ACOUSTICS AND AIR

BOX HILL NORTH LOCAL WATER CENTRE

REVIEW OF ENVIRONMENTAL FACTORS (ACOUSTICS)

REPORT NO. 14391
VERSION C

MAY 2015

PREPARED FOR

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DOCUMENT CONTROL

Version	Status	Date	Prepared By	Reviewed By
A	Final	19 January 2015	George Jenner	John Wassermann
B	Final	22 January 2015	George Jenner /Luke Warren	-
C	Final	26 May 2015	George Jenner	-

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Wilkinson Murray is an independent firm established in 1962, originally as Carr & Wilkinson. In 1976 Barry Murray joined founding partner Roger Wilkinson and the firm adopted the name which remains today. From a successful operation in Australia, Wilkinson Murray expanded its reach into Asia by opening a Hong Kong office early in 2006. 2010 saw the introduction of our Queensland office and 2011 the introduction of our Orange office to service a growing client base in these regions. From these offices, Wilkinson Murray services the entire Asia-Pacific region.

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GLOSSARY OF ACOUSTIC TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

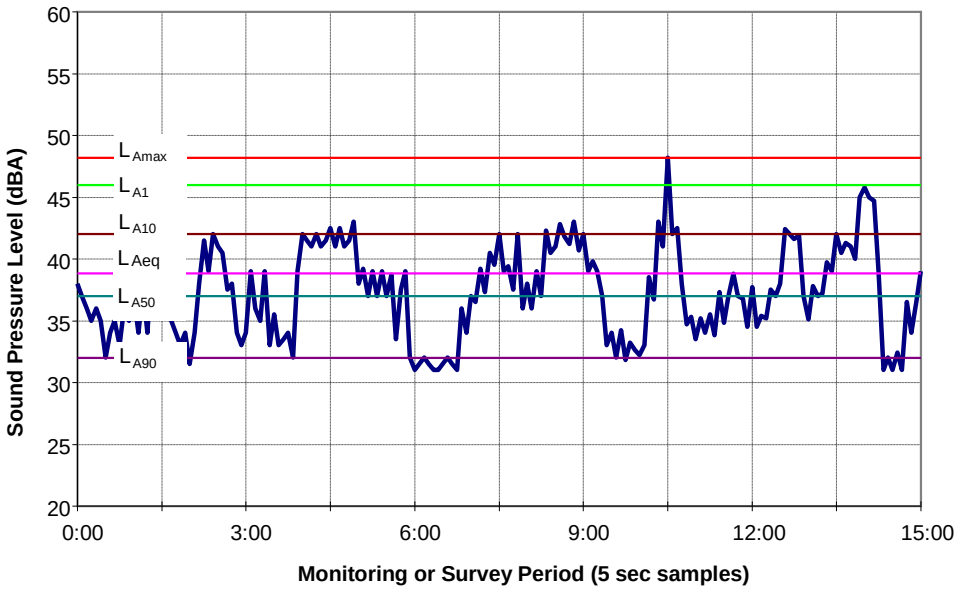
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.

Typical Graph of Sound Pressure Level vs Time



1 INTRODUCTION

Wilkinson Murray Pty Limited has been engaged by RPS Australia Asia Pacific on behalf of Flow Systems Pty Ltd to provide an operational noise assessment of the proposed Local Water Centre (LWC) located at Box Hill North. The LWC is to be located on part of Lot 10 DP 593517 (existing) within the Box Hill North Residential Precinct as shown in Figure 2-1.

The noise assessment evaluates potential noise and vibration impacts associated with the construction and operation of the facility in accordance with the Environmental Protection Authority (EPA) *Interim Construction Noise Guideline (ICNG), Road noise Policy (RNP)* and NSW *Industrial Noise Policy (INP)*.

New residential development requires the co-ordinated provision of reticulated water and sewerage services. The provision of a LWC is the best alternative type of water treatment facility because the off-site impacts are limited; and because it is scalable and allows supply to increase in line with the anticipated residential development and the volume of waste to be treated. The Box Hill North North LWC also makes a significant contribution to sustainability through the provision of recycled water back to the residential area.

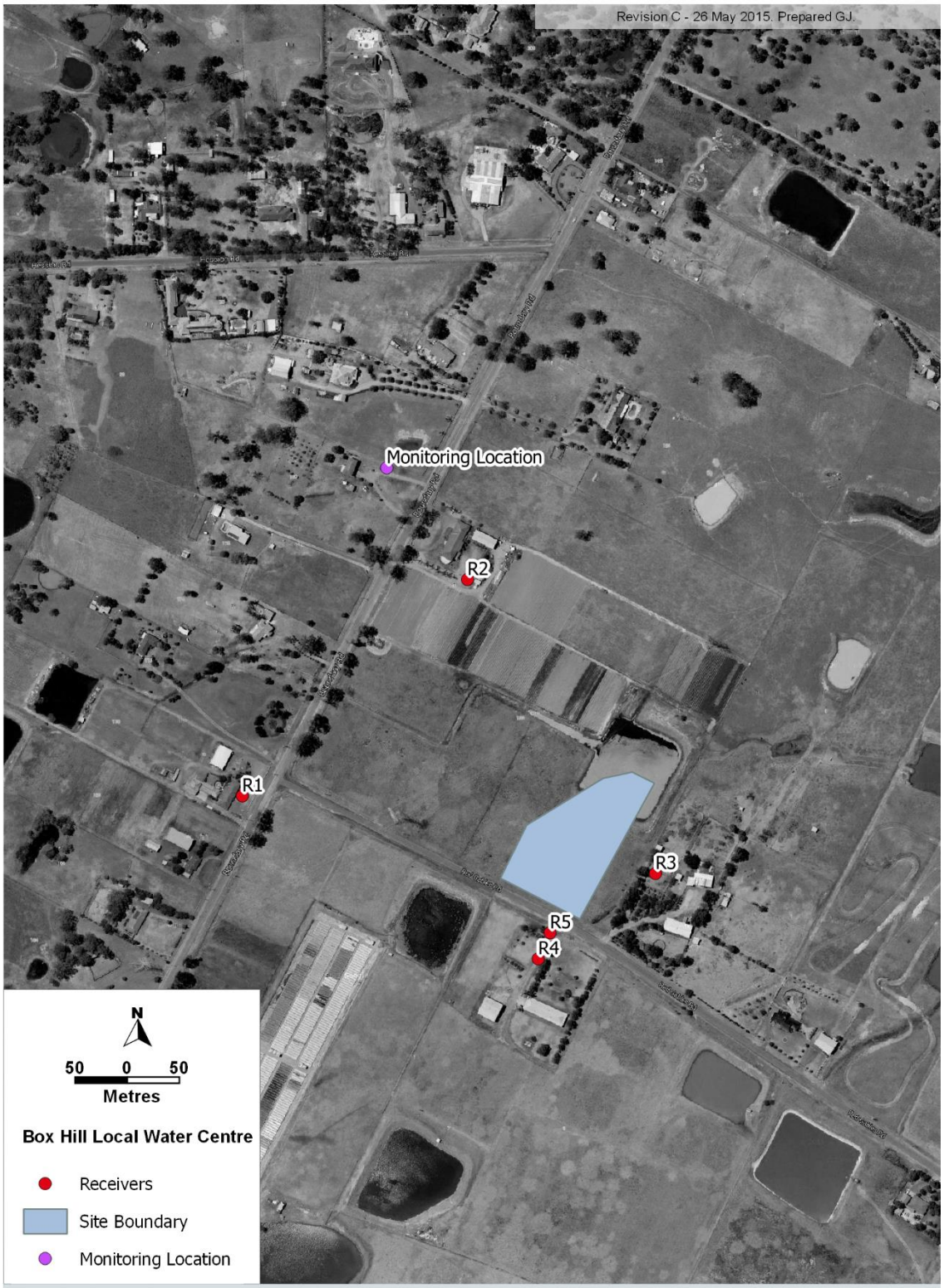
The alternative(s) to the proposed Box Hill North North LWC is to build a traditional local sewage treatment plant with potential discharge to the local waterway, or more expensively to pipe the sewage to an existing sewage treatment plant for treatment and disposal, which would also require an amplification/upgrade of the existing receiving treatment plant. Either alternative would be more expensive, take longer to implement, have greater potential environmental impacts, and fail to achieve sustainability initiatives for water re-use.

2 SITE & PROJECT DESCRIPTION

2.1 Surrounding Land Uses

The proposed location of the site is located at Red Gables Road, Box Hill North. The land surrounding the site will facilitate a new residential community. The existing area is predominantly rural in nature. Existing residential areas or noise catchment areas (NCAs) are currently located approximately 150m to the west, 100m to the east and 285m to the west of the site, and more than 500m to the east of the site. Figure 2-1 shows the subject area, noise monitoring location and the nearest existing and future residential receivers. Locations R1, R2, R3 and R4 represent the nearest existing residential receivers surrounding the site. R3 also represents the closest future residential receiver to the east, and R5 the nearest future residential receiver to the south.

Figure 2-1 Locality Map



Site Location and Sensitive Receivers

2.2 Description of the Proposed Operation Works

The intended LWC will utilise sewage from the future residential area to produce high quality water. The sewage is treated at the LWC to provide recycled water plumbed into houses for non-drinking uses, such as toilet flushing, washing machines, irrigation and car washing, thus reducing drinking water demand. The facility is intended to operate 24 hours, 7 days per week, housed in a low-scale, single level building within an open space setting.

The operation will be on the following basis:

- the facility will operate 24 hours a day, 7 days per week;
- the recycled water, which is transported by pipe system back to customers; and
- any waste water screenings will be collected and disposed of, by way of an authorised waste disposal contractor.

A concept layout for the LWC is shown in Figure 2-2. The proposal will be developed in stages:

1. Interim sewer servicing tanks (ISST) will be constructed and operated first at the east of the site;
2. Western local water centre built and commissioned (Number 1 on Figure)
3. ISST removed
4. Eastern local water centre built and commissioned (Number 2 on Figure).

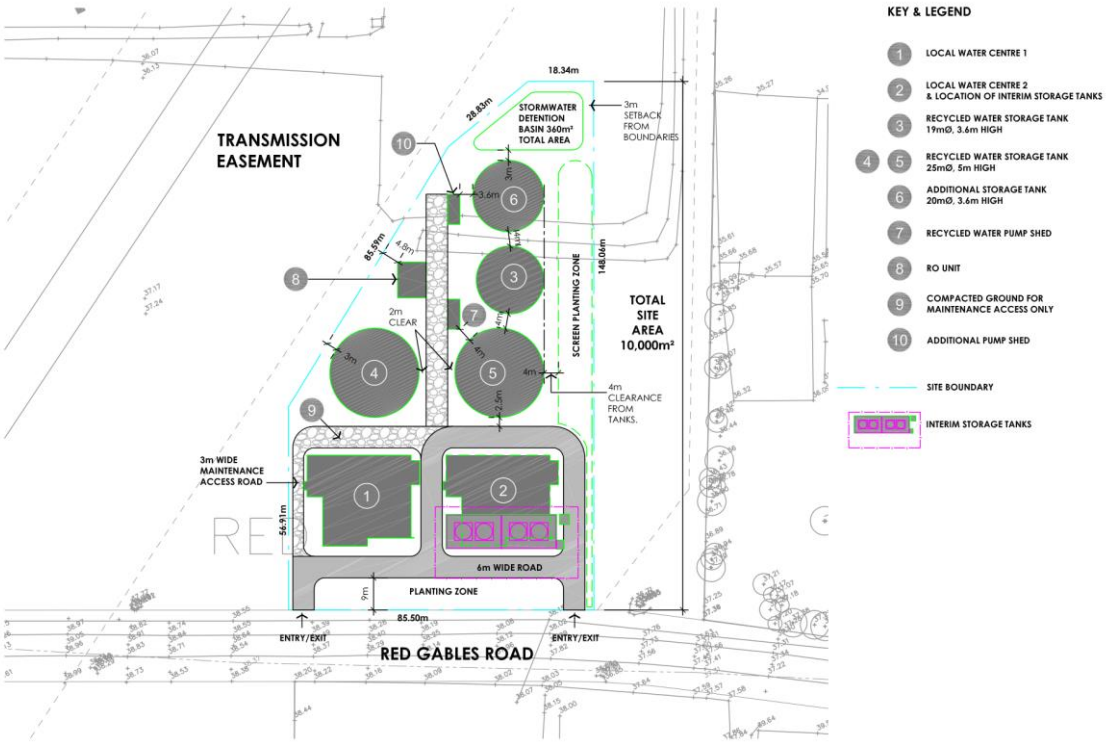
The following describes the LWC and its associated noise sources (equipment):

- Two operations building will house plant and equipment involved in water treatment processes. The buildings are approximately 24m x 10m each and have a skillion roofs ranging from 3.6m to 6.1m height across its width. The building will have a mix of Colorbond and off-form concrete materials in natural and muted grey colours in its facades, and dressed with narrow bands of glass windows to soften the elevations. The eastern elevations will carry a roller door for access to the facility as well as a single door access from operations to delivery area. The western elevation will carry the entry doors to operations and acoustic aluminium louvered doors to blowers and compressors rooms. The roofs will also be of Colorbond material. Air-conditioning units will be used for conditioning the Control room.
- Aligned with the operations buildings, will be the treatment tanks approximately 5m in height. They will be constructed of off-form concrete panels in natural colours. Staircases located at the east and west of the buildings will provide access to the roof of the structure for servicing purposes. Located near the western face of the buildings is a back-up generator, sitting externally to the buildings beneath the access staircases, which will provided power to the facility in the event that primary power supply becomes insufficient. The generators will be surrounded by block walls up to 1m above the height of the generators. The facility buildings will contain plant items including membrane drain pumps, WAS pump, permeate pumps, membrane blowers, process blowers, compressors and WAS dewatering.

- Two drinking water storage tanks are located in the eastern part of the site. A further two tanks to store recycled water are located to the eastern part of the site. Capacity ranges from 1.2 million litres to 2.5million litres each, and will stand approximately 5m high above ground level, and be up to 25m in diameter. The tanks will be constructed of steel and sit in a compacted earth and gravel area.

The tanks will be interconnected with pipes and pumps and the like to each other, and to the treatment plant building. Pumps for drinking water and recycled water tanks are to be housed in sheds of Colorbond material for weather and acoustic screening (Number 7 on Figure 2-2).

Figure 2-2 Site Layout Plan



Once the facility is fully operational, truck movements will be limited to chemical deliveries and is estimated at two to six trucks per month. Operator(s) will visit the site 2-3 times per week in standard utilities or passenger vehicles. An additional six trucks per week will be required to collect the solid waste bins.

2.3 Outline of Construction Works

To enable the operation of the proposal, the construction work on the interim facility (interim flow balance tanks) will commence once the network operators licence is granted which is anticipated for late 2015. The interim facility will be constructed by first clearing and grubbing the site for the facility. The land will be generally contoured to the required bulk earthworks design. A temporary hardstand area will be built for the interim flow balance tanks and temporary access road.

The first Box Hill North LWC will then be constructed once detailed designs are complete and commissioned once a suitable quantity of sewage is available for commissioning of the facility. It is anticipated that construction, equipping and commissioning will take approximately 12 months to complete.

The construction of the first Box Hill North LWC will commence with detailed excavation and installation of under-slab pipework and conduits followed by traditional form, reinforcement and pouring of concrete floors and walls. The concrete tanks will be hydraulically tested and the building finished with architectural finishes. The steel storage tanks will be constructed on concrete ring beam foundations. Spoil from the construction of the Box Hill North LWC is expected to be minimal and will be managed in accordance with a Construction Environmental Management Plan (CEMP) for the proposal. It is likely that all spoil will be used for re-contouring of the land surrounding the building and facilities.

Once the building and tanks are substantially complete, it will be equipped with mechanical, electrical and control equipment including pumps, mixers, inlet screens, odour control unit, membranes, UV disinfection and chemical dosing tanks.

The second Box Hill North LWC will be constructed when demand requires it. This is currently estimated to be 2024.

2.3.1 Construction Hours

The Box Hill North LWC will be constructed during the following hours:

- Monday to Friday 7.00am to 6.00pm; and
- Saturday 8.00am to 1.00pm.

2.3.2 Construction Plant & Equipment

The following plant and equipment would be required to undertake the proposed works:

- Front end loader / Chainsaws / Mulcher;
- Small tipper trucks;
- Rigid and articulated delivery trucks;
- Excavator;
- Concrete trucks;
- Cranes;
- Grader;
- Portable generators;
- Scaffold;
- Elevated work platforms; and
- General construction / building tools.

2.3.3 Construction Traffic

Vehicle movements during construction will mostly consist of the floating of earthmoving equipment and concrete agitator trucks delivering concrete during scheduled pours. Concrete truck movements will occur at various stages throughout the construction period and will peak at around eight concrete trucks per day at the peak of the construction. In addition, there will be an average of two truck movements per day for the delivery of other plant, materials and equipment.

3 EXISTING NOISE ENVIRONMENT

Unattended noise monitoring was conducted at 180 Boundary Road, Box Hill North from 26 November to 4 December 2014. The location and its relation to the site is shown in Figure 2-1.

The noise monitoring equipment used for the unattended measurements consisted of an ARL-NGARA Environmental Noise Logger set to A-Weighted, Fast response continuously monitoring over 100ms sampling periods. This equipment is capable of remotely monitoring and storing noise level descriptors for later detailed analysis. The equipment calibration was checked before and after the survey and no significant drift occurred.

The logger determines L_{A1}, L_{A10}, L_{A90} and L_{Aeq} levels of the ambient noise. The L_{A1}, L_{A10} and L_{A90} levels are the levels exceeded for 1%, 10% and 90% of the sample time respectively (See Glossary of Acoustic Terms for further explanations). The L_{A1} is indicative of maximum noise levels due to individual noise events such as the occasional passby of a heavy vehicle. This is used for the assessment of sleep disturbance. The L_{A90} level is normally taken as the background noise level during the relevant period. The L_{Aeq} level is the Equivalent Continuous Sound Level and has the same sound energy over the sampling period as the actual noise environment with its fluctuating sound levels. The L_{Aeq} is used for the assessment of operational noise and traffic noise. The L_{A10} is used for the assessment of construction noise.

The detailed measurement results are shown in graphical format in Appendix A.

The measured RBLs are shown in Table 3-1. The RBLs for the standard periods of daytime, evening and night time are presented. The RBL for evening is higher than that for daytime. In such cases the *INP* recommends that the daytime level be used for evening. Therefore, the RBL for all periods is 36dBA.

Table 3-1 Measured Rating Background Noise Levels (dBA)

Location	Day (7am-6pm)	Evening (6pm-10pm)	Night (10pm-7am)
180 Boundary Road	36	38	36

4 CONSTRUCTION ROAD TRAFFIC NOISE ASSESSMENT

4.1 Relevant Road Traffic Noise Criteria

Whilst there are no criteria which relate to temporary changes in traffic noise during construction periods, it is desirable that noise associated with truck deliveries to the site comply with the criteria shown in the NSW *Road Noise Policy (RNP)* published by EPA in March 2011. The main roads affected by heavy vehicle movements will be Boundary Road, considered a sub-arterial road, and Red Gables Road which is a local road. On this basis, the traffic noise criteria have been taken from the *RNP* and are shown in Table 4-1.

Table 4-1 Road Noise Criteria

Road Category	Type of Project / Land Use	Assessment Criteria – dBA	
		Day (7am-10pm)	Night (10pm-7am)
Local Roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq,1hr}$ 55 (external)	$L_{Aeq,1hr}$ 50 (external)
Sub-Arterial Roads	Existing residences affected by additional traffic on existing freeways / arterial / sub-arterial roads generated by land use developments	$L_{Aeq,15hr}$ 60 (external)	$L_{Aeq,9hr}$ 55 (external)

A review of the road noise criteria in Table 4-1 indicates that the applicable criteria are $L_{Aeq,1hr}$ of 55dBA for local roads and $L_{Aeq,15hr}$ of 60dBA for sub-arterial roads.

4.2 Road Traffic Noise Assessment

Road traffic noise has been calculated for heavy vehicle movements to the site and existing traffic movements have been ignored. The anticipated peak movements per day is five concrete trucks per day at the peak of the construction. Typically, there will be an average of two truck movements per day for the delivery of other plant, materials and equipment. Based on this information the following noise levels have been calculated:

- Red Gables Road – $L_{Aeq,1hr}$ of 40dBA at the façade of the nearest noise sensitive receiver (approximately 75m from the road). This is based on 1 movement per hour; and
- Boundary Road – $L_{Aeq,15hr}$ of 49dBA at the façade of the nearest noise sensitive receiver (approximately 20m from the road). This is based on 5 movements per day.

The predicted road traffic noise levels above are well within the *RNP* criteria. Therefore, noise impacts would be minimal.

5 CONSTRUCTION NOISE & VIBRATION ASSESSMENT

5.1 Construction Noise & Vibration Criteria

The following sections detail the applicable site-specific noise and vibration criteria based on the guidelines from EPA, being the *Interim Construction Noise Guideline* and *Assessing Vibration: A Technical Guideline*.

5.1.1 Construction Noise Management Levels (NML's)

The EPA released the "*Interim Construction Noise Guideline*" *(CNG)* in July 2009. The guideline provides noise goals that assist in assessing the impact of construction noise.

For residences, the basic daytime construction noise goal is that the $L_{Aeq,\ 15min}$ noise management level should not exceed the background noise by more than 10dBA. This is for standard hours: Monday to Friday 7.00am-6.00pm, and Saturday 8.00am-1.00pm. Outside the standard hours, where construction is justified, the noise management level would be background + 5dBA. Table 5-1 details the *ICNG* noise management levels and its application.

Table 5-1 Construction Noise Management Levels at Residences

Time of Day	Management Level $L_{Aeq,15min}$ (dBA)	How to Apply
Recommended Standard Hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Noise affected RBL + 10dBA	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq,(15min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. 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 75dBA	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 proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided.

Time of Day	Management Level $L_{Aeq,15min}$ (dBA)	How to Apply
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 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2.

Typically, no works should be undertaken on Sundays.

Based on the measured RBLs levels, the following applicable noise management levels (NML's) for construction activities at surrounding residential receivers have been adopted:

- Monday-Friday 7.00am-6.00pm $L_{Aeq,15min}$ 46 (36+10) dBA
- Saturday 7.00am to 1.00pm $L_{Aeq,15min}$ 46 (36+10) dBA
- Highly noise affected $L_{Aeq,15min}$ 75 dBA

5.1.2 Site Vibration Criteria

Typically, vibration impacts are determined using following documents:

- Building damage – German Standard DIN 4150: Part 3 – 1999 *Structural vibration in buildings: Effects on structures*. Since vibration in the frequency band below 10Hz is not expected, the limit at the residential foundation would be 5mm/s peak component particle velocity (pcpv); and
- Human comfort – *Environmental noise management assessing vibration: A technical guide* (DEC, 2006). Since vibration from the construction site below 8Hz is not expected, the comfort limit becomes 0.4mm/s rms vertical vibration.

However, as the distance from vibration intensive plant to the nearest residential receiver is considered to be large (approximately 70m), ground vibration at surrounding residential receivers would be low. On this basis, the recommended safe working distances for vibration intensive plant suggested in the Transport Construction Authority's *Construction Noise Strategy* (2012) have been adopted in this assessment to evaluate the vibration impacts. Table 5-2 sets out the recommended safe working distances for various vibration intensive plant.

Table 5-2 Recommended Safe Working Distances for Vibration Intensive Plant

Item	Description	Safe Working Distance	
		Cosmetic Damage	Human Response
Small Hydraulic Hammer	(300 kg – 5 to 12t excavator)	2m	7m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7m	23m
Pile Boring	≤ 800 mm	2m (nominal)	N/A
Jackhammer	Hand held	1m (nominal)	Avoid contact with structure

- Construction Noise Strategy, 2012, Transportation Construction Authority

A review of the information in Table 5-2 indicates that the human comfort vibration impacts at surrounding residences would be minimal when using rock breakers. Furthermore, structural damage vibration criteria in residential buildings are much higher than human comfort criteria, and the nearest residential receiver is situated far enough for impacts to be minimal in all circumstances. Therefore, no further vibration consideration is required.

5.2 Construction Equipment and Noise Source Levels

Sound Power Levels (SWLs) for typical construction plant are detailed in Table 5-3. These SWLs have been measured at other similar construction sites. The table provides both Sound Power Level and Sound Pressure Levels (SPL) at 7m for the equipment. Sound Power Level is independent of measurement position.

Table 5-3 Typical Construction Plant Sound Levels (dBA)

Plant	Sound Power Level	Sound Pressure Level at 7m
Concrete Truck	105	80
Concrete Pump – 120 mm diameter / 50 bar	103	78
Concrete Saw	116	91
50t Crane	105	80
Dump Truck	108	83
Compressor	100	75
Bobcat	103	78
Generator and Power Hand Tools	105	80
D10 Bulldozer	114	89
15t Excavator	103	83
40t Excavator	110	90
Crawler Cranes	98	73
16H Grader	108	83
Front End Loader	112	87
Hammer Hydraulic	122	97
Wood Chipper	117	102

5.3 Predicted Construction Noise Levels

Calculation of likely construction noise at surrounding receivers has been undertaken for the proposed construction works.

Site-related noise emissions were modeled with the "CadnaA" noise prediction software using the ISO 9613 noise prediction algorithms. Factors that are addressed in the noise model are:

- equipment sound level emissions and location;
- screening effects from barriers;
- receiver locations;
- ground topography;
- noise attenuation due to geometric spreading;
- ground absorption; and
- atmospheric absorption.

Noise predictions have been made based on the possible worst-case impacts taking into consideration the most likely construction scenarios. This has been made based on Wilkinson Murray's previous experience with similar scale construction projects. As a worst-case scenario, this assumes that most of the relevant plant would be operating during most of the 15-minute assessment period. The following have been assumed for each of the noise significant scenarios:

- Site Clearing / Grubbing

  As the site has no large trees the noisiest activity in this scenario would be from the use of a front end loader to clear land. $L_{Aeq,15min}$ noise level for this activity would be 108dBA.

- Bulk Earthworks

  Noisiest activity in this scenario would be from excavation works carried out by a 15t excavator, tipper trucks and articulated trucks working at the same time. $L_{Aeq,15min}$ noise level for this activity would be 113dBA.

- Foundation Construction

  Noisiest activity in this scenario would be from the pouring of concrete floors and walls. This would be carried out by a concrete agitator truck idling on site and a concrete pump transferring liquid concrete to the designated areas. $L_{Aeq,15min}$ noise level for this activity would be 107dBA.

- Superstructure Construction

  Noisiest activity in this scenario would be from the steel cage installation that would involve lifting of heavy loads using a 50t crane, an 8 wheel crane truck with delivery truck idling on site. $L_{Aeq,15min}$ noise level for this activity would be 108dBA.

- General Construction / Scaffolding

  Noisiest activity in this scenario would be from the use of power hand tools. $L_{Aeq,15min}$ noise level for this activity would be 105dBA

Some specific control measures, which are referred to in Sections 5.5 and 5.6 below, have been considered necessary for the site and these have been included in the predicted noise levels.

There are a number of stages of the work proposed and some stages will be noisier than others. Table 5-4 shows the predicted noise levels at each of the NCAs for the noise significant stages of the work during normal construction hours.

Table 5-4 Predicted Construction Noise Levels at Residence – $L_{Aeq,15\ min}$ (dBA)

Receiver	Predicted Noise Level	Weekday NML	Exceedance
Site Clearing and Grubbing			
1	51	46	5
2	54	46	8
3	64	46	18
4	66	46	20
Bulk Earthworks			
1	56	46	10
2	59	46	13
3	69	46	23
4	71	46	25
Foundation Construction			
1	50	46	4
2	53	46	7
3	63	46	17
4	65	46	19
Superstructure Construction			
1	51	46	5
2	54	46	8
3	66	46	20
4	67	46	21

A review of results in Table 5-4 indicates the following:

- During the land clearing stage, exceedances of up to 20 dBA are predicted during standard hours at the nearby existing residences at Receivers 3 and 4. This magnitude of exceedance is consistent with similar sites where residences overlook development sites.
- During the structure stage exceedances of up to 25 dBA are predicted during standard hours at the nearby existing residences at Receivers 3 and 4. Fit-out works are less noise intensive and this would result in general compliance at residences during this stage (not shown in Table 5-4).

Based on these findings the adoption of reasonable and feasible noise management and mitigation will be required. These measures should be determined in detail when a contractor, with defined construction techniques, has been engaged on the project. However, "in-principle" mitigation measures are detailed in Section 6.4 and Section 6.5.

5.4 Construction Noise Mitigation Measures

Without mitigation, noise levels from construction activities have been predicted to exceed the noise management levels nominated in the guidelines at some surrounding receivers. Therefore, noise control measures are recommended to ensure that noise is reduced where feasible.

The following project specific mitigation measures are recommended;

- Selection of quietest feasible construction equipment;
- Localised treatment such as barriers, shrouds and the like around fixed plant such as pumps, generators and concrete pumps; and
- Provision of respite periods.

In addition, the following measures should be included in a Noise and Vibration Management Plan to be prepared prior to issue of a Construction Certificate (CC):

- *Plant Noise Audit* – Noise emission levels of all critical items of mobile plant and equipment should be checked for compliance with noise limits appropriate to those items prior to the equipment going into regular service. To this end, testing should be established with the contractor;
- *Environmental Inductions* – It is important that an induction is provided to all site personnel with an emphasis on understanding and managing noise impacts;
- *Equipment Selection* – All fixed plant at the work sites should be appropriately selected, and where necessary, fitted with silencers, acoustical enclosures and other noise attenuation measures in order to ensure that the total noise emission from each work site complies with EPA guidelines;
- *Site Noise Planning* – Where practical, the layout and positioning of noise-producing plant and activities on each work site should be optimised to minimise noise emission levels; and
- Install a 2.4 metre type-A hoarding on the boundary of the site. This should be a minimum 17mm thick structural plywood or equivalent panel.

The adoptions of the above measures are aimed at working towards achieving the noise management levels established at surrounding receivers.

5.5 Community Liaison & General Approaches to Mitigation

An effective community relations programme should be put in place to keep the community that has been identified as being potentially affected appraised of progress of the works, and to forewarn potentially affected groups (e.g. by letterbox drop, meetings with surrounding owners / tenants, etc.) of any anticipated changes in noise and vibration emissions prior to critical stages of the works, and to explain complaint procedures and response mechanisms. Close liaison should be maintained between the communities overlooking work sites and the parties associated with the construction works to provide effective feedback in regard to perceived emissions. In this manner, equipment selections and work activities can be coordinated where necessary to minimise disturbance to neighbouring communities, and to ensure prompt response to complaints, should they occur.

5.6 Noise & Vibration Management Plan

A Construction Noise and Vibration Management Plan for the site is recommended prior to construction. Areas that should be addressed in plan include:

- noise and vibration monitoring;
- response to complaints**;**
- responsibilities;
- monitoring of noise emissions from plant items;
- reporting and record keeping;
- non-compliance and corrective action; and
- Community consultation and complaint handling.

The plan should be developed by the successful contractor and be part of their Construction Environmental Management Plan.

6 OPERATIONAL NOISE ASSESSMENT

6.1 Relevant Operational Noise Criteria

This section of the report discusses noise guidelines and criteria for the assessment of operational noise. Appropriate criteria are contained within the NSW Environmental Protection Authority (EPA) *NSW Industrial Noise Policy (INP).*

6.1.1 *Industrial Noise Policy*

The *INP* is designed to assess noise using the more stringent of the following two approaches:

- Intrusive noise impacts in the short term for residences; and
- Amenity for particular land uses such as residences.

The *INP's* intrusive noise goal is the noise level 5dBA above the background noise level for each time period (daytime, evening or night time) of interest. The background noise level is derived from the measured L_{A90} noise levels.

The amenity goal sets an upper limit to the total industrial noise level ($L_{Aeq,period}$) in an area from all industrial noise sources (existing and future). The criterion depends on the time of day, area classifications and the relationship of the total measured $L_{Aeq,period}$ (and contribution from existing industrial noise) to determine the Acceptable Noise Level (ANL) for the development. Traffic noise would also be taken into account in areas where the noise environment is significantly affected by traffic noise.

The potentially affected area will be rural-residential. Given this, the acceptable amenity noise levels ($L_{Aeq,period}$ dBA) which apply over the whole day, evening or night period are as follows and are applicable only to noise from industrial sources:

- Daytime 55dBA
- Evening 45dBA
- Night Time 40dBA

In summary, the overall industrial noise from all industrial noise sources in the area (including the subject development) should not exceed the above amenity noise levels over the day evening and night periods.

Furthermore, the *INP* also suggests some sources may cause less annoyance where only a single event occurs for a limited duration, such as the back-up generator where it does not usually operate and will be tested in operation during daytime hours either once per month for 30 minutes, or once every 2 months for 1 hour. The adjustment for duration is presented below in Table 6-1. This applies where a single noise-event noise is continuous for a period of less than two and a half hours in any 24-hour period. The acceptable noise level may be increased by the adjustment as shown in Table 6-1 on the following page. This adjustment is designed to account for unusual and one-off events, and does not apply to regular high-noise levels that occur more frequently than once per day.

Table 6-1 Adjustments for Duration (dBA)

Duration of Noise (one event in any 24-hr period)	Increase in Acceptable Noise Level at Receptor	
	Daytime & Evening (0700-2200 h)	Night Time (2200-0700 h)
1.0 to 2.5 hours	2	Nil
15 minutes to 1 hour	5	Nil
6 minutes to 15 minutes	7	2
1.5 minutes to 6 minutes	15	5
Less than 1.5 minutes	20	10

6.1.2 Project Specific Criteria

Both amenity and intrusiveness criteria are adopted for this assessment. Table 6-2 presents a summary of the noise criteria for the existing residential receivers surrounding the proposed site using the measured RBL values presented in Table 3-1.

Table 6-2 Project Specific Criteria (dBA)

Time Period[1]	Intrusiveness Criterion $L_{Aeq,15min}$	Amenity Criterion $L_{Aeq,period}$
Daytime	**41**	55
Evening	**41**	45
Night Time	**41**	40

Notes: 1. Daytime 7.00am–6.00am; Evening 6.00pm–10.00pm; Night 10.00pm-7.00am
2. Noise criteria applicable to this assessment are highlighted in **bold**

Since the noise will be constant and not varying in level, the lower criterion for each period will apply, as highlighted in the table.

As the back-up generator does not usually operate and will be tested in operation during daytime hours either once per month for 30 minutes, or once every 2 months for 1 hour, a positive adjustment of 5dB will apply to the daytime project specific criteria of 41dBA. The adjusted daytime acceptable level is 46dBA L_{Aeq}.

6.2 Calculation Method

Noise levels were calculated using the Bruel & Kjaer Predictor computer modelling program based on ISO 9613 algorithms. Using Predictor it is possible to build a model of the facility noise sources and the surrounding area. The model is capable of taking account of the following parameters:

- noise source levels;
- topography between the facility and the residences;
- any shielding by buildings between noise sources and receivers; and
- meteorological effects which could change noise propagation.

Because the facility is well within 300m of the nearest proposed residences, meteorological enhancement of noise propagation are not significant and have not been considered in the assessment.

Noise source levels used in this assessment were provided by Permeate Partners Pty Ltd unless otherwise indicated. The noise source levels are summarised in Table 6-3.

Table 6-3 Noise Source Levels per Local Water Centre

Description	Qty	Sound Pressure Level at 1m
Back-up Generator	1x duty	81dBA each
Membrane Tank Drain Pump	1x duty	75dBA each
WAS Pump	1x duty	72dBA each
Permeate Pump	1x duty / 1x standby	75dBA each
Membrane Blower	1x duty / 1x standby	75dBA each
Process Blower	2x duty / 1x standby	75dBA each
Compressor	1x duty / 1x standby	65dBA each
WAS Dewatering	1x duty	72dBA each
Drinking Water Distribution Pumps	2x duty / 1x standby	75dBA each
Recycled Water Distribution Pumps	2x duty / 1x standby	75dBA each
6hp Air-Con Unit (Wilkinson Murray database)	1x duty	64dBA each

Based on the noise source levels in Table 6-3 the reverberant noise levels inside the equipment room was calculated to be 86dBA and 82dBA inside the sheds enclosing drinking/recycled water distribution pumps.

Sheds enclosing drinking water distribution pumps and recycled water distribution pumps are assumed to be constructed from Colorbond to be consistent with the equipment building and control room.

Noise emission from the site were calculated to the nearest residential properties and are presented in Section 6.3 and Section 6.4.

With respect to the ISST, noise emission would be from a tanker truck attached to the outlet of the tank. For assessment of this temporary facility it was assumed to have a sound power level of 100 dBA.

6.3 Noise from ISST

When the interim tanks are at full capacity (noting it will take time to build up to this as houses are built and connect), there will be up to six tankers visit the site per day for up to an hour each, and for 7 days per week and potentially sometimes at night.

It is recommended that if the existing residences at receiver 3 and 4 are occupied, they should be shielded from the tanker pump by movable temporary screens while the tanks are emptied. The temporary screens should be 2.1m high.

Wilkinson Murray understands that it is unlikely that any new residences will be built and occupied in the vicinity of this ISST while operational. By the time the development grows to near the LWC, the ISST will have been decommissioned and the LWC commissioned.

Scenario	Criteria Day / Evening / Night (dBA)	Receiver				
		1	2	3	4	5
Interim Storage Tanks	41/41/41	37	37	45	50	N/A
Interim Storage Tanks with Shielding	41/41/41	37	37	40	38	N/A

6.4 Operational Noise Emission Levels – All Equipment (Excluding Back-Up Generator)

The results of the modelling for all equipment operating (excluding back-up generator) are presented in Table 6-4.

The table shows the following:

- Noise from the ISST is predicted to comply at all receivers;
- Noise from the LWC 1 without Specific Noise Mitigation applied is predicted to exceed the criterion at the nearest future residence. For this reason the following predictions assume that Specific Noise Mitigation is applied to both Local Water Centres;
- Noise from the Local Water Centre 1 **with** Specific Noise Mitigation applied is predicted to comply with the criteria at all receivers.
- Noise from the Local Water Centre 1 and Local Water Centre 2 combined **with** Specific Noise Mitigation applied is predicted to comply with the criteria at all receivers.

The specific mitigation required is:

- Specific Noise Mitigation (1) – lining of Colorbond on the internal face of the plant room with appropriate air gap to accommodate minimum 50mm thick polyester or glasswool insulation of density 14kg/m3
- Specific Noise Mitigation (2) – The internal walls of the pump house should be lined with minimum 50mm thick polyester or glasswool insulation of density 30kg/m3

Table 6-4 Predicted $L_{Aeq,15min}$ Noise Levels At Residences – dBA

Scenario	Criteria Day / Evening / Night (dBA)	Receiver				
		1	2	3	4	5
Local Water Centre 1 without Specific Noise Mitigation	41 / 41 / 41	20	24	39	39	43
Local Water Centre 1 with Specific Noise Mitigation	41 / 41/ 41	17	19	27	25	29
Local Water Centre 1 & 2 with Specific Noise Mitigation	41 / 41 / 41	21	22	33	31	33

The first line of the table indicates that without the specified noise mitigation, compliance will not be achieved at receiver 5.

The second line of the table indicates that without any mitigation applied, noise from the plant is predicted to exceed the 41 dBA goal at location 5.

As indicated in the final two lines of the table, when all plant are operating, excluding back-up generator, the predicted noise levels comply with the limiting 41 dBA night time noise criterion at the nearest existing residential receivers and new residential receivers. Therefore, no further acoustic consideration is required.

Noise contours for the mitigated case are shown in Appendix A.

6.5 Noise Emission Levels – With Back-Up Generator

The generator will be surrounded by a block wall up to 1m above the height of the generator.

The predicted noise levels when the back-up generator is in operation are presented in Table 6-5.

Note that as the back-up generator does not usually operate and will be tested during daytime hours either once per month for 30 minutes, or once every 2 months for 1 hour, a positive adjustment of 5dB will apply to the daytime project specific criteria of 41 dBA.

Table 6-5 Predicted $L_{Aeq,15min}$ Noise Levels At Residences (Existing & Future) With Back-Up Generator – dBA

Scenario	Criteria Daytime	Receiver				
		1	2	3	4	5
Operation with Backup Generator	46	30	34	34	40	39

A review of the predicted noise levels from all noise sources with the back-up generator in Table 6-5 indicates compliance with the adjusted daytime acceptable noise level of 46 dBA at the

nearest existing residential receivers and new residential receivers. Therefore, no further acoustic consideration is required.

Noise contours for the case of operation with the back-up generator are shown in Appendix B.

6.6 Tonality of Noise

There is some potential that the noise may be tonal in character. According to the *INP*, a modification factor of 5 dBA should be added to account for the higher intrusiveness of the noise in such circumstances. Should a 5 dBA modification factor be applicable, noise emission from site could exceed the night time criterion of 41 dBA at the nearest new residential receivers. It is therefore recommended that equipment with tonal characteristic are to be avoided at the procurement stage.

7 CONCLUSION

Operational noise associated with the proposed Box Hill North LWC has been assessed against noise criteria set out in the EPA's *Industrial Noise Policy*.

Preliminary calculations showed that the predicted noise level from the LWC would exceed the noise criteria at the nearest receivers. Therefore mitigation measures have been recommended.

With appropriate mitigation the predicted noise levels from the plant comply with all criteria on all occasions at the nearest existing and future residential receivers given that the following recommended treatment is implemented:

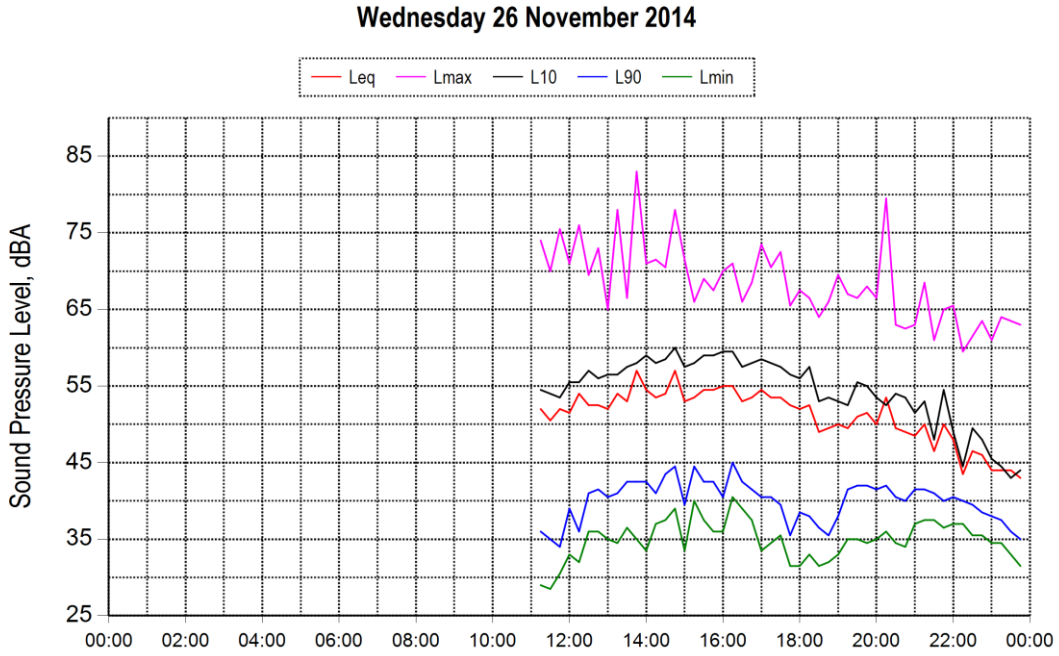
- Specific Noise Mitigation (1) – lining of Colorbond on the internal face of the plant room with appropriate air gap to accommodate minimum 50mm thick polyester or glasswool insulation of density 14kg/m^3.
- Specific Noise Mitigation (2) – The internal walls of the pump house should be lined with minimum 50mm thick polyester or glasswool insulation of density 30kg/m3.

Noise from the back-up generator is screened block wall 1m higher than the generator itself. Predicted noise levels from the back-up generator comply with the adjusted acceptable daytime noise level on all occasions at the nearest existing and future residential receivers.

Should the existing residential receivers 3 and 4 be occupied, when it comes time to empty the interim tanks, a 2.1m high temporary movable screen should be used to shield these receivers from the pump of the tankers.

APPENDIX A

NOISE MEASUREMENT RESULTS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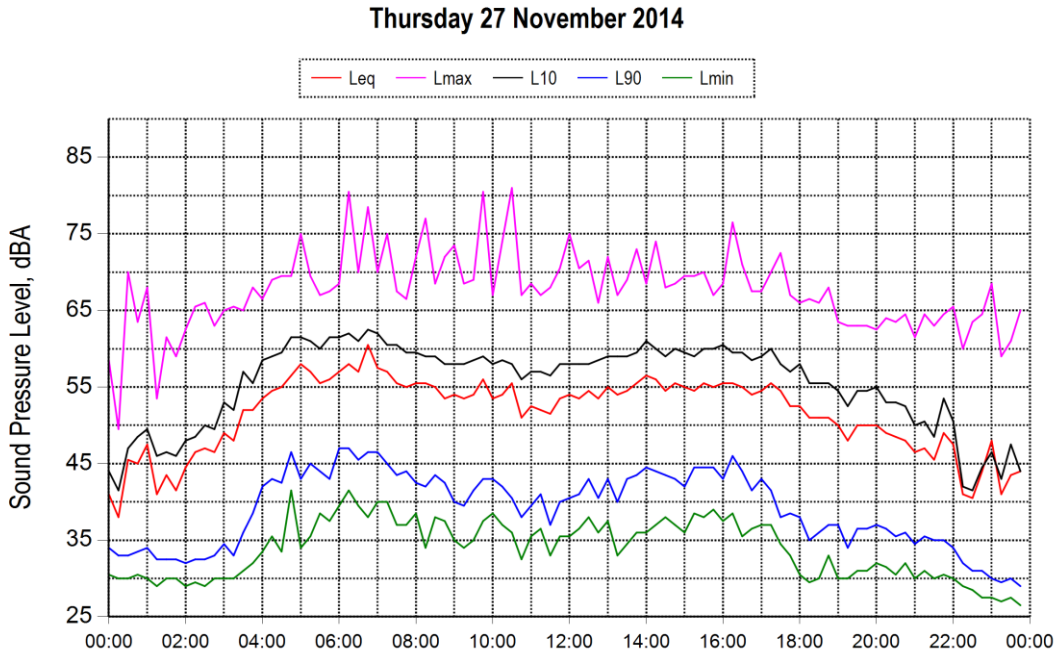
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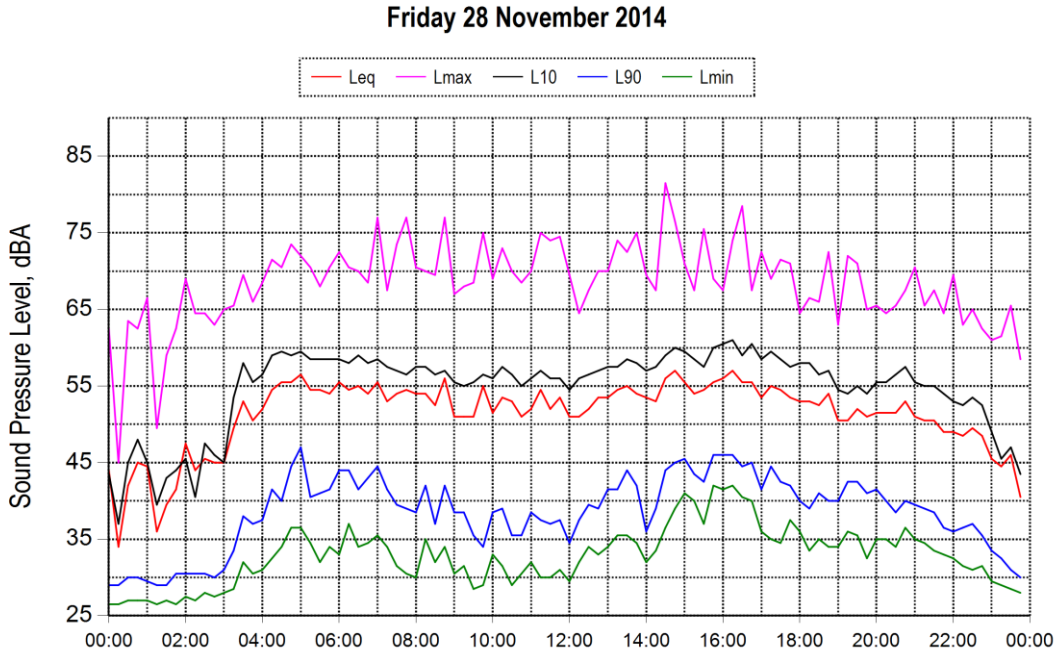
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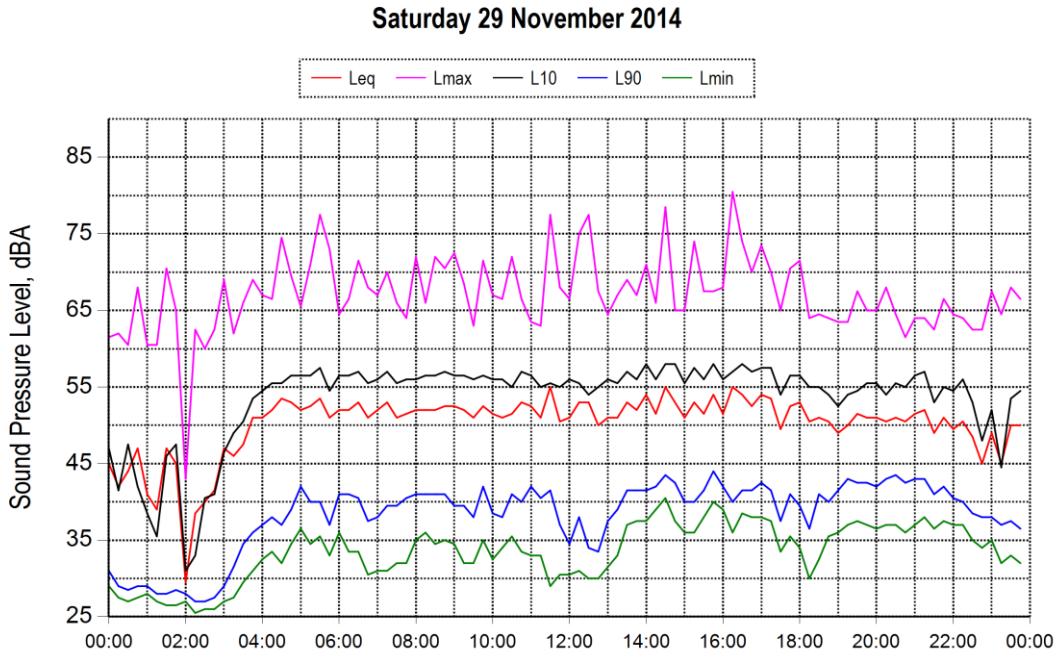
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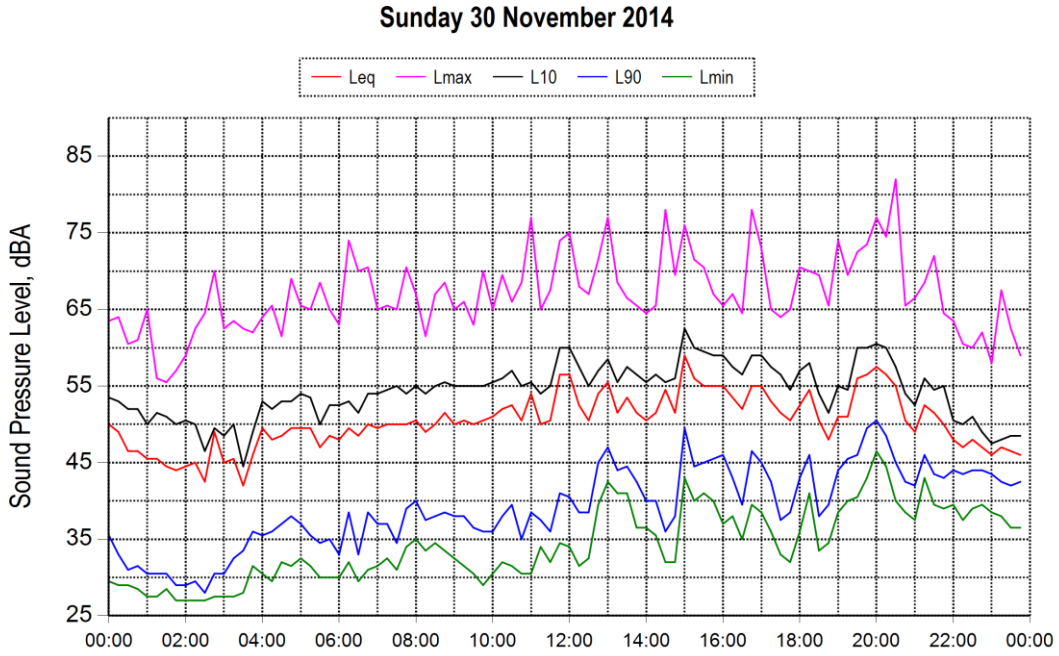
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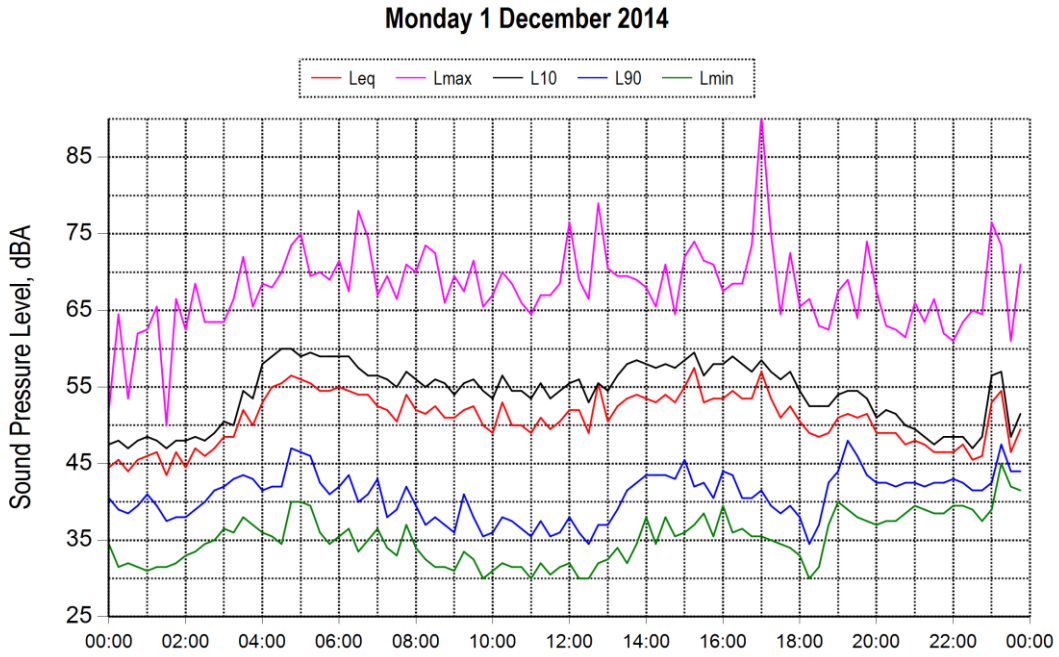
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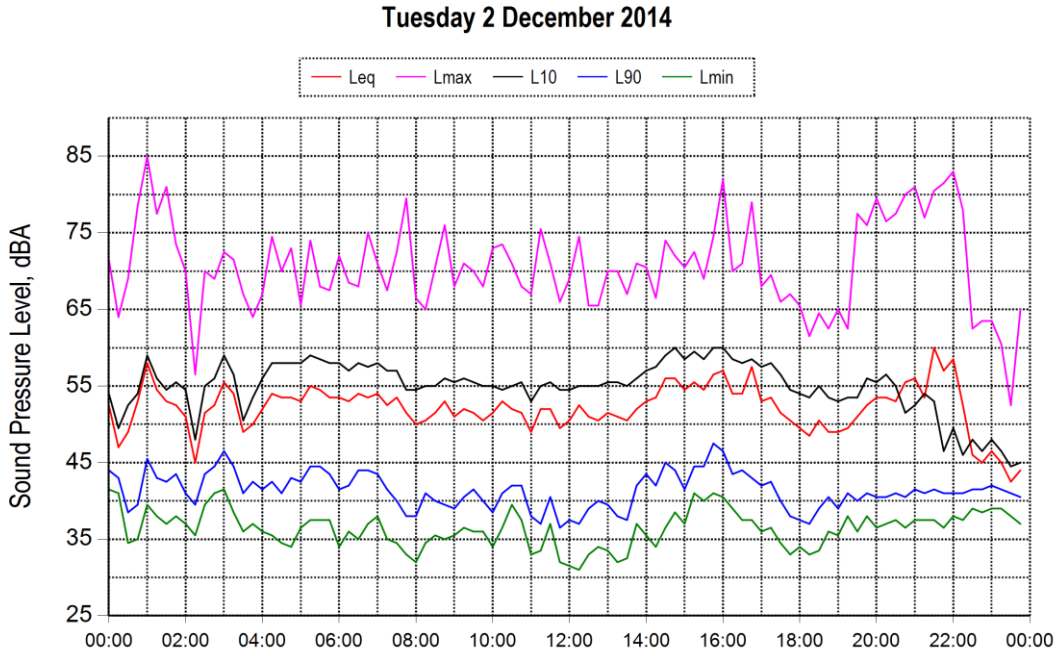
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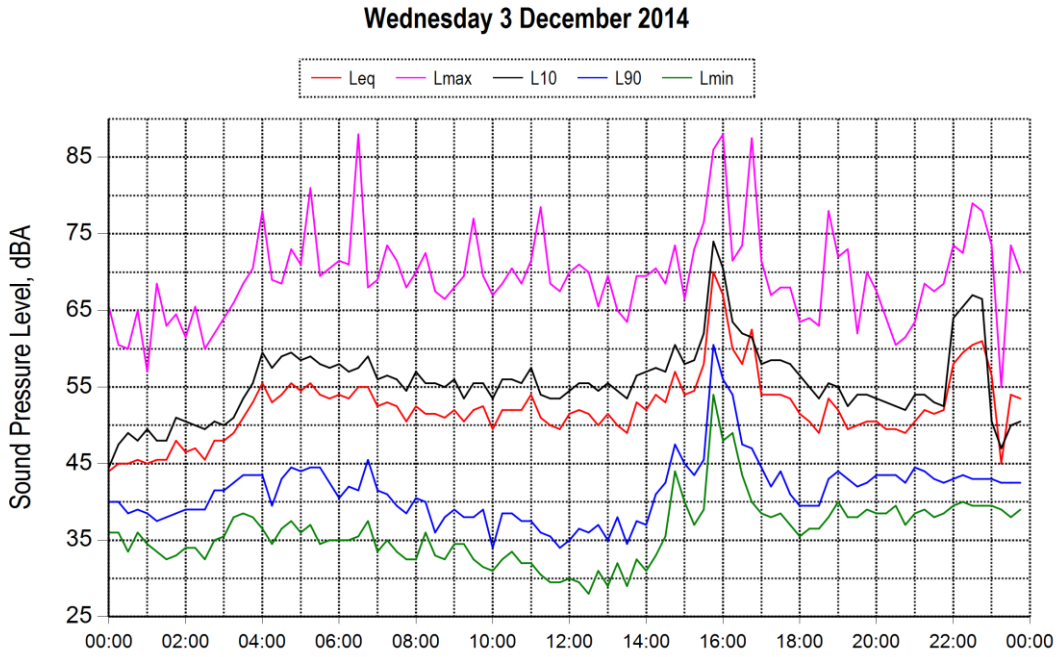
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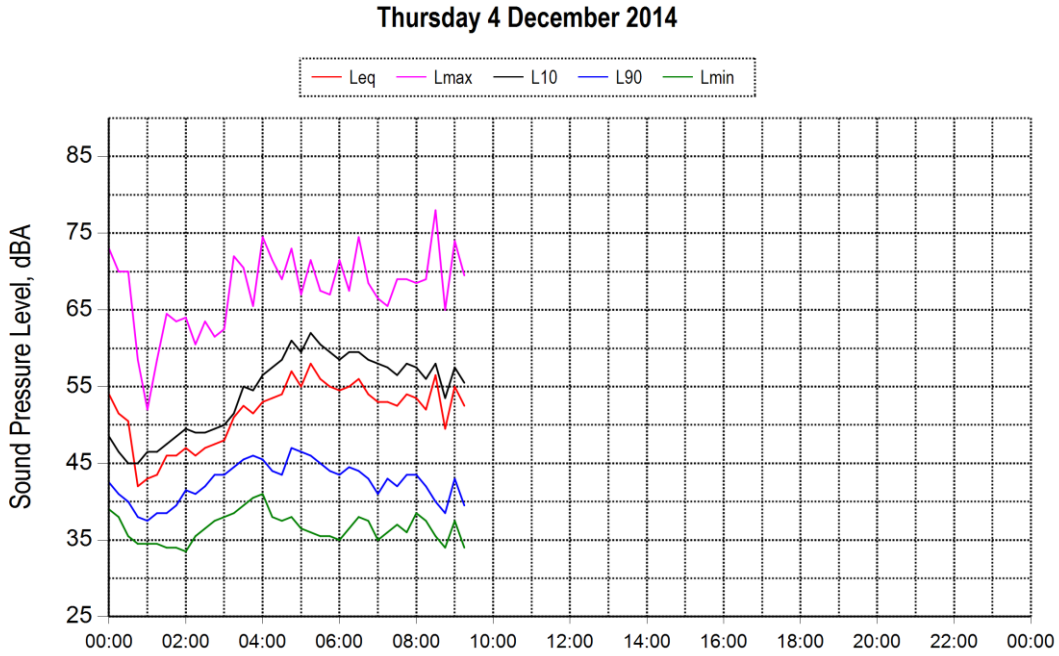
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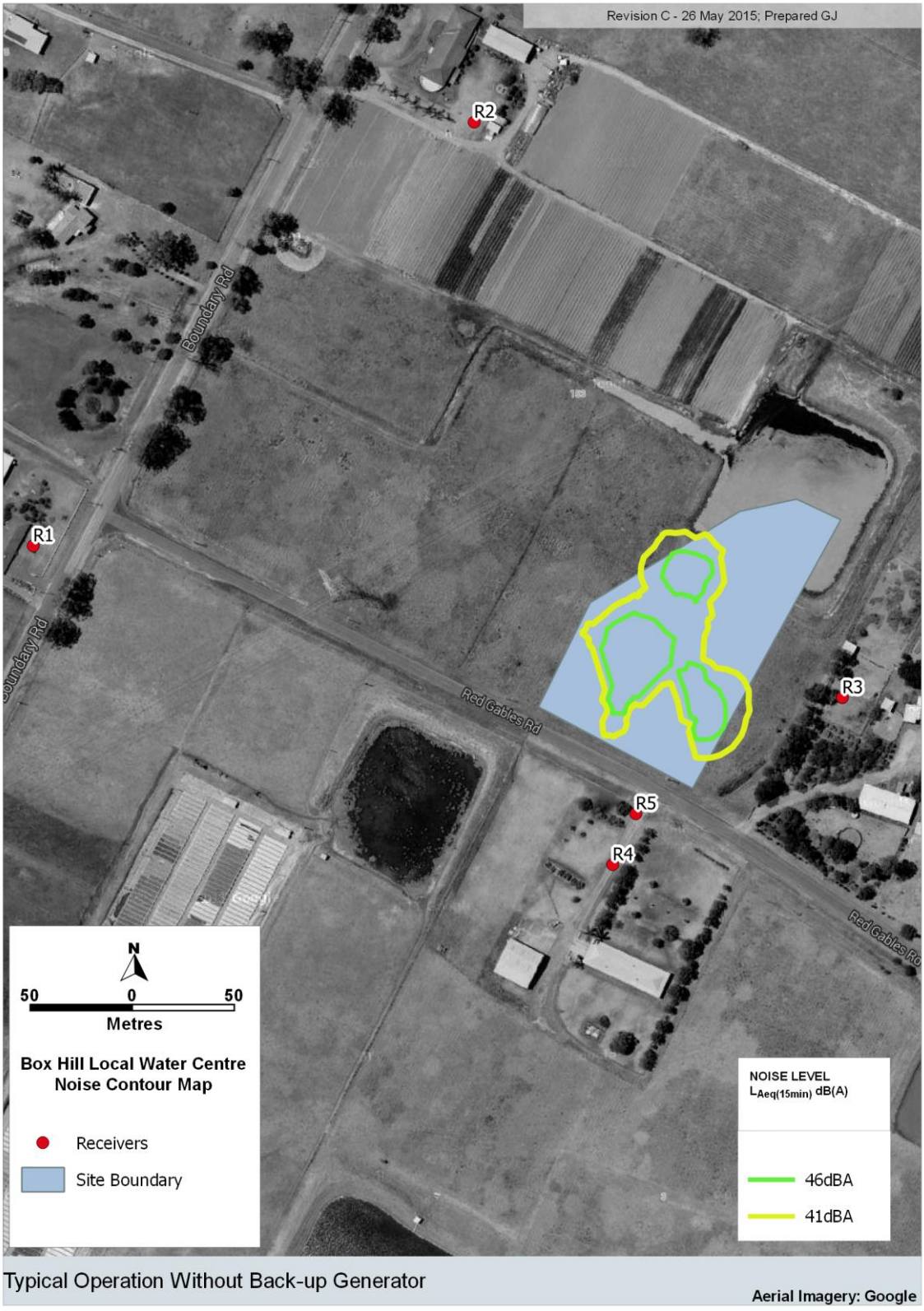
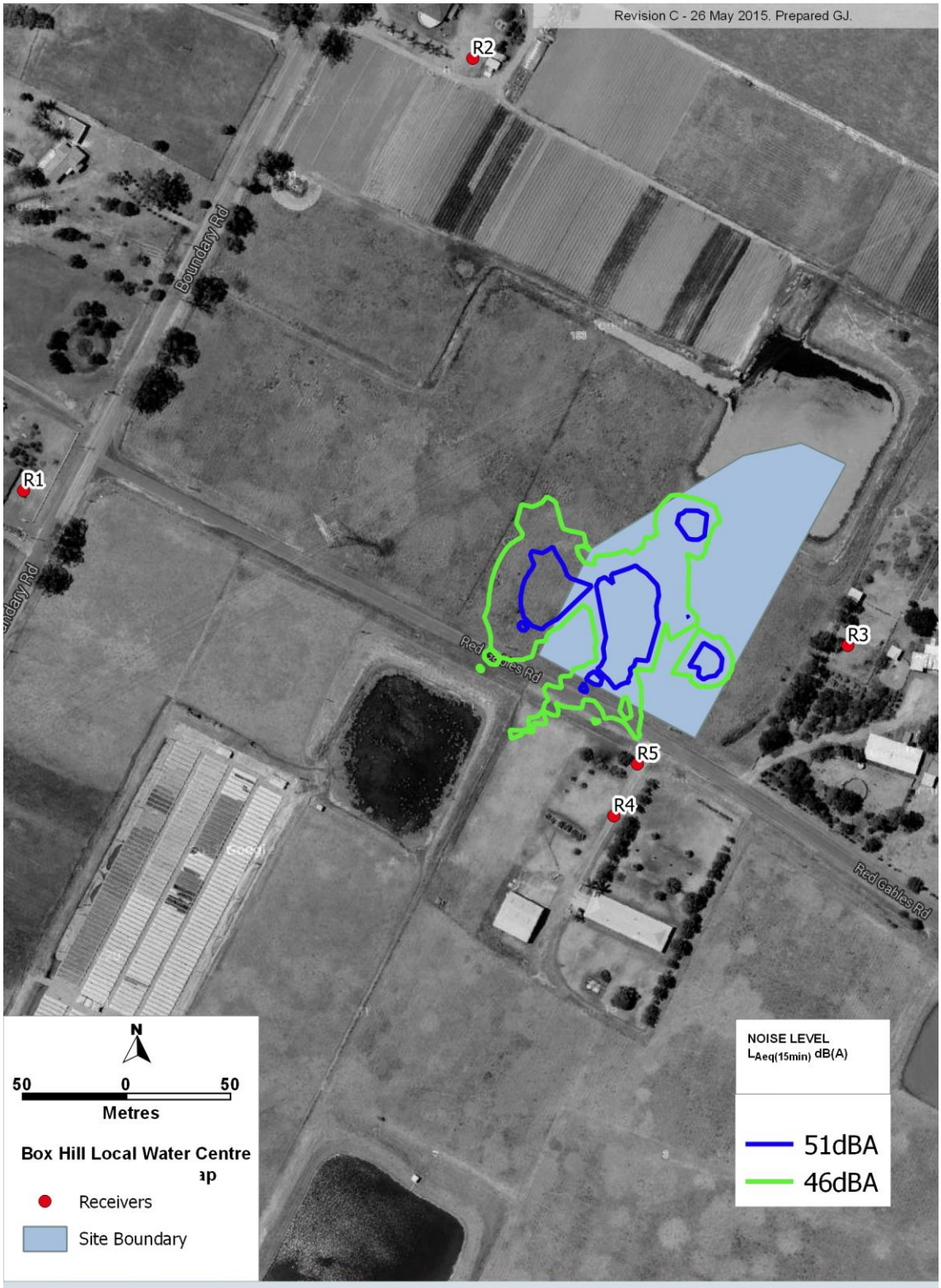
APPENDIX B

OPERATIONAL NOISE CONTOUR


Revision C - 26 May 2015; Prepared GJ
R1
R2
R3
R4
R5
Boundary Rd
Red Gables Rd
N
50
0
50
Metres
Box Hill Local Water Centre
Noise Contour Map
Receivers
Site Boundary
NOISE LEVEL
LAeq(15min) dB(A)
46dBA
41dBA
Typical Operation Without Back-up Generator
Aerial Imagery: Google

APPENDIX C

OPERATIONAL NOISE CONTOUR WITH BACK-UP GENERATOR



Typical Operation with Back-up Generator

Aerial Imagery: Google