: L_{10} 62 dBA, L_{eq} 57 dBA, L_{90} 50 dBA Noise from insects dominant 45 to 50 dBA (4 to 10kHz) Distant mowers, engine noise and banging noises coming from neighbouring residence to the east. Closer to trees, insects very loud 80dBA

Note: * The reported noise levels, excluding the statistical noise levels, are the instantaneous levels read from the sound level meter, and generally represent the range in noise levels or maximum noise levels for a particular noise source.

5.3 Noise Logging

Noise logging was undertaken at Locations A, B, D and E as shown on **Figure 5.1**.

Logging was undertaken from 22/02/2017 to 02/03/2017 using field and laboratory calibrated Larson Davis LD831 environmental noise loggers. Noise logging was undertaken in the free field.

Data from the Bureau of Meteorology (Mareeba) indicates that weather during the monitoring period was generally fine and warm, but with rainfall on Wednesday 22nd (5mm), Saturday 25th (8.6mm), Sunday 26th (18.0mm) and Wednesday 1st (0.8mm). Overall, the noise monitoring data is considered acceptable for use in this report.

The measured noise levels and statistical results at each location are shown in **Appendix C**.

The background noise levels (minL_{90} or rating background level [RBL]) at each logging location are shown below in **Table 5.2**. The levels presented in **Table 5.2** include the as-measured L_{90} levels, and the L_{90} noise levels with the influence of insect noise (4 kHz and 8 kHz octave bands, and occasionally the 16 kHz octave band) removed.

Table 5.2 Rating Background Noise Levels (RBLs) from Noise Logging

Location	Rating Background Noise Level (RBLs) L_{90}			Rating Background Noise Level (RBLs) L_{90} (less insects)		
	Day	Evening	Night	Day	Evening	Night
A – north	44	46	43	33	25	25[1]
B – east	49	42	42	36	29	25
D – west	41	45	44	32	27	26
E – north	48	45	42	34	31	25[2]

Note: 1 At Location A the RBL at night was measured as 20 dBA, however, a minimum background noise level of 25 dBA is applied as per QLD DEHP guidelines.

2 At Location E the RBL at night was measured as 23 dBA, however, a minimum background noise level of 25 dBA is applied as per QLD DEHP guidelines.

It could be considered that the RBLs (less insects) are more representative of the background noise environment that could be measured in cooler months (winter) when insect noise may be reduced. Never-the-less it is considered reasonable practice to remove insect noise from RBLs as a means of determining project noise limits, as insect noise tends to be limited to higher frequencies and thus may have minimal masking effect on most noises which tend to be in other frequency bands.

From the results above the following comments are made:

- At locations A, B, D and E insect noise is dominant. There is also noise from frogs and other animals.
- There are periods where the noise levels are dominated by rain noise.
- Noise measurements at Location B are affected by nearby mechanical plant.

6. Operational Noise Emissions Assessment

6.1 Zip Lines

6.1.1 Overview

There are three (3) zip line location options proposed in Part E, Stage 1B in the southern zone of the development (Refer **Figure 3.2**). Zip lines produce noise from the trolley moving along the cable, and potentially from the shouts and screams of people using the zip lines. It is expected that loud noise from people can be managed, but there remains the noise from the zip line itself.

6.1.2 Noise Criteria

It is considered that an appropriate noise criterion is the 'background creep' criterion (refer **Section 4.5.2**) for noise that varies over time, i.e. the $L_{Aeq,adj,T}$ noise level is not to exceed the existing background noise level (RBL) by more than 5 dBA. Background monitoring was not specifically conducted near the zip line, but if the quietest RBL measurement results are taken from **Table 5.2**, the noise limits can be calculated as follows:

- Day 37 dBA $L_{Aeq,adj,T}$
- Evening 30 dBA $L_{Aeq,adj,T}$
- Night 30 dBA $L_{Aeq,adj,T}$

6.1.3 Noise Levels and Assessment

The three zip line locations have been modelled with a zip line sound power level of 103 dBA moving along each zip line at a speed of approximately 14 km/h. The noise levels have been calculated based on 1 zip line movement (per each of the three locations) per 15 minutes, and a second scenario with 5 zip line movements (per each of the three locations) per 15 minutes. The noise contours developed by SoundPLAN v7.4 for the second scenario (20 movements per hour) are included in **Figure D.1** in **Appendix D**. Noise levels in terms of the L_{max} parameter are included in **Figure D.2** for reference, but these are not assessed further.

The calculated noise levels for each scenario are shown for the worst-affected residents (in ranked order) in **Table 6.1**.

Table 6.1 Calculated Noise Levels from Ziplines (All 3 Zipline Locations in Use)

Receiver	Noise Levels, $L_{Aeq,15mins}$, dBA	
	1 movement per 15 minutes (for each of 3 ziplines)	5 movement per 15 minutes (for each of 3 ziplines)
R28 - 186 Mount Haren Road (Billabong Hotel)	33	40
133 Mount Haren Road	30	37
R01 - 7 Hilltop Close	25	32
R02 - 10 Hilltop Close	24	31
5 Perry Close	21	28

From the results in **Table 6.1** it can be seen that the noise levels are compliant with the day time limit of 37 dBA when each zipline is used for 1 movement per 15 minutes (4 per hour). If the movements were

increased to 2 per 15 minutes, a 3 dBA increase would be expected and the levels would still remain compliant.

If it was desired to operate ziplines in the evening or night when lower noise limits apply, or have more than 2 zipline runs per 15 minutes (for each of the three zipline locations) then further noise investigation is required and potentially noise mitigation measures investigated. Noise reduction levels of the order of 5 to 10 dBA may be expected with low noise trolleys and cables, which would allow significantly more zipline use or extend the permissible hours of use.

6.1.4 Summary

In conclusion, it is considered that zip line activities are able to achieve compliant noise levels. It is recommended that the 'background creep' criterion be applied to this noise source. Further investigation should be conducted as the design progresses in the future. It is expected that use of the facility would require completion of a detailed noise management plan.

6.2 Helipad

6.2.1 Overview

A privately used helipad is proposed in Stage 1B adjacent the southern boundary of the site (Refer **Figure 3.2**). The site is approximately 1 kilometre from the nearest existing dwellings to the east, with the exception of the nearby Billabong Hotel which is approximately 100 metres from the helipad site.

It is understood there is some degree of cooperation between the developer and the operator of the Billabong Hotel such that this minimal distance has been accepted. It is noted that the Billabong Hotel Facebook page includes a photo of a helicopter located adjacent the lake beside the Billabong Hotel, and so it would seem that helicopter noise is not unusual to the location.

6.2.2 Noise Criteria

A separation distance of 1 kilometre is achieved, excluding the Billabong Hotel, and thus the helipad would comply with the Victorian EPA Noise Control Guidelines 2008 noise criterion which proposes a minimum separation distance of 150 to 250 metres. The site would also satisfy the permit relaxation conditions for the Victorian Department of Planning and Community Development Practice Note 75 December 2012 subject to limited daytime flights as per **Section 4.7**. The separation distance also satisfies the NSW EPAR requirement to avoid classification as a Designated Development if movements are limited to no more than 7 helicopter flight movements per week (including taking-off or landing).

Assessment to determine compliance with the ASA criterion of 40 dBA $L_{eq,24hours}$ is prepared as follows.

6.2.3 Noise Data

Noise levels from another helipad were measured by ASK at a site in New South Wales. The noise levels were measured for an existing operation and predicted for future operations with the intent of complying with the ASA criteria of 40 dBA $L_{eq,24hours}$.

Noise levels at a residence approximately 450 metres from the helipad and flightpath were approximately 34 to 39 dBA $L_{eq,24hours}$ with a total of 20 movements (i.e. 10 take offs and 10 landings). This noise level complies with the ASA criterion noted above.

6.2.4 Noise Levels and Assessment

As noted above, the helipad is approximately 1000 metres from the nearest existing dwellings to the east on the Highway. If a minimum distance of 500 metres could be maintained for the flight path, the

predicted noise level at the existing dwelling would be up to approximately 39 dBA $L_{eq,24hours}$ with a total of 20 movements (i.e. 10 take offs and 10 landings). This achieves the ASA noise criterion.

6.2.5 Summary

In conclusion, where a minimum distance of 500 metres is maintained for the flight path, the predicted noise level at the existing dwelling would be compliant (20 movements over 24 hrs).

It is recommended that a flight path be nominated which maximises the distance to the residences. The helipad separate distance of 1 kilometre (excluding Billabong Hotel as discussed above), a flight path separation distance of 500 metres and maximum 20 flights per day, would achieve the nominated noise criteria.

If flight path separation distance is decreased then the movements may be required to be further restricted, and conversely if flight path separation distance is increased then the movements may be able to be increased.

6.3 Sewage Treatment Plant

6.3.1 Overview

The estimated wastewater volume that will be generated in the operation of the project will likely exceed the capacity of the Kuranda Wastewater Treatment Plant and reticulation network servicing the Mareeba Shire Council (Arup, 2017). Thus an onsite wastewater treatment plant is proposed to treat the wastewater generated onsite and produce high quality recycled water for non-potable re-use (Arup, 2017).

The operation of an STP in the northern zone is less likely to impact the existing sensitive receptors than the proposed sensitive receptors onsite due to its relative location. Therefore, the proposed sensitive receptors assessed in this study for the operation of an STP are all located on-site as presented in **Table 6.2** and **Figure 6.1**.

Table 6.2 List of Proposed Sensitive Receptors with UTM Coordinates (WGS84 Z55)

ID	Property Description	Approximate Distance and Direction from Proposed Sewage Treatment Plant	Easting (m)	Northing (m)
29	Business and Leisure Hotel	130 m to the east	351248	8139764
30		130 m to the east	351259	8139691
31		250 m to the south-east	351348	8139576
32	Premium Villas	410 to the south-east	351447	8139427
33		140 m to the south-west	351064	8139554
34		200 m to the south-west	350998	8139521
35	Lifestyle Villas	250 m to the south-west	350859	8139618
36	Queenslander Lot (Farm-Stay Accommodation)	620 m to the north	350966	8140327

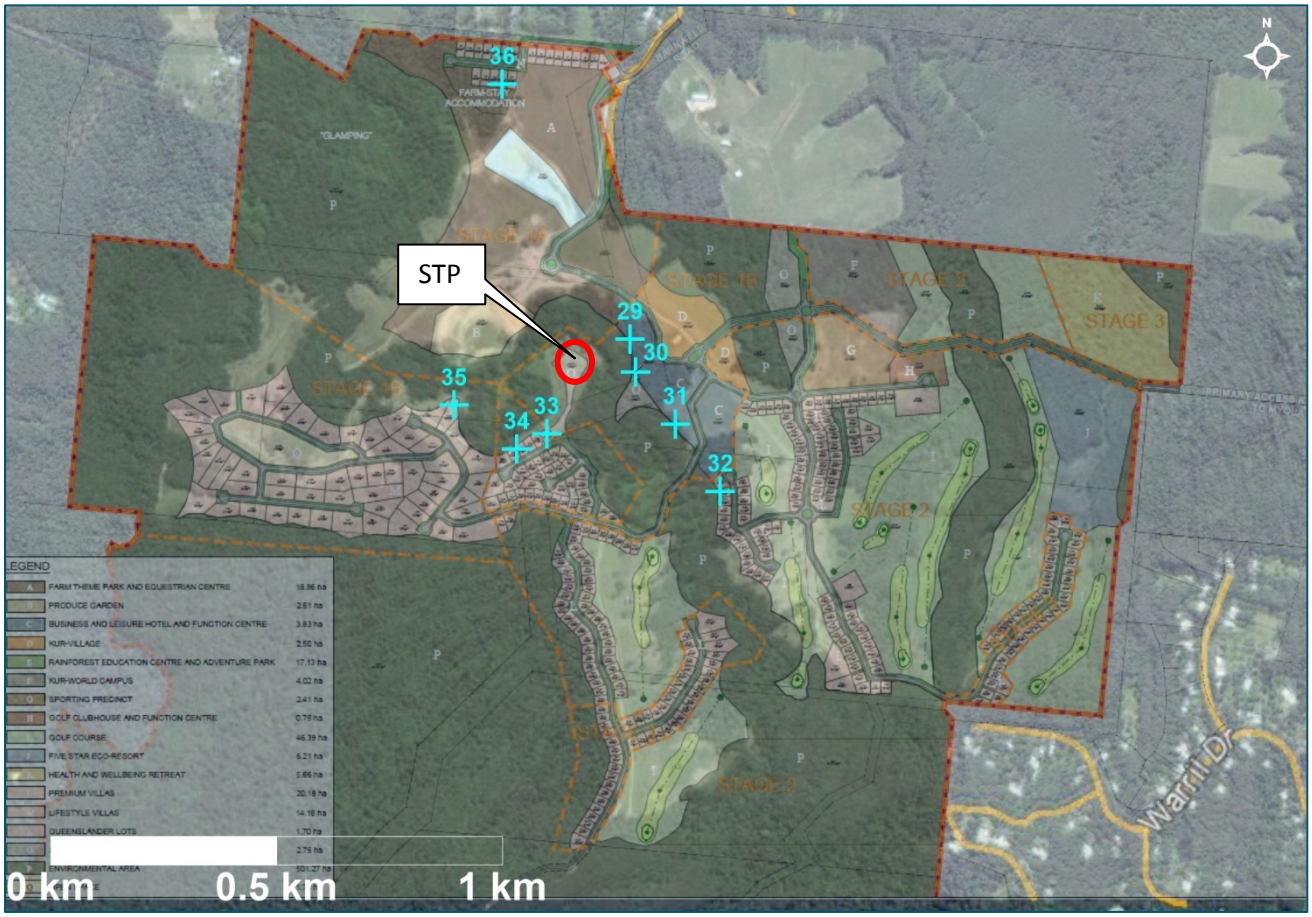


Figure 6.1 Location of Sensitive Receptors Near the Sewage Treatment Plant Site

The receptor locations listed in **Table 6.2** and identified in **Figure 6.1** are proposed receptors that have the potential to be impacted by the proposed northern zone STP. They were selected based on the future presence of a sensitive land use and the distance and direction of the proposed receptors from the proposed STP.

6.3.2 Noise Criteria

It is considered that an appropriate noise criteria is the 'background creep' criterion (refer **Section 4.5.2**) for noise that is continuous, i.e. the $L_{A90,T}$ noise level is not to exceed the existing background noise level (RBL) by more than nil dBA. Background monitoring was not specifically conducted near the sewage treatment site, but if the quietest RBL measurement results are taken from **Table 5.2**, the noise limits can be calculated as follows:

- Day 32 dBA $L_{Aeq,adj,T}$
- Evening 25 dBA $L_{Aeq,adj,T}$
- Night 25 dBA $L_{Aeq,adj,T}$

Note: More stringent noise criteria could be considered for the site, to further minimise potential risk of annoyance from the plant, however, that could occur later in the project design stages.

6.3.3 Noise Data

Plans for the STP are not available at the time of writing of this report. Most of the operational STPs however have similar components and operations. It has been assumed that the proposed STP for the

development would have similar components and operation to a larger-sized STP previously reviewed by ASK.

The development will have a maximum occupancy of 4,000 people and an estimated average dry weather flow (ADWF) of 0.5 ML/day to 1.1 ML/day (Arup, 2017). The other site reviewed by ASK had a capacity of 8,800 people. Therefore, it is proposed to consider the noise emission data from the other site, and scale back the noise levels by a factor of 10*log(4000/8800), i.e. a correction of – 3 dBA.

The noise levels from the other project were up to 23 dBA at approximately 370 metres, under downwind adverse conditions. Applying the proposed correction of – 3 dBA, gives a subject site STP noise level of 20 dBA at 370 metres.

6.3.4 Noise Levels and Assessment

Noise levels have been calculated at the nearest sensitive receivers, being a business hotel at 130 metres from the sewage treatment plant. Based on a noise level of 20 dBA at 370 metres, and utilising CONCAWE algorithms, the calculated noise level at 130 metres is 31 dBA.

The calculated noise level complies with the daytime limit in **Section 6.3.2** of 32 dBA, but exceeds the evening and night limits of 25 dBA.

It is possible that the background noise environment will be noisier around the hotels in the future, and thus the noise limits would increase accordingly. However, it is presumed that the intention is to maintain a low background noise level where possible, and thus the 25 dBA limit is considered applicable.

At this stage there is no detailed design available for the plant to enable specific recommendations, however, the above preliminary review indicates that noise control measures will likely be required.

6.3.5 Summary

The proposed sewage treatment plant has the potential to exceed relatively low noise limits, and thus would require a detailed noise assessment during its design development. It is likely that noise mitigation measures will be required, and it would be recommended that post-construction noise testing is undertaken to prove compliant noise levels.

6.4 Mechanical Plant (General)

It is expected that there will be significant mechanical plant located around the development including air-conditioning, refrigeration, exhaust and supply fans, generators and other items.

At this stage there is no detailed design available for the plant to enable specific recommendations, however, it is proposed that all plant and equipment (inclusive of other continuous noise sources) achieves the 'background creep' criterion (refer **Section 4.5.2**) for noise that is continuous, i.e. the $L_{A90,T}$ noise level is not to exceed the existing background noise level (RBL) by more than nil dBA. Based on the data in **Table 5.2** the strictest (lowest) limits can be calculated as follows:

- Day 32 dBA $L_{Aeq,adj,T}$
- Evening 25 dBA $L_{Aeq,adj,T}$
- Night 25 dBA $L_{Aeq,adj,T}$

The relatively low limits will require careful consideration of plant location, design and selection.

6.5 Amplified Music and Patron Noise (General)

6.5.1 Overview

It is expected that there will be a number of venues with amplified music and moderate to large numbers of people, e.g. hotel and function centre, sports, golf clubhouse, 5 star eco resort, and equestrian centre. There are no concept designs for these facilities at the current masterplan level of design.

It is generally expected that where the activities are indoors, the noise emissions can be readily controlled through building design. In this way, high noise level music venues can be built in relatively close proximity to sensitive receivers (onsite or off site) with acceptable noise emissions. Increasing setback distances between the buildings and nearby houses would logically reduce the building acoustic requirements.

Where noise occurs outdoors, mitigation of noise occurs through locating the activities as far from sensitive receivers as possible, and to provide shielding as best as possible (e.g. shielding from topography, non-sensitive buildings, barriers).

6.5.2 Noise Criteria

It is considered that an appropriate noise criterion is the 'background creep' criterion (refer **Section 4.5.2**) for noise that varies over time, i.e. the $L_{Aeq,adj,T}$ noise level is not to exceed the existing background noise level (RBL) by more than 5 dBA. Based on the quietest background noise level (RBL) measurement results from **Table 5.2**, the most stringent noise limits can be calculated as follows:

- Day 37 dBA $L_{Aeq,adj,T}$
- Evening 30 dBA $L_{Aeq,adj,T}$
- Night 30 dBA $L_{Aeq,adj,T}$

For licensed venues it would also be necessary to achieve compliance with the requirements of the Queensland Office of Liquor and Gaming Regulation (OLGR). OLGR provide specific noise criteria within the Liquor Regulation 2002 (the regulation) and Liquor Act 1992 (the Act). Reference should also be made to the Guideline 50 for Acoustic Consultants (dated 1 June 2010) published by OLGR. This document is incomplete with respect to all the acoustic issues to be considered, but provides general assistance. The OLGR noise criteria for activities before 10pm are less stringent than the noise limits described above. After 10pm, the OLGR noise criteria are more stringent and consider the spectral noise emissions of the activities.

6.5.3 Patron Noise Levels and Assessment

Patron noise levels have been calculated using the formula in Hayne[2] 2011 and basic acoustic formula for outdoor hemispherical propagation: Lp = Lw – 20*log(distance) – 8. The calculated noise levels for various patron group sizes and distances are included in **Table 6.3**. Noise levels could be higher if the patrons were drinking alcohol.

[2] Paper Hayne et al, "Prediction of Noise from Small to Medium Sized Crowds', Paper Number 133, Proceedings of Acoustics 2011

Table 6.3 Patron Noise Calculations

Patrons	Sound Power Level, $L_{w,eq}$ dBA	Noise Levels at Various Distances, L_{eq} dBA				
		10m	25m	50m	100m	200m
10	79	51	43	37	31	25
25	85	57	49	43	37	31
50	89	61	54	48	41	35
100	94	66	58	52	46	40
200	99	71	63	57	51	44

From **Table 6.3** it can be seen that the day time limit of 37 dBA $L_{Aeq,adj,T}$ would be achieved at 50 metres from 10 patrons, 100 metres from 25 patrons, and 200 metres from 50 patrons. The night limits are more stringent and compliance requires approximately double the setback distance.

It is noted that where there is solid 'acoustic' screening between the patrons and sensitive receivers the resulting noise levels may be 5 to 10 dBA less. Additionally, there can be additional screening from intervening vegetation to consider.

6.5.4 Amplified Noise Levels and Assessment

Outdoor amplified music can be a source of annoyance at relatively large distances, particularly in quiet areas. Any outdoor music would require significant separation distances from residences.

6.5.5 Summary

Overall, noise emissions from activities within buildings can be readily controlled via building construction measures.

Outdoor noise is more difficult to mitigate and care has to be taken when locating activities requiring large groups of people or music. Where sports fields are proposed, it is recommended to locate any stands, stadia, clubhouse or other gathering areas, as far from sensitive receivers as possible. Where possible it is best to use screening from natural topography and intervening non-sensitive buildings.

6.6 Vehicles

6.6.1 Overview

KUR-World intends to have three access points. A forth access (East-West access from the Rainforest Education Centre and Adventure Park) is under consideration.

The primary access will be from the east of the site, being constructed from Myola Road along an existing gazetted road reserve (refer **Figure 6.2**). Secondary access will be provided from Barnwell Road in the north of the site (refer **Figure 6.3**). A third emergency access will be provided at Warril Drive in the east/south-east of the site and will be controlled by a gate (refer **Figure 6.4**). Access to the site will be designed and constructed in accordance with the FNQROC design guidelines.

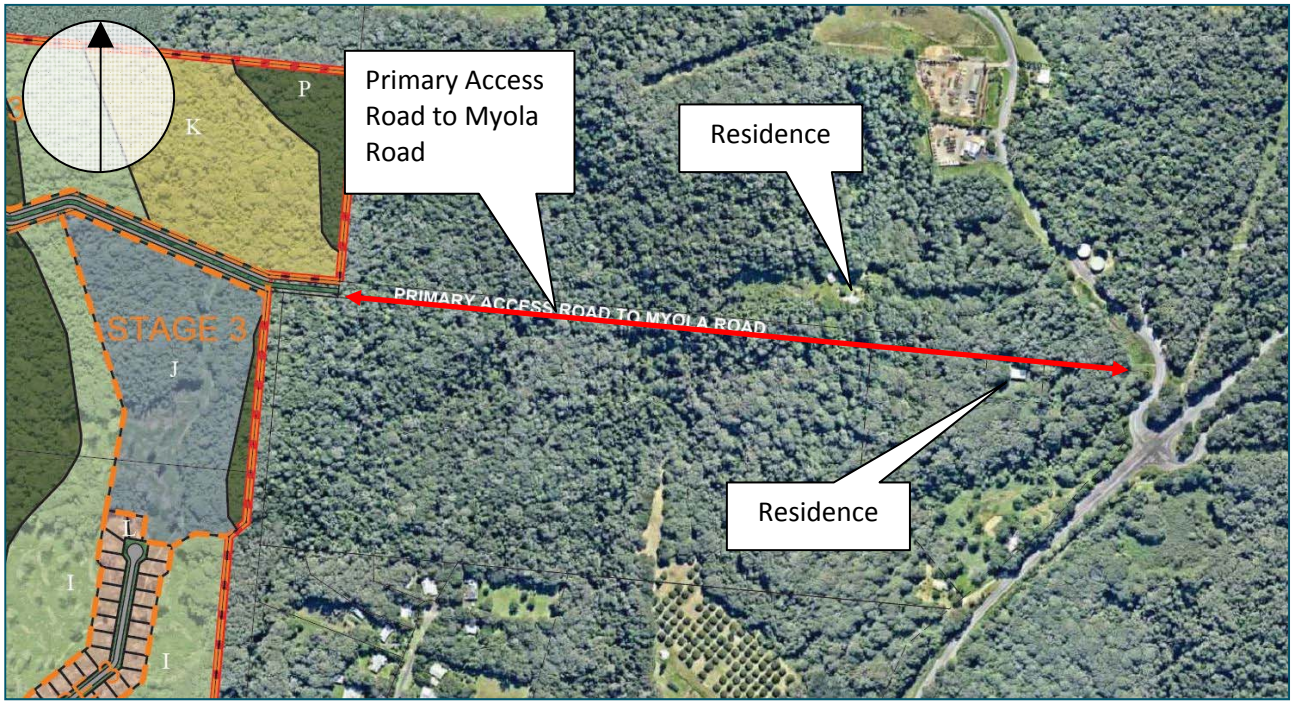


Figure 6.2 Primary Access from Myola Road to North-East

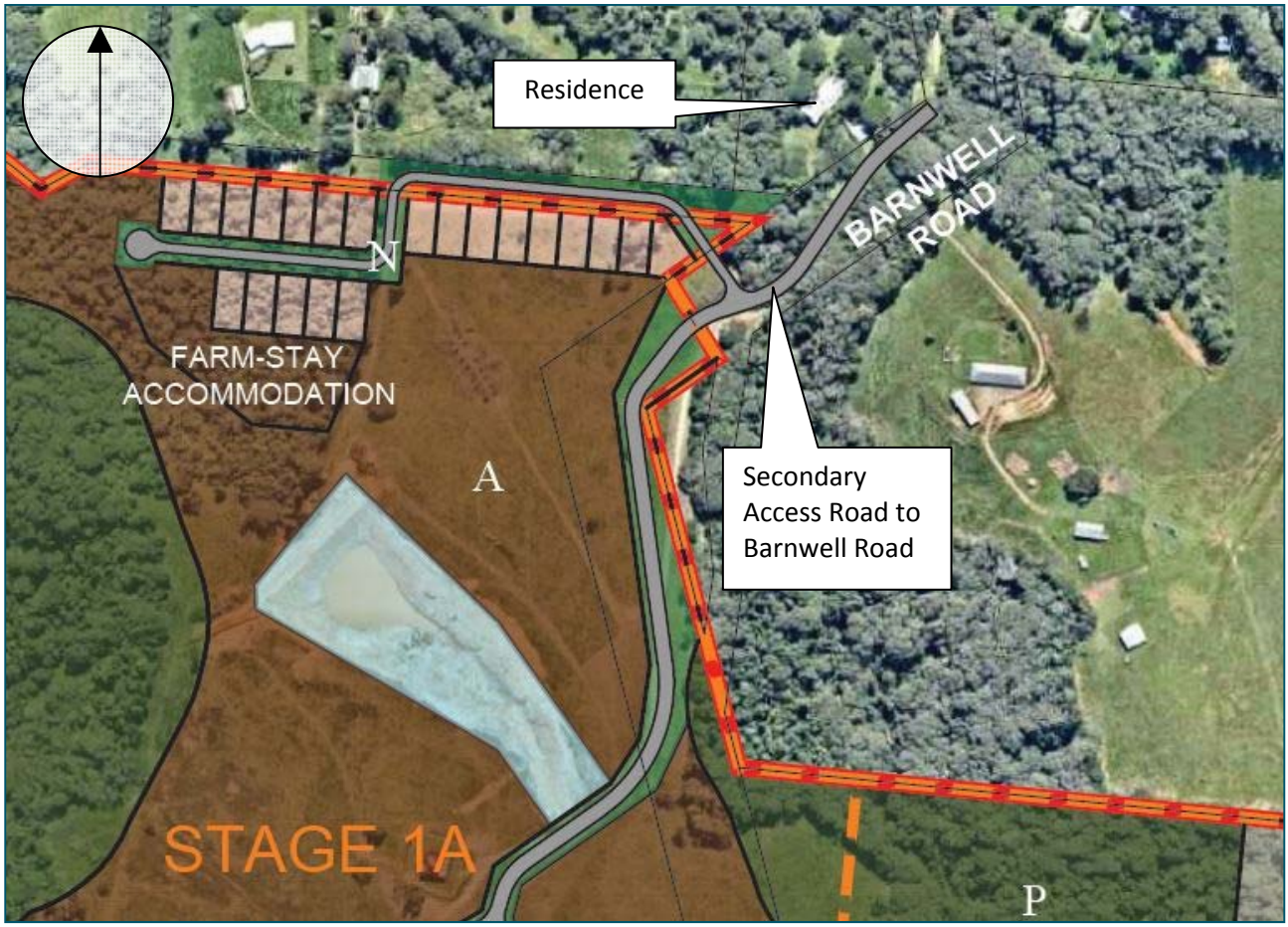


Figure 6.3 Secondary Access from Barnwell Road to North

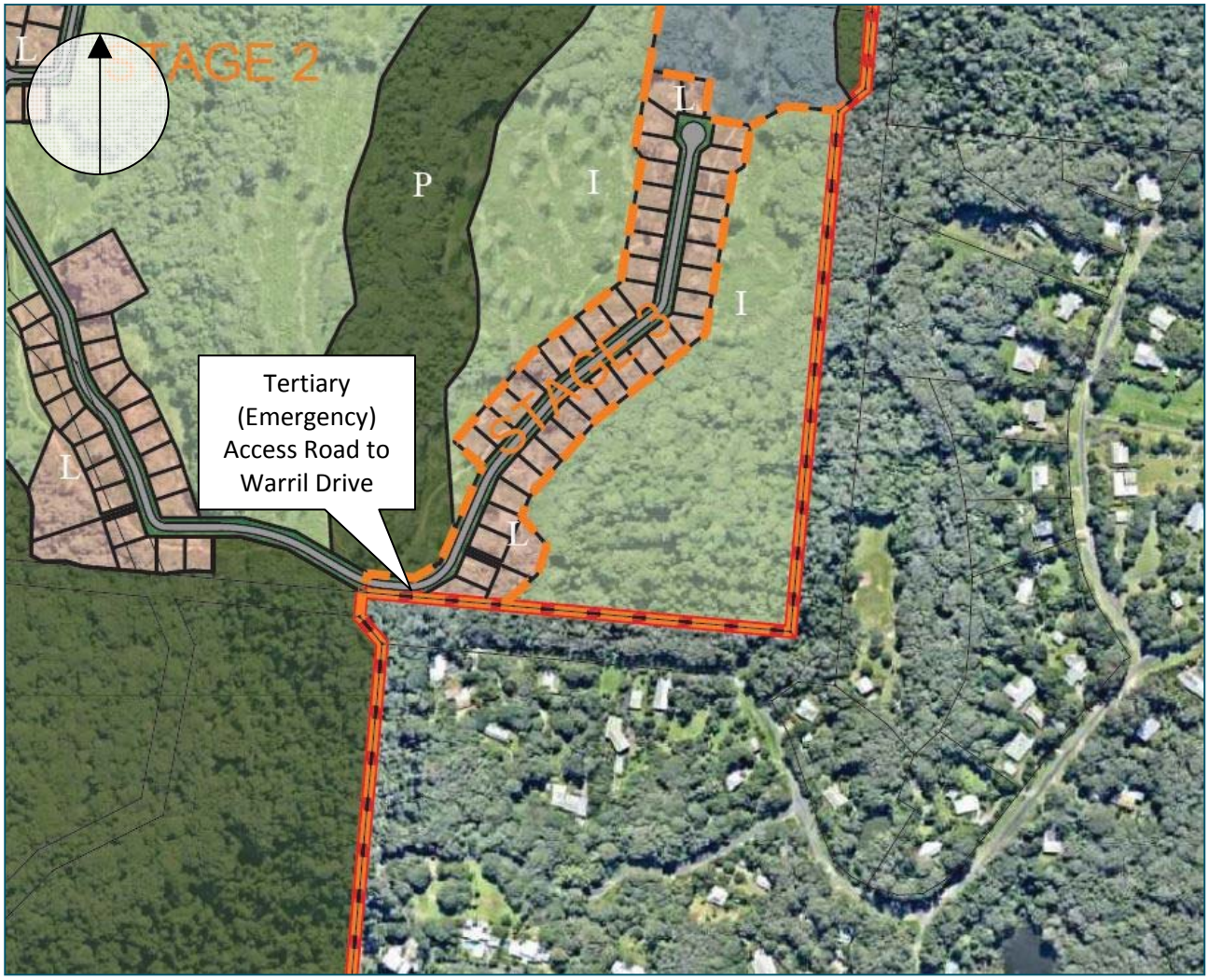


Figure 6.4 Tertiary (Emergency) Access from Warril Drive to East/South-East

From a review of the access locations within Google Earth with the Queensland Globe layers activated, it would appear that the access roads are within existing road reserves.

Noise from the emergency access will not be assessed as likely traffic flows would be limited, and the access is onto an existing road reserve.

KUR-World includes an internal road network which will allow for movement of people and services between the various parts of the development. The internal road network, particularly the main connecting roads to the primary access, is located a relatively large distance from existing residences, and thus is not considered further. Noise from the internal road network is likely to be audible at existing residences but not excessive.

6.6.2 Noise Criteria

Where vehicles are travelling on an existing or gazetted future Council road corridor, it is considered appropriate to assess noise levels against Council regulatory requirements. In this instance, ASK is unaware of any documented road traffic noise criteria for Mareeba Shire Council. Therefore, reference will be made to the external road traffic noise criteria contained within the Department of Transport and Main Roads (DTMR) Transport Noise Management Code of Practice Volume 1 – Road Traffic Noise, dated November 2013. The noise criteria for a new access controlled road near existing residences are as follows:

- 63 dBA $L_{10(18hour)}$ where the existing noise level is greater than 55 dBA $L_{10(18hour)}$

- 60 dBA $L_{10(18hour)}$ where the existing noise level is less than 55 dBA $L_{10(18hour)}$

Where vehicles are travelling on a private internal road, it is considered appropriate to assess noise levels at existing residences using the following criteria:

- The 'Background Creep' criteria for noise that varies over time (refer **Section 4.5.2**), i.e. the noise emissions are not to exceed the background noise level by more than 5 dBA.
- The acoustic quality objectives in **Section 4.5.3**, including:
  - Daytime and evening: 50 dBA $L_{Aeq,adj,1hr}$ outside existing residences near the proposed roads.
  - Night: 37 dBA $L_{Aeq,adj,1hr}$ outside existing residences near the proposed roads (note: this corresponds to achieving the 30 dBA internal noise limit).

It is not proposed to assess noise levels at proposed future residences within the KUR-World development.

6.6.3 Noise Levels and Assessment – Primary Access to Myola Road

The centreline of the proposed primary access road to Myola Road is located approximately 20 metres and 40 metres from the nearest existing dwellings. At the closest distance of 20 metres, compliance with the DTMR noise criteria of '60 dBA $L_{10(18hour)}$ where the existing noise level is less than 55 dBA $L_{10(18hour)}$' would be achieved with the following calculation inputs:

- 2100 vehicles per day (AADT)
- 5% heavy vehicles
- Average 5% road gradient
- 16.5 metres from residential facade to kerb (i.e. 20 metres from centreline of road to residential facade)
- Absorptive (vegetated ground between house and road)

A limit of 2100 vehicles per day may not be sufficient for the future development given the number of proposed accommodation rooms and various proposed uses. If a noise barrier was constructed adjacent the road, and was able to provide line-of-sight shielding, e.g. 1.5m to 2.0m height barrier assuming nearest dwelling is lowset, then the allowable traffic volume could be increased from 2100 to 6000 vehicles per day AADT. Further barrier height increases could be considered if necessary. A more detailed assessment is recommended for this access road when details become available.

6.6.4 Noise Levels and Assessment – Secondary Access via Barnwell Road

The centreline of the proposed primary access road to Barnwell Road is located approximately 17 metres from the nearest existing dwelling. At that distance, compliance with the DTMR noise criteria of '60 dBA $L_{10(18hour)}$ where the existing noise level is less than 55 dBA $L_{10(18hour)}$' would be achieved with the following calculation inputs:

- 2000 vehicles per day (AADT)
- 5% heavy vehicles
- Average 2% road gradient
- 13.5 metres from residential facade to kerb (i.e. 17 metres from centreline of road to residential facade)
- Absorptive (vegetated ground between house and road)

A limit of 2000 vehicles per day may be sufficient for the future development given the limited use of this road, compared to the primary access road. A more detailed assessment is recommended for this access road when details become available.

6.6.5 Summary

Noise from the access roads to the site and internal road network has been considered. It is considered that a road side noise barrier may be needed adjacent the house located 20 metres off the southern side of the primary access road to Myola Road. Noise barriers are not proposed for the secondary or tertiary (emergency) access roads.

7. Noise Intrusion Assessment

7.1 Pet Resort

7.1.1 Overview

There is an existing dog kennel facility located at 131 Boyles Road, as shown on **Figure 2.3** as Location 24 to the west of the development area. Noise from kennel facilities can be a source of annoyance, and a brief discussion with Mareeba Shire Council has revealed that there is a history of noise issues associated with these kennels.

7.1.2 Noise Criteria

To assist with determining appropriate noise limits reference is made to the Planning and Environment Judgment (No 936 of 2014) regarding a much larger (150 dog) kennel proposed at Lowood. Some comments as follows:

- The judgment included a number of noise management requirements.
- The judgment included noise limits based on:
  - The average maximum noise level ($L_{Amax,avg}$) which was calculated based on the background noise level plus 10 dBA in the day, and background noise level plus 5 dBA in the evening and night.
  - The equivalent continuous noise level ($L_{Aeq,adj,15mins}$) which was calculated based on the background noise level plus 3 dBA in the day and evening, and background noise level plus 0 dBA in the night.
- The judgment included specific requirements for compliance noise monitoring and building inspections.
- The DA noise report included with the judgment indicates that residences were as close as 120 metres from the proposed kennel.
- The DA report included a number of noise mitigation requirements in terms of building construction, building ventilation and 2.5m high noise barriers.

It is noted that the L_{eq} criteria above are approximately midway between the 'background creep' criterion (refer **Section 4.5.2**) for noise that (i) varies over time and (ii) is continuous. Background monitoring was conducted towards the western side of the site (Location D as per **Figure 2.2**) with the measurement results in **Table 5.2**. The noise limits are calculated as follows:

- Day 35 dBA $L_{Aeq,adj,T}$ and 42 dBA $L_{Amax,avg}$
- Evening 30 dBA $L_{Aeq,adj,T}$ and 32 dBA $L_{Amax,avg}$
- Night 26 dBA $L_{Aeq,adj,T}$ and 31 dBA $L_{Amax,avg}$

7.1.3 Noise Data

There are a wide range of noise source levels for kennels. From the DA report associated with the aforementioned judgment, a source noise level of 90 dBA at 3 metres was considered representative of the average maximum noise level of a large barking dog. This corresponds to a sound power level of 108 dBA $L_{w,Amax,avg}$. The report also made reference to an average bark of 83 dBA at 3 metres, which corresponds to a sound power level of 101 dBA, and this may be a reasonable estimate of the L_{eq} sound power level of dogs barking.

It is proposed to undertake calculations based on indicative sound power levels of $L_{w,max}$ 108 dBA and $L_{w,eq}$ 101 dBA for large dogs.

7.1.4 Noise Levels and Assessment

The proposed L_{max} sound power level is 7 dB higher than the L_{eq} sound power level. Based on this 7 dB difference and the limits in **Section 7.1.2**, compliance with the L_{max} noise limit would result in compliance with the L_{eq} noise limits.

There is no specific information available for the kennels to enable detailed modelling to be undertaken. Therefore, a noise model has been prepared with a barking dog sound source ($L_{w,max}$ 108 dBA) located in the middle of the kennel facility, and no allowance has been included for building screening, noise barriers or screening from vegetation. Noise contours have been determined using the SoundPLAN v7.4 modelling software and the ISO 9613 algorithms. The model does not include noise attenuation from vegetation (forest) and thus may be conservative.

The predicted noise levels are shown in **Figure D.3**. From these contours it can be seen that noise levels at the western part of Stage 1B residential development are up to 40 to 45 dBA L_{max}. Based on the sound power levels nominated above, this translates to a noise level of 33 to 38 dBA L_{eq}.

To achieve the noise limits nominated in **Section 7.1.2**, the following reduction would be required:

- Day 0 to 3 dBA
- Evening 8 to 13 dBA
- Night 9 to 14 dBA

It is generally expected that dogs would be indoors in the evening and night, and thus the noise mitigation in those periods is to be achieved through appropriate building construction. The daytime reduction of 0 to 3 dBA may be achieved by the vegetation between the kennels and the proposed residences, or through minimal screening at the kennels. Overall, it is considered the attenuation would be achievable.

It is noted that there are existing residences to the west and south-west of the kennels. The nearest is listed in **Table 2.1** as receptor 25 (165 Boyles Road). From **Figure D.3** the predicted noise level is 40 to 45 dBA L_{max}, which is the same predicted at the proposed KUR-World residences. Therefore, on the basis that the pet resort should achieve compliance at the existing residences, it would appear likely that compliance would be achieved at the proposed KUR-World residences.

7.1.5 Summary

In conclusion, it is considered that pet resort noise levels would likely be compliant or will be no worse than experienced at other existing nearby residences.

7.2 Billabong Hotel

7.2.1 Overview

The Billabong Hotel is located approximately 100 metres from proposed locations for development activities and is surrounded with forest. The Billabong Hotel includes off road motor activities, paintball, a licensed venue with amplified music and patrons. The Billabong Hotel webpage indicates that the venue is suitable for indoor and outdoor events up to 2000 people, and has an amphitheatre that can hold 5000 to 10,000 people.

7.2.2 Review

The location of the Billabong Hotel is approximately 1 kilometre from the southern residences in Stage 2 of the development, and over 1 kilometre from the proposed 'glamping' area in Stage 1B. The Hotel is approximately 900 metres from existing residences to the east, 1.3 kilometres from existing residences to the north-east.

7.2.3 Noise Levels and Assessment

Amplified music noise emissions have been modelled for two locations (i) the Billabong Hotel amphitheatre and (ii) the Billabong Hotel deck (adjacent the lake). There is no specific information on the music levels at the Hotel, and so the standard music noise spectrum included in the Queensland Office of Liquor and Gaming Regulation (OLGR) acoustic guidelines has been utilised. The sound power level of the music is modelled as 120 dBA (129 dBZ). The noise level is reported as the L_{eq}(1hour) parameter.

Noise contours have been determined using the SoundPLAN v7.4 modelling software and the ISO 9613 algorithms. The model does not include noise attenuation from vegetation (forest) and thus may be conservative.

The noise levels are included in **Appendix D** in **Figure D.4** (Amphitheatre location) and **Figure D.5** (Hotel deck location). The following observations are made regarding the figures:

- **Figure D.4** (Amphitheatre music location)
  - The noise level at the KUR-World south-east 'glamping' area is <25 dBA to 40 dBA
  - The noise level at the southern end of the KUR-World Stage 3 residential area is 30 to 35 dBA
  - The noise levels at nearest residences R29 (133 Mount Haren Road) and R32 are both 35 to 40 dBA
- **Figure D.5** (Hotel deck music location)
  - The noise level at the KUR-World south-east 'glamping' area is <25 dBA to 40 dBA
  - The noise level at the southern end of the KUR-World Stage 3 residential area is 35 to 40 dBA
  - The noise levels at nearest residences R29 (133 Mount Haren Road), R32 and R33 are all 30 to 35 dBA

From the above observations it can be seen that the noise levels are similar at the proposed KUR-world sensitive areas ('Glamping' and southern extent of Stage 3 residences) and the existing nearby sensitive areas (residences). The absolute level of the noise levels in **Figure D.4** and **D.5** is not considered important as the actual music levels are unknown and modelling does not consider attenuation from vegetation, but rather the relative difference between noise levels at existing and proposed residences are more important.

7.2.4 Summary

Overall, the proposed KUR-World residences are no closer to the Billabong Hotel than existing residences, and are not predicted to be exposed to higher noise levels than existing residences. On that basis, there is not expected to be a significant imposition on the operation of the Billabong Hotel due to the KUR-World development.

8. Construction Noise Assessment

8.1 Overview

The staging of the delivery of KUR-World facilitates construction activity on the site for a period of at least six years.

Construction works will initially include earthworks and road construction. Subsequently, works will include building and services construction.

8.2 Noise Criteria

8.2.1 Noise Level Targets

Construction noise level targets for the project have been adopted from the NSW Interim Construction Noise Guideline (ICNG) (NSW DECC, 2009) as discussed in **Section 4.8**. The noise level targets for construction are based on the ambient background noise level plus an allowance of 10 dB for activity during Monday to Saturday from 6:30 am to 6:30 pm (recommended standard hours), or an allowance of 5 dB (as a guide) for activity outside standard hours.

Based on the results of noise logging for the day (7:00am to 6:00pm), evening (6:00pm to 10:00pm) and night (10:00pm to 7:00am) periods, the range of construction noise level targets for each period of the day are presented in **Table 8.1**. It is noted that the ICNG noise targets are recommended for within and outside standard operating hours (6:30am to 6:30pm). For the purpose of this assessment, noise targets have been nominated for day, evening and night if some activities were to operate 24 hours per day. For the purpose of this assessment the daytime period is considered to be from 6:30am to 6:30pm, consistent with the recommended hours of construction.

The noise level targets presented in **Table 8.1** are based on RBLS (less insect noise) from **Table 5.2**. It is not proposed to use the data at Location E (North) as it was close to Location A (North) but had higher noise levels.

Table 8.1 Construction Noise Screening Criteria

Location	Rating Background Noise Level (RBLs) L_{90} (less insects)			ICNG Noise Affected Level dBA $L_{eq(15\ minute)}$ (Highly Noise Affected Level in Brackets)		
	Day	Evening	Night	Day	Evening	Night
A – north	33	25	25	43 (75)	30	30
B – east	36	29	25	46 (75)	34	30
D – west	32	27	26	42 (75)	32	31

Note: The highly noise affected level only applies in the daytime.

It is important to note that the ICNG targets are not noise limits as such, but screening criteria for assessing whether construction noise is likely to have adverse impacts and hence whether "feasible and reasonable" work practices should be implemented during the construction process in order to reduce noise levels. Where noise levels exceed the "Noise Affected Level" some community reaction to construction noise is expected and the project should implement mitigation measures to reduce noise impacts.

8.2.2 Prediction Methodology

Environmental noise calculations have been conducted for this assessment of noise impacts from construction work associated with the development.

The sound power levels (Lw) applied in this assessment have been chosen based on typical mobile and fixed plant. The sound power levels applied in the assessment for this plant have been obtained from ASK's extensive noise source database, which includes data obtained from ASK noise measurements as well as review of published literature.

It should be noted that the plant items detailed in this study are at this stage indicative of the plant required to complete the construction of the Project. The accuracy of the calculations would be affected should plant be modified, moved (substantially) or replaced.

The successful contractor, in preparing noise control measures for their Environmental Management Plan (EMP) will need to confirm noise levels of the actual equipment to be used.

8.2.3 Assumptions and Technical Limitations

As with most proposed developments, the impact assessment process is based on defining representative scenarios reflecting typical conditions likely to be experienced during construction and operation of the project.

Prediction of noise impacts from any construction project involves unknown source characteristics in that the particular construction equipment to be used on site is not confirmed until detailed planning for the construction process is conducted.

The adopted methodology is based on the NSW ICNG and is a “screening criterion” approach – i.e. the assessment identifies which construction activities have higher risks of resulting in noise or vibration impacts and therefore which activities require noise mitigation measures to be incorporated into planning the activity.

During the detailed planning of the construction sequence these activities should be planned and managed to minimise noise impacts, e.g. by including mitigation measures as discussed in this EIS chapter.

The prediction of acoustic impacts based on representative sources, means that there is the possibility that the actual source construction or operational noise levels may be higher (or lower) than predicted in this assessment (e.g. a particularly noisy construction activity). If this occurs in practice, additional mitigation measures will be implemented as documented in a Noise Management Plan to be prepared for the project. Actual residual impacts will, however, be determined by the acoustic impacts after appropriate mitigation is applied.

8.3 Construction Noise Sources, Levels and Assessment

8.3.1 Noise Sources

The typical construction sound power levels for construction vehicles and piling are presented in **Table 8.2**.

Table 8.2 Typical Sound Power Levels for Construction Activities and Equipment

Equipment Type	Sound Power Level, $L_{w,eq}$ dBA
Dozer	108
Excavator	116
Front end loader	112
Grader	111
Profiler	113
Road truck	111
Rock breaker	118

Equipment Type	Sound Power Level, $L_{w,eq}$ dBA
Vibratory Roller	105
Water cart	111
Piling	117

Reference sound power levels presented in **Table 8.2** have been obtained from multiple sources including:

- AS2436-2010 - Guide to noise and vibration control on construction, demolition and maintenance sites.
- Department of Environment, Food and Rural Affairs - Update of Noise Database for Prediction of Noise on Construction and Open Sites, 2005.
- Information held in ASK libraries.

8.3.2 Noise Levels – General Construction

Based on the sound power levels presented in **Table 8.2**, the typical noise levels for construction equipment are presented in **Table 8.3**.

Table 8.3 Predicted Noise Levels for Construction Equipment at Various Distances

Equipment Type	Predict Noise Level, $L_{eq,adj,15min}$ dBA								
	5m	10m	20m	35m	50m	75m	100m	150m	200m
Dozer	83	77	71	66	62	59	56	52	49
Excavator	91	85	78	73	69	66	63	59	56
Front end loader	87	81	74	69	66	62	59	55	52
Grader	86	80	73	68	65	61	58	54	51
Profiler	88	81	75	70	67	63	60	56	53
Road truck	86	79	73	68	65	61	58	54	51
Rock breaker	93	87	80	75	71	67	64	60	58
Vibratory Roller	80	73	67	62	58	54	52	48	45
Water cart	85	79	73	67	64	60	57	53	50
Piling	92	86	79	74	70	66	63	59	57

The predicted noise levels presented in **Table 8.3** indicate that construction noise levels are predicted to:

- Exceed the 'Noise affected' day time noise levels of 42 to 46 dBA L_{eq} at all distances shown in **Table 8.3.**
- Exceed the 'Highly noise affected' day time noise limit of 75 dBA L_{eq} at distances of up to 20m for the various equipment types.

The predicted noise levels represent an estimation of the potential noise impacts and are useful in identifying and managing risk.

The in-situ noise levels may be lower during construction activities due to time equipment spends idling or working over a large work area rather than a small stationary area. Conversely, cumulative noise impacts need to be considered when multiple plant items are located in close proximity. The following example considers the potential cumulative 15 minute sound power level of a grouping of equipment:

- Excavator, L_w 116 dBA, operating for 50% of period: $L_{w,15min}$ 113 dBA
- Trucks x 3, L_w 111 dBA, assume 1 of 3 trucks active/driving at any one time: $L_{w,15min}$ 111 dBA
- Dozer, L_w 108 dBA, operating for 50% of period: $L_{w,15min}$ 105 dBA
- Grader, L_w 111 dBA, operating for 100% of period: $L_{w,15min}$ 111 dBA
- Water Cart, L_w 111 dBA, operating for 50% of period: $L_{w,15min}$ 108 dBA
- TOTAL $L_{w,15min}$ 117 dBA

From the above calculation it can be seen that the overall sound power level of 117 dBA is only 1 dB higher than the highest individual sound power level of 116 dBA for an excavator (refer **Table 8.2**). Thus the cumulative impact may not necessarily be significantly higher than the individual sound power level once the operational duty of the equipment is considered. Never-the-less, in some instances there could be multiple items operating and overall or cumulative impacts should be considered.

8.3.3 Noise Levels – Trucks on Access Roads

During construction there will be trucks accessing the site from the Secondary Access Road (Barnwell Road, refer **Section 6.6**), and also the Primary Access Road once that road is constructed. From **Section 6.6.3** and **6.6.4** it was identified that the closest house to either of these roads is 17 metres from the road centreline.

Based on a truck sound power level of 111 dBA (refer **Table 8.2**), a road speed of 40 km/h, and a separation distance of approximately 17 metres, the calculated noise level for a single truck passby at the closest adjacent residence is $L_{eq,15min}$ 55 dBA. From **Table 8.1** this noise level would result in the residence being noise affected, but not highly noise affected.

The use of Barnwell Road, and subsequently the primary access road to Myola Road, as haul trucks for construction traffic would have a noise impact on nearby residences. A noise management plan for the development should have a specific section addressing this traffic noise issue including any potential noise control measures.

8.4 Mitigation Measures

The predicted construction noise levels presented in **Section 8.3** indicated that the noise levels associated with construction vehicles have the potential to exceed the construction noise goals presented in the NSW ICNG.

Several management and mitigation measures are available in order to reduce the noise levels associated with construction activities. Australian Standard AS2436-2010 *Guide to noise and vibration control on construction, demolition and maintenance sites* provides guidance for the preparation of noise and vibration management plans and other issues. Table C3 within Appendix C of the standard, provides guidance on the typical effectiveness of various physical noise controls and is presented in **Table 8.4**.

Table 8.4 Relative Effectiveness of Various Forms of Noise Control (AS2436-2010 Table C3)

Form of Noise Control	Typical Noise Reduction
Distance	Approximately 6 dBA per doubling of distance
Screening	Normally 5 to 10 dBA, maximum 15 dBA
Enclosure	Normally 15 to 25 dBA, maximum 50 dBA
Silencing	Normally 5 to 10 dBA, maximum 20 dBA

As indicated in **Table 8.4**, there are several ways to reduce construction noise emissions from site, these methods are discussed as follows:

- Distance: Increasing separation distance between noisy plant and the sensitive locations is an effective method, but limited by required construction locations and the existing nearby residences.
- Screening: The construction of temporary acoustic screen fences can be a viable way to reduce noise emissions from fixed and mobile plant on some sites. Noise screens are most effective when located close to the source or close to the receiver, as they work by cutting line of site from the source to the receiver. Noise screen may be less effective or ineffective if there are gaps in the barrier.
- Enclosing: The construction of enclosures is generally practical for stationary plant such as air-conditioning plant, pumps and generators.
- Silencing: With a similar effectiveness to screening, silencers can be installed on ventilation and exhausts of plant. They can be effective at reducing the noise emitted from exhausts pipes on mobile plant. The use of silencers can be limited by the availability of suitable upgrades and the effect on the general operation of the plant.

Typically, it is considered likely that screening and/or silencing would be the most effective, reasonable and practicable method for reducing construction noise levels at nearby sensitive locations. However, there may be instances where it is not practicable to construct noise screens or install silencers.

All general activities relating to the construction works should be carried out in accordance with best practice measures to reduce the potential for noise impacts, including the following:

- Modern and well-maintained equipment should be used to undertake the works.
- Noisy or vibration generating plant, equipment and activities should be substituted with lower impact options where possible.
- Arrange work flow to minimise the use of reversing alarms on vehicles and plant. Use equipment with broadband alarms where possible.
- Locate noisy plant, site vehicle entrances and off-site truck parking areas away from sensitive receptors where possible.
- Plant known to emit noise strongly in one direction should, where possible, be orientated so that the noise is directed away from the closest noise-sensitive areas.
- Where machines are fitted with mufflers, these should be kept in good condition and replaced if degradation has led to noticeably increased noise emissions.
- There should be continuous training of operators, labourers, subcontractors and supervisors through induction training and ongoing meetings on the need to minimise noise impacts on surrounding local residents.
- Where machines are fitted with engine covers, these should be kept closed when the machine is in use.
- The drivers of machinery should be provided with appropriate communication equipment, to ensure that signalling by other means (e.g. horns) is kept to a minimum.
- Noise sensitive receptors should be informed of any nearby construction works, or significant changes to nearby construction works, in advance (preferably at least one weeks' notice, except for emergency works) of works occurring.
- Provide advanced notice, where possible, to stakeholders when loud construction or demolition activity is proposed to be undertaken.
- Open communication should occur with stakeholders located in the vicinity of construction areas who could potentially be impacted by activities resulting in noise and vibration emissions. A construction engagement program should be developed and implemented to create a dialogue with stakeholders during the construction phase.

- A designated communication channel, i.e. email and phone number, should be established, to facilitate communication with stakeholders. This communication method should be actively managed to ensure complaints and issues can be addressed as soon as practically possible.

A Construction Noise and Vibration Management Plan should be developed for the Project, including these mitigation strategies.

9. Recommendations & Conclusion

ASK Consulting Engineers Pty Ltd (ASK) was commissioned to provide noise and vibration consultancy services to assess the KUR-World project. The results of this assessment are as follows:

- Noise emissions have been considered for various components of the development as follows:
  - Three potential zip lines are proposed in Part E, Stage 1B in the southern zone of the development. It is considered that zip line activities are able to achieve compliant noise levels. It is recommended that the 'background creep' noise criterion be applied to this noise source. Further investigation should be conducted as the design progresses in the future. It is expected that use of the facility would require completion of a detailed noise management plan. (Refer **Section 6.1**)
  - A privately used helipad is proposed in Stage 1B adjacent the southern boundary of the site (Refer **Figure 3.2**). The site is approximately 1 kilometre from the nearest existing dwellings to the east, with the exception of the nearby Billabong Hotel which is approximately 100 metres from the helipad site. It is understood there is some degree of cooperation between the developer and the operator of the Billabong Hotel such that this minimal distance has been accepted. It is noted that the Billabong Hotel Facebook page includes a photo of a helicopter located adjacent the lake beside the Billabong Hotel, and so it would seem that helicopter noise is not unusual to the location. It is recommended that a flight path be nominated which maximises the distance to the residences. The helipad separate distance of 1, a flight path separation distance of 500 metres and maximum 20 flights per day, would achieve the nominated noise criteria. (Refer **Section 6.2**)
  - A sewage treatment plant is proposed in the centre of the northern zone of the development, which is as close as 130 metres to proposed nearby residences (Hotel). The proposed sewage treatment plant has the potential to exceed the proposed relatively low noise limits, and thus would require a detailed noise assessment during its design development. It is likely that noise mitigation measures will be required. (Refer **Section 6.3**)
  - It is expected that there will be significant mechanical plant located around the development including air-conditioning, refrigeration, exhaust and supply fans, generators and other items. Noise limits have been proposed in **Section 6.4**. The relatively low limits will require careful consideration of plant location, design and selection.
  - It is expected that there will be a number of venues with amplified music and moderate to large numbers of people, e.g. hotel and function centre, sports, golf clubhouse, 5 star eco resort, and equestrian centre. Noise emissions from activities within buildings can be readily controlled via building construction measures. Outdoor noise is more difficult to mitigate and care has to be taken when locating activities requiring large groups of people. Where sports fields are proposed, it is recommended to locate any stands, stadia, clubhouse or other gathering areas, as far from sensitive receivers as possible. Where possible it is best to use screening from natural topography and intervening non-sensitive buildings. (Refer **Section 6.5**)
  - Three access points have been assessed: (i) primary access from the east of the site from Myola Road along an existing gazetted road reserve, (ii) secondary access from Barnwell Road in the north of the site, and (iii) tertiary (emergency) access at Warril Drive in the east/south-east of the site. It is considered that a road side noise barrier may be needed adjacent the house located 20 metres off the southern side of the primary access road to Myola Road. Noise barriers are not proposed for the secondary or tertiary (emergency) access roads. (Refer **Section 6.6**)
- Noise intrusion into the development has been considered for various off-site activities as follows:
  - Kuranda Landscape Supplies and Kuranda Raw Materials to the east, and the quarry on the Kennedy Highway to the south, have all been considered and given the large separation distances are considered very unlikely to impact on the development site (Refer **Section 2.4**)

- A small orchard to the north is considered very unlikely to impact on the development site (Refer **Section 2.4**).
- The Kuranda Pet Resort to the west of KUR-World is understood to have a history of noise related concerns, but the substance of those concerns is currently unknown. It is considered that pet resort noise levels would likely be compliant or will be no worse than experienced at other existing nearby residences. (Refer **Section 7.1**)
- The Billabong Hotel to the south includes a range of noisy activities including music festivals. It has been considered. The proposed KUR-World residences are no closer to the Billabong Hotel than existing residences, and are not predicted to be exposed to higher noise levels than existing residences. On that basis, there is not expected to be a significant imposition on the operation of the Billabong Hotel due to the KUR-World development. (Refer **Section 7.2**)

- Construction noise and vibration impacts have been considered in broad terms in **Section 8** with the following recommendations and conclusions:
  - A construction Noise and Vibration Management Plan should be developed. The management plan should include the standard mitigation measures nominated in **Section 8** of the report.
  - The use of Barnwell Road, and subsequently the primary access road to Myola Road, as haul trucks for construction traffic would have a noise impact on nearby residences. A noise management plan for the development should have a specific section addressing this traffic noise issue including any potential noise control measures.

Appendix A Glossary

Parameter or Term	Description
dB	The decibel (dB) is the unit measure of sound. Most noises occur in a range of 20 dB (quiet rural area at night) to 120 dB (nightclub dance floor or concert).
dBA	Noise levels are most commonly expressed in terms of the 'A' weighted decibel scale, dBA. This scale closely approximates the response of the human ear, thus providing a measure of the subjective loudness of noise and enabling the intensity of noises with different frequency characteristics (e.g. pitch and tone) to be compared.
Day	The period between 7am and 6pm.
Evening	The period between 6pm and 10pm.
Night	The period between 10pm and 7am.
Free-field	The description of a noise receiver or source location which is away from any significantly reflective objects (e.g. buildings, walls).
L_1	The noise level exceeded for 1% of the measurement period.
L_{10}	The noise level exceeded for 10% of the measurement period. It is sometimes referred to as the average maximum noise level.
L_{90} or $L_{90,T}$	The noise level exceeded for 90% of the measurement period of the duration 'T', if defined. This is commonly referred to as the background noise level.
L_{A90} or $L_{A90,T}$	As for L_{90} except the measurement weighting is defined as A-weighted
L_{eq}	The equivalent continuous sound level, which is the constant sound level over a given time period, which is equivalent in total sound energy to the time-varying sound level, measured over the same time period.
$L_{eq,1hour}$	As for L_{eq} except the measurement intervals are defined as 1 hour duration.
$L_{eq,T}$	As for L_{eq} except the measurement interval is defined as duration of 'T'.
$L_{eq,adj,T}$	As for L_{eq} except the measurement interval is defined as duration of 'T' and the level is adjusted for tonality or impulsiveness, if required.
L_{max}	Maximum A-weighted sound pressure level.
L_{eq}(24 hour) or $L_{eq,24hours}$	The average L_{eq} noise level over the 24-hour period from midnight to midnight.
L_{10}(18 hour)	The arithmetic average of the one-hour L_{10} values between 6am and midnight. This parameter is used in the assessment of road traffic noise.
Rating Background Level (RBL)	The Rating Background Level (RBL) is the overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period. The RBL is determined using the lowest 10th percentile method, where the lowest tenth percentile of the background noise levels (L_{90}) are determined for each day in each monitoring period (day, evening and night), and the median value from the monitoring period is taken as the RBL during the day, evening and night. This methodology is defined in the Queensland Department of Environment and Heritage Protection (EHP) guidelines.
L_p	The sound pressure level of a noise. The instantaneous noise level, which is noted during a noise event.
L_w	The sound power level of a noise source is its inherent noise, which does not vary with distance from the noise source. It is not directly measured with a sound level meter, but rather is calculated from the measured noise level and the distance at which the measurement was undertaken.
$L_{w,eq}$	The sound power level expressed as the equivalent sound level.

Appendix B Project Drawings

LEGEND

A	FARM THEME PARK AND EQUESTRIAN CENTRE	18.96 ha
B	PRODUCE GARDEN	2.51 ha
C	BUSINESS AND LEISURE HOTEL AND FUNCTION CENTRE	3.83 ha
D	KUR-VILLAGE	2.50 ha
E	RAINFOREST EDUCATION CENTRE AND ADVENTURE PARK	17.13 ha
F	KUR-WORLD CAMPUS	4.02 ha
G	SPORTING PRECINCT	2.41 ha
H	GOLF CLUBHOUSE AND FUNCTION CENTRE	0.75 ha
I	GOLF COURSE	46.39 ha
J	FIVE STAR ECO-RESORT	6.21 ha
K	HEALTH AND WELLBEING RETREAT	5.66 ha
L	PREMIUM VILLAS	20.18 ha
M	LIFESTYLE VILLAS	14.18 ha
N	QUEENSLANDER LOTS	1.70 ha
O	SERVICES/INFRASTRUCTURE	2.75 ha
P	ENVIRONMENTAL AREA	501.27 ha
Q	OPEN SPACE	1.75 ha

BARNWELL ROAD

FARM-STAY ACCOMMODATION

"GLAMPING"

STAGE 1A

STAGE 1B

STAGE 1B

STAGE 1

STAGE 2

STAGE 3

STAGE 3

STAGE 2

STAGE 1B

"GLAMPING"

PRIMARY ACCESS ROAD TO MYOLA ROAD

MYOLA ROAD

KENNEDY HIGHWAY

North

ZIP-LINE OPTION 1 (1.5km LONG)

ZIP-LINE OPTION 2 (1.26km LONG)

ZIP-LINE OPTION 3 (1.2km LONG)

HELIPAD

KUR-World

CONCEPT MASTER LAYOUT

REV-G ISSUED 29 SEPTEMBER 2017

Appendix C Noise Monitoring Results

C.1 Noise Monitoring Results from Location A

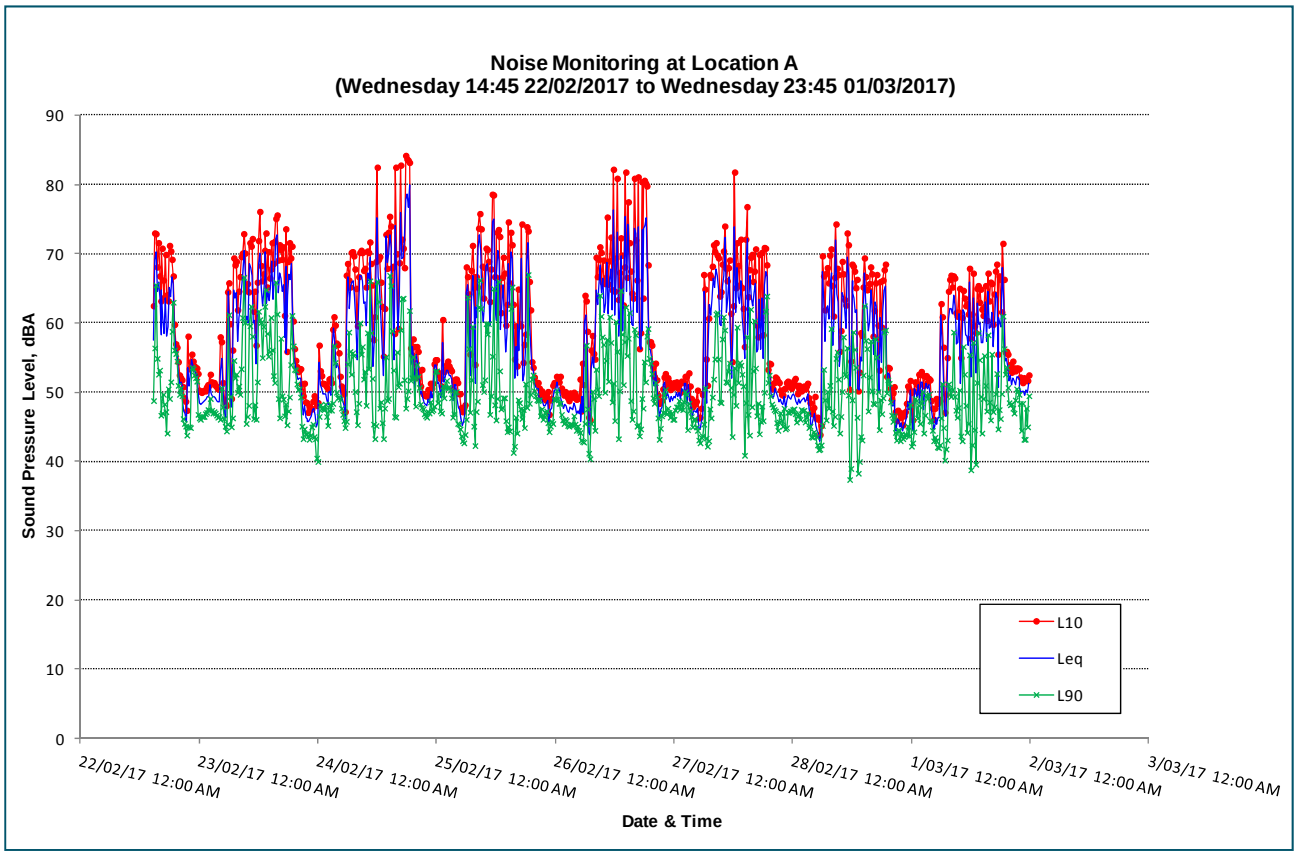


Figure C.1 Graph of Noise Logging Results at Location A

Table C.1 Statistical Noise Levels at Location A

Parameter	Statistic	Noise Levels dBA		
		Day	Evening	Night
L_{max}	Maximum	92	85	79
	Top 10%	82	74	66
	Average	74	61	58
	(Median)	73	58	56
	Bottom 10%	67	53	53
	Minimum	55	50	49
L_1	Maximum	87	84	72
	Top 10%	79	73	61
	Average	71	58	54
	(Median)	71	55	53
	Bottom 10%	65	50	50
	Minimum	49	48	45
L_{10}	Maximum	84	84	70
	Top 10%	73	71	58
	Average	67	57	52
	(Median)	67	54	51
	Bottom 10%	59	49	48
	Minimum	46	46	44
L_{eq}	Maximum	78	80	67
	Top 10%	70	67	55
	Average	63	55	50
	(Median)	63	52	49
	Bottom 10%	56	48	46
	Minimum	44	44	43
L_{90}	Maximum	67	67	64
	Top 10%	61	56	50
	Average	52	50	47
	(Median)	50	49	47
	Bottom 10%	44	45	43
	Minimum	37	43	40

C.2 Noise Monitoring Results from Location B

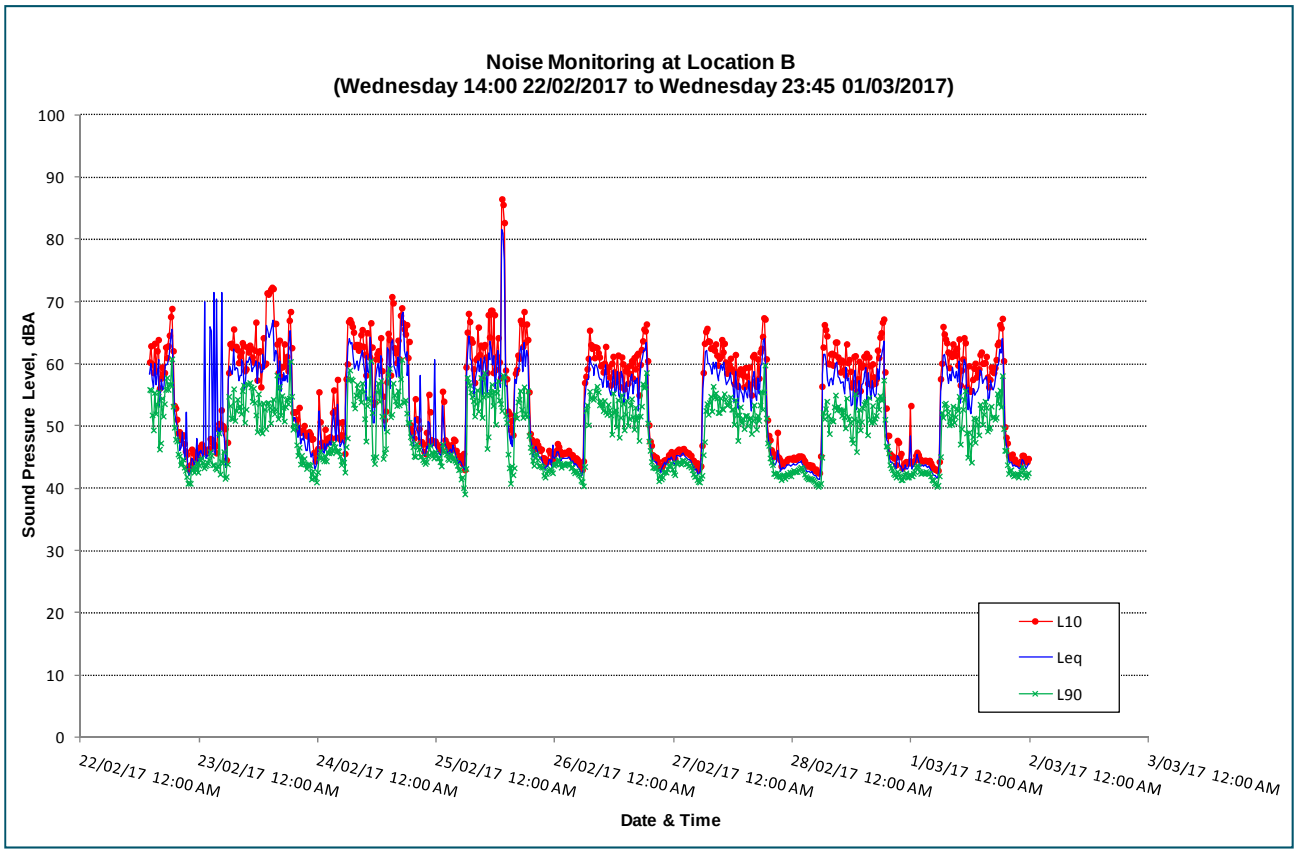


Figure C.2 Graph of Noise Logging Results at Location B

Table C.2 Statistical Noise Levels at Location B

Parameter	Statistic	Noise Levels dBA		
		Day	Evening	Night
L_{max}	Maximum	99	83	97
	Top 10%	72	70	68
	Average	68	59	56
	(Median)	67	58	54
	Bottom 10%	63	50	48
	Minimum	57	47	46
L_1	Maximum	91	70	86
	Top 10%	69	68	64
	Average	65	54	51
	(Median)	64	51	47
	Bottom 10%	60	46	45
	Minimum	54	44	44
L_{10}	Maximum	87	69	68
	Top 10%	65	66	58
	Average	61	51	48
	(Median)	61	49	46
	Bottom 10%	57	45	44
	Minimum	49	43	43
L_{eq}	Maximum	82	65	72
	Top 10%	61	62	57
	Average	58	50	47
	(Median)	58	47	45
	Bottom 10%	54	44	43
	Minimum	47	43	41
L_{90}	Maximum	61	61	59
	Top 10%	56	55	47
	Average	53	47	44
	(Median)	53	45	43
	Bottom 10%	49	42	41
	Minimum	41	41	39

C.3 Noise Monitoring Results from Location D

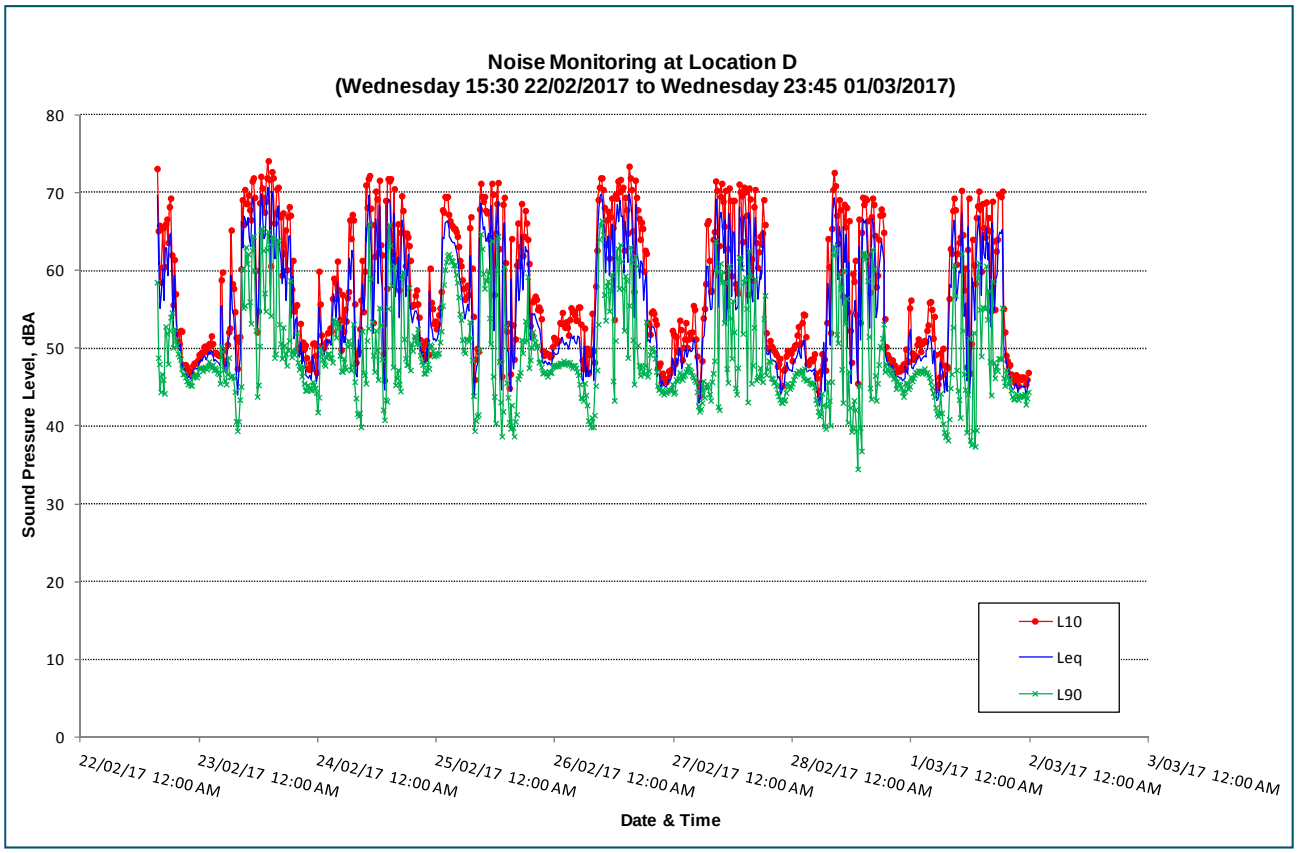


Figure C.3 Graph of Noise Logging Results at Location D

Table C.3 Statistical Noise Levels at Location D

Parameter	Statistic	Noise Levels dBA		
		Day	Evening	Night
L_{max}	Maximum	86	73	76
	Top 10%	75	69	68
	Average	70	58	59
	(Median)	71	57	58
	Bottom 10%	64	50	52
	Minimum	56	47	47
L_1	Maximum	79	72	72
	Top 10%	73	68	63
	Average	68	56	55
	(Median)	69	54	54
	Bottom 10%	59	48	49
	Minimum	51	46	46
L_{10}	Maximum	74	70	70
	Top 10%	71	66	59
	Average	63	54	52
	(Median)	65	52	51
	Bottom 10%	52	47	47
	Minimum	45	45	44
L_{eq}	Maximum	71	65	66
	Top 10%	68	62	56
	Average	60	52	50
	(Median)	61	50	49
	Bottom 10%	50	46	45
	Minimum	44	44	43
L_{90}	Maximum	66	59	62
	Top 10%	62	52	51
	Average	51	48	47
	(Median)	49	48	47
	Bottom 10%	41	45	43
	Minimum	35	43	39

C.4 Noise Monitoring Results from Location E

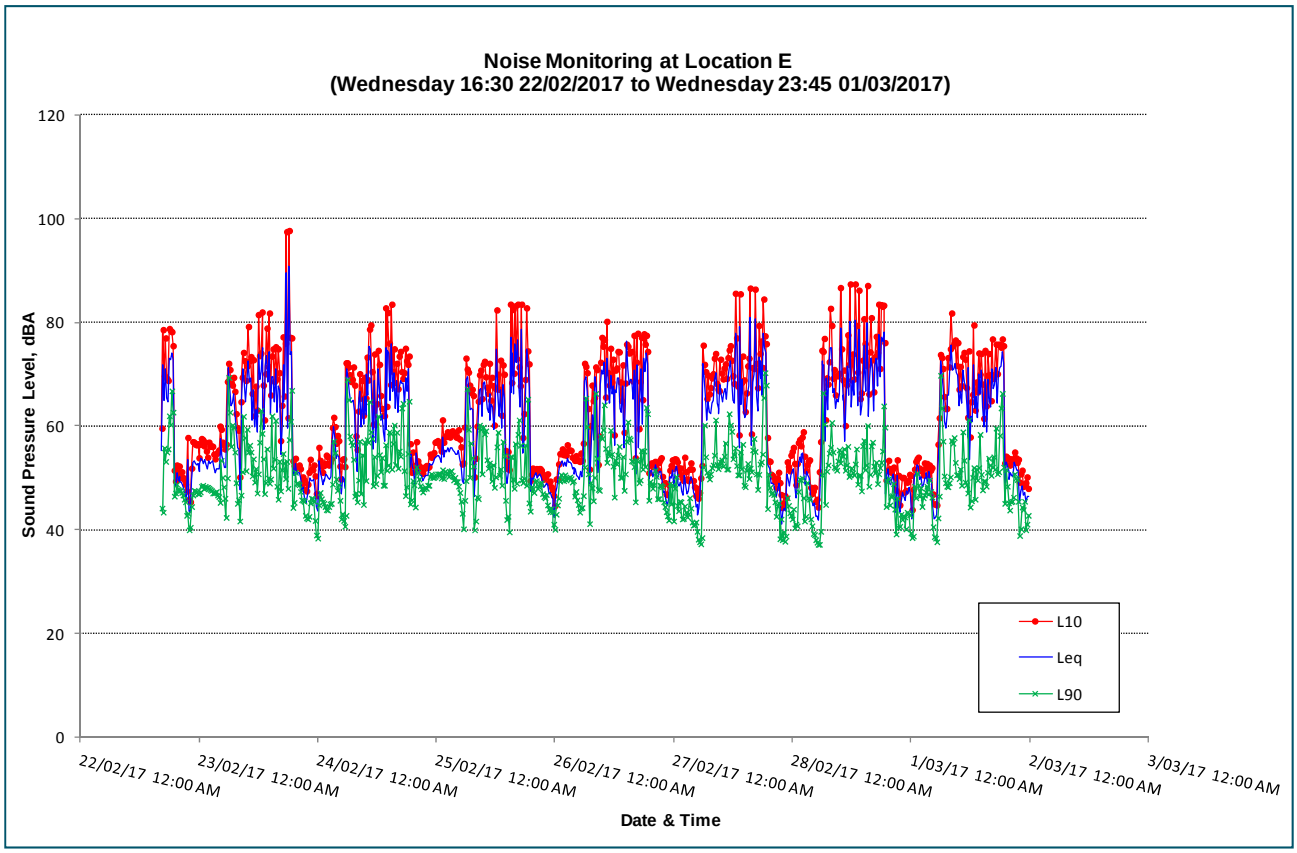


Figure C.4 Graph of Noise Logging Results at Location E

Table C.4 Statistical Noise Levels at Location E

Parameter	Statistic	Noise Levels dBA		
		Day	Evening	Night
L_{max}	Maximum	98	98	79
	Top 10%	84	81	71
	Average	77	63	62
	(Median)	76	58	61
	Bottom 10%	69	54	55
	Minimum	60	51	52
L_1	Maximum	98	98	78
	Top 10%	84	79	71
	Average	75	60	58
	(Median)	75	54	57
	Bottom 10%	67	51	51
	Minimum	55	48	48
L_{10}	Maximum	98	98	77
	Top 10%	79	77	66
	Average	70	58	55
	(Median)	70	53	54
	Bottom 10%	62	50	47
	Minimum	50	45	44
L_{eq}	Maximum	89	91	73
	Top 10%	74	74	61
	Average	66	55	52
	(Median)	66	51	51
	Bottom 10%	58	48	45
	Minimum	46	43	41
L_{90}	Maximum	66	70	70
	Top 10%	59	62	51
	Average	53	50	47
	(Median)	52	48	46
	Bottom 10%	48	44	40
	Minimum	40	38	37

Appendix D Noise Contours

Project: KUR World
Project Number: 8852

Figure

D.1

Zipline Leq(1hour)

Calculation 4.6m above ground.

See tablulated results for predicted noise levels at each receptor.

Leq(1hour)

(Free-Field)
in dB(A)

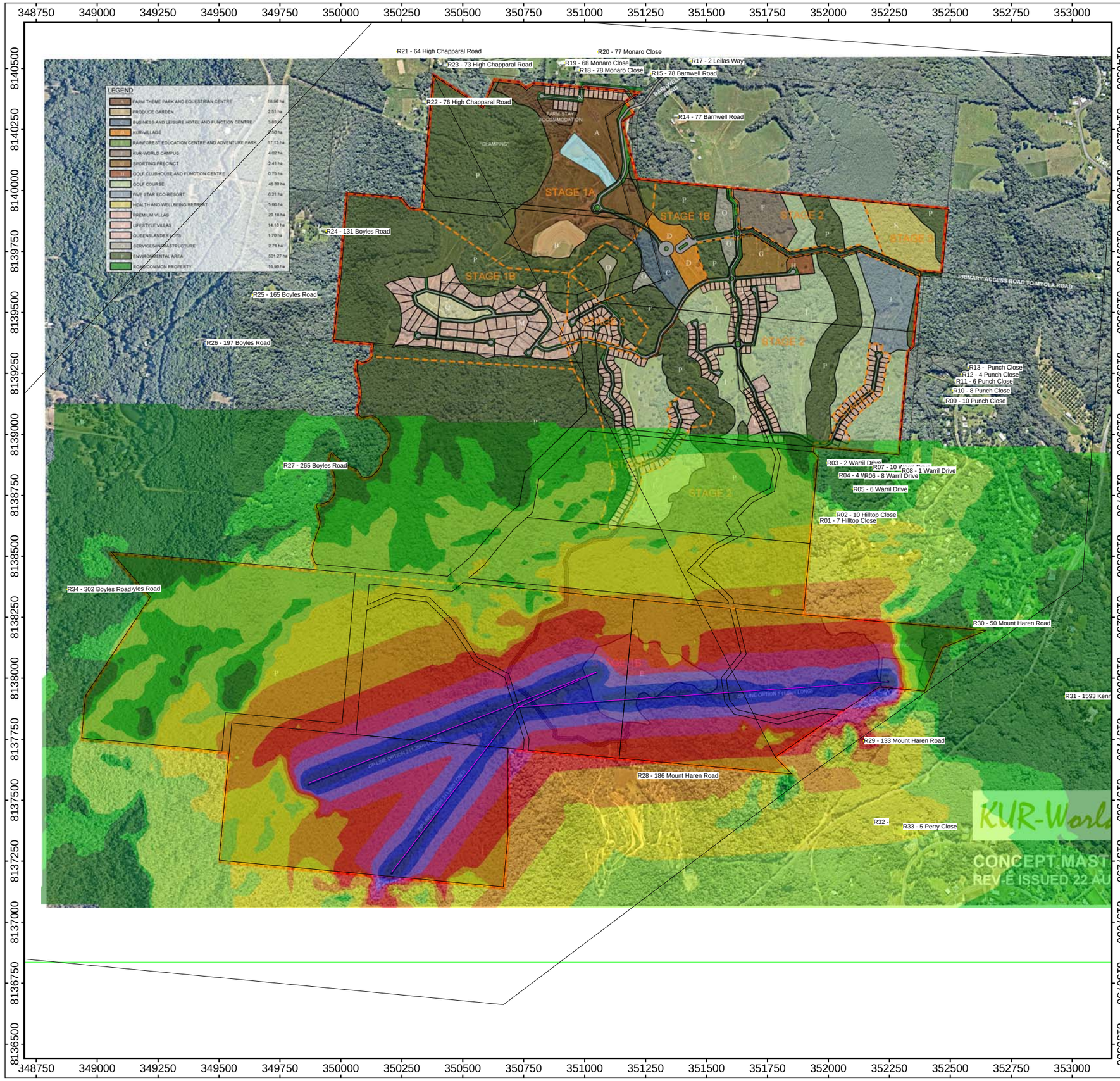
		<=	25
25	<	<=	30
30	<	<=	35
35	<	<=	40
40	<	<=	45
45	<	<=	50
50	<	<=	55
55	<	<=	60
60	<	<=	65
65	<		

Signs and symbols

Line source

ACOUSTICS & AIR QUALITY

E:\Models\8852_KUR_world\FigD.1_Zipline_Leq.sgs



Project: KUR World
Project Number: 8852

Figure

D.2

Zipline Lmax

Calculation 4.6m above ground.

See tablulated results for predicted noise levels at each receptor.

Lmax
(Free-Field)
in dB(A)

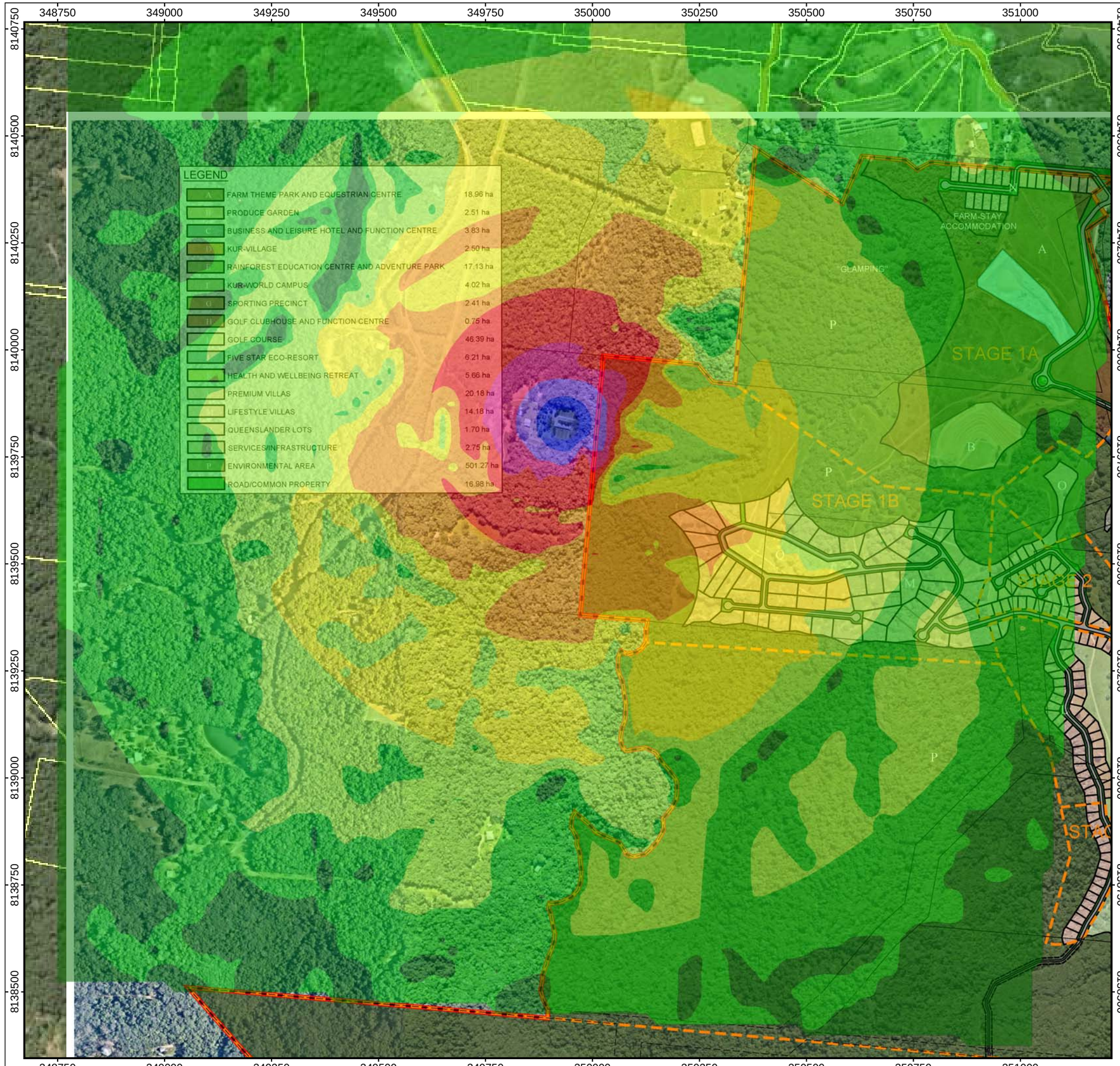
	<=	25
25 <	<=	30
30 <	<=	35
35 <	<=	40
40 <	<=	45
45 <	<=	50
50 <	<=	55
55 <	<=	60
60 <	<=	65
65 <		

Signs and symbols

Line source

ask ACOUSTICS & AIR QUALITY

E:\Models\8852_KUR_world\FigD.2_Zipline_Lmax.sgs



Project: KUR World
Project Number: 8852

Figure

D.3

Kennel

Calculation 4.6m above ground.

Lmax

(Free-Field)
in dB(A)

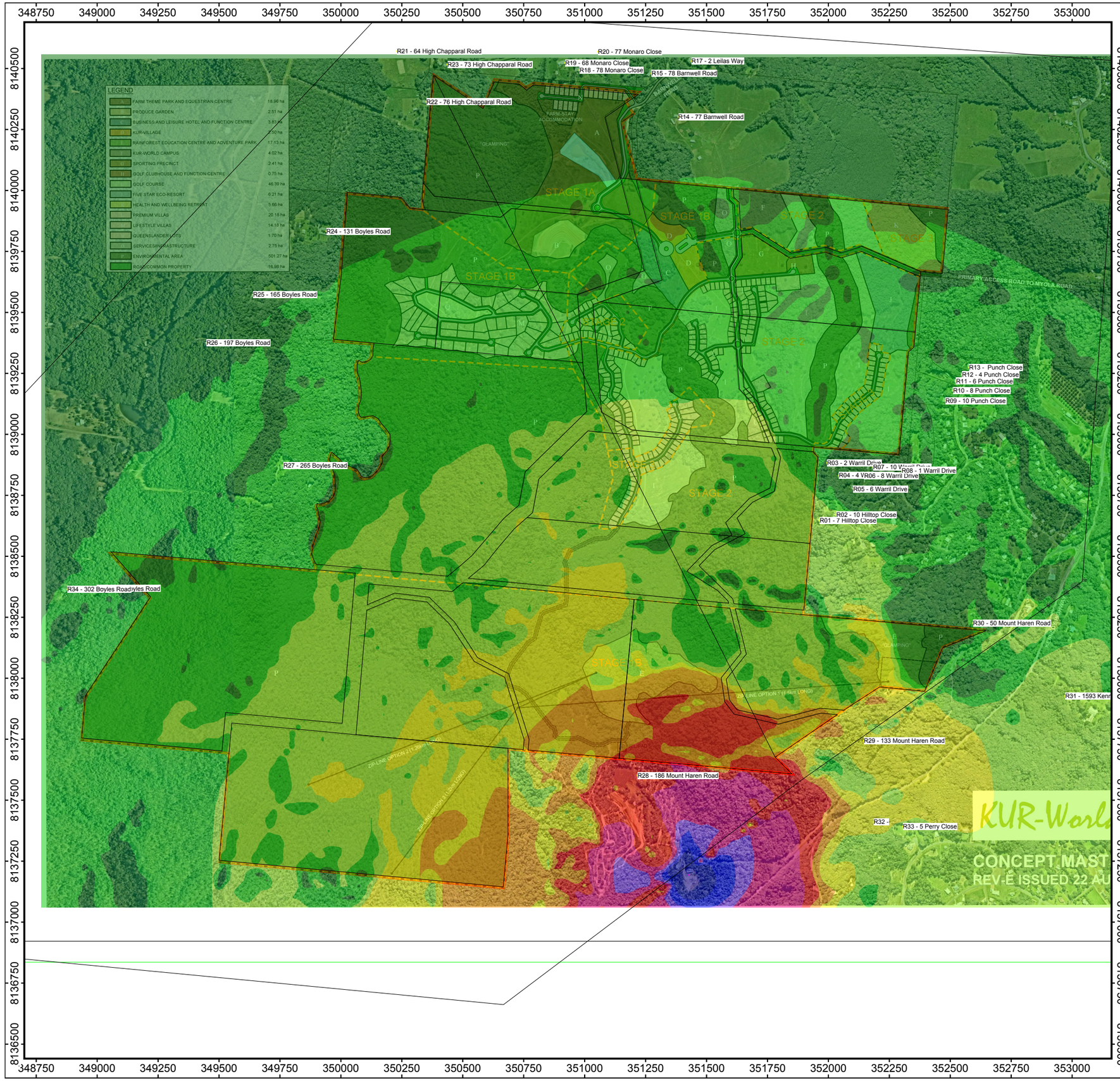
		<=	25
25 <		<=	30
30 <		<=	35
35 <		<=	40
40 <		<=	45
45 <		<=	50
50 <		<=	55
55 <		<=	60
60 <		<=	65
65 <			

Signs and symbols

Line source

ask ACOUSTICS & AIR QUALITY

E:\Models\8852_KUR_world\FigD.3_Kennel.sgs



Project: KUR World
Project Number: 8852

Figure

D.4

Billabong - Amphitheatre Leq(1hour)

Calculation 1.5m above ground

Leq(1hour)
(Free-Field)
in dB(A)

	<=	25
25 <	<=	30
30 <	<=	35
35 <	<=	40
40 <	<=	45
45 <	<=	50
50 <	<=	55
55 <	<=	60
60 <	<=	65
65 <		

Signs and symbols

- Point source
- Point receiver

ACOUSTICS & AIR QUALITY

W:\8800\8852 - Kur World\Noise model\8852_KUR_world_20171012\FigD.4_Billabong - Amphitheatre.sgs

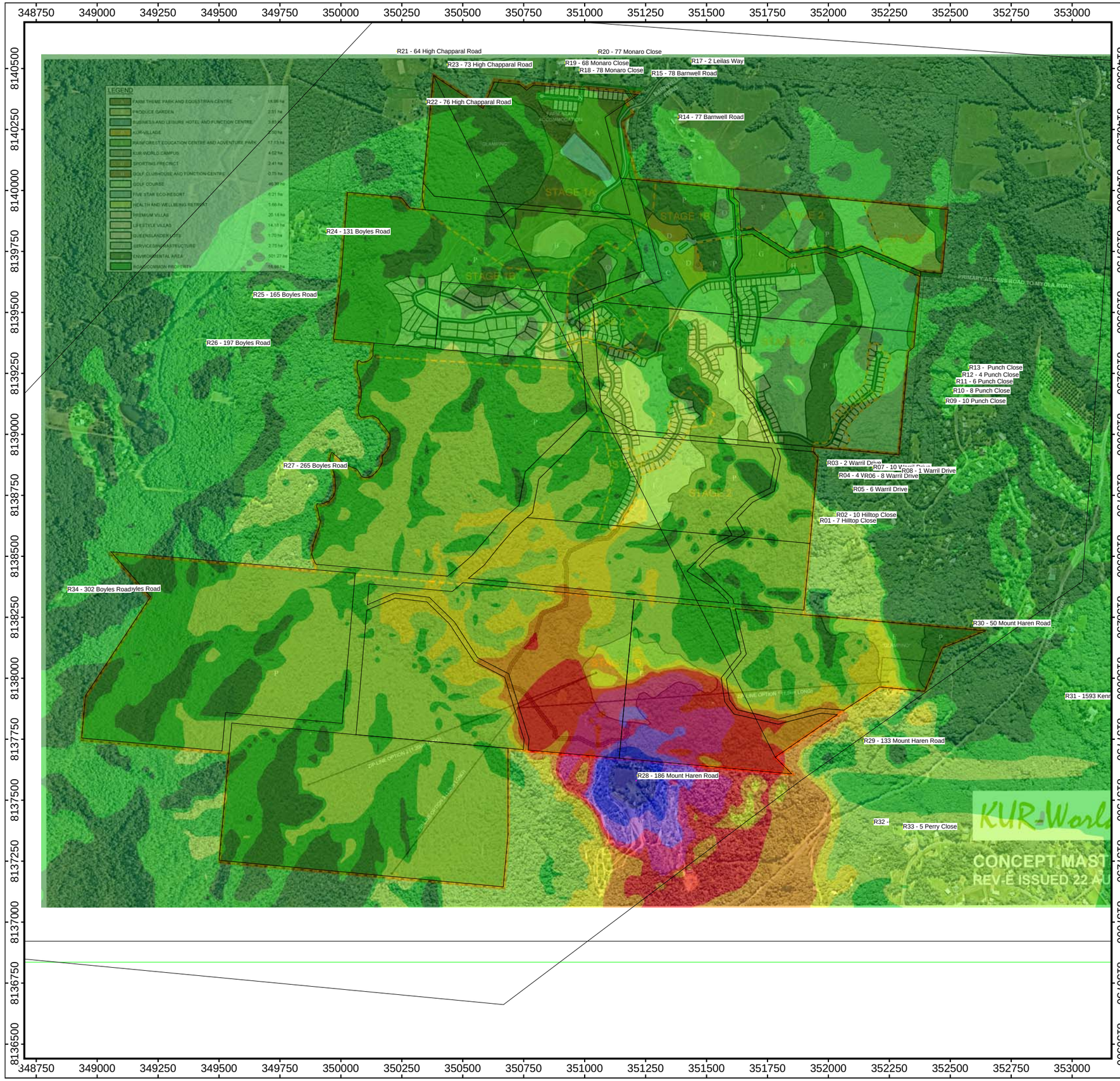
Project: KUR World
Project Number: 8852

Figure

D.5

Billabong Hotel Leq(1hour)

Calculation 1.5m above ground.



Leq(1hour)

(Free-Field)
in dB(A)

		<=	25
25 <		<=	30
30 <		<=	35
35 <		<=	40
40 <		<=	45
45 <		<=	50
50 <		<=	55
55 <		<=	60
60 <		<=	65
65 <			

Signs and symbols

- Point source
- Point receiver

ask ACOUSTICS & AIR QUALITY

W:\8800\8852 - Kur World\Noise model\8852_KUR_world_20171012\FigD.5_Billabong - Hotel.sgs