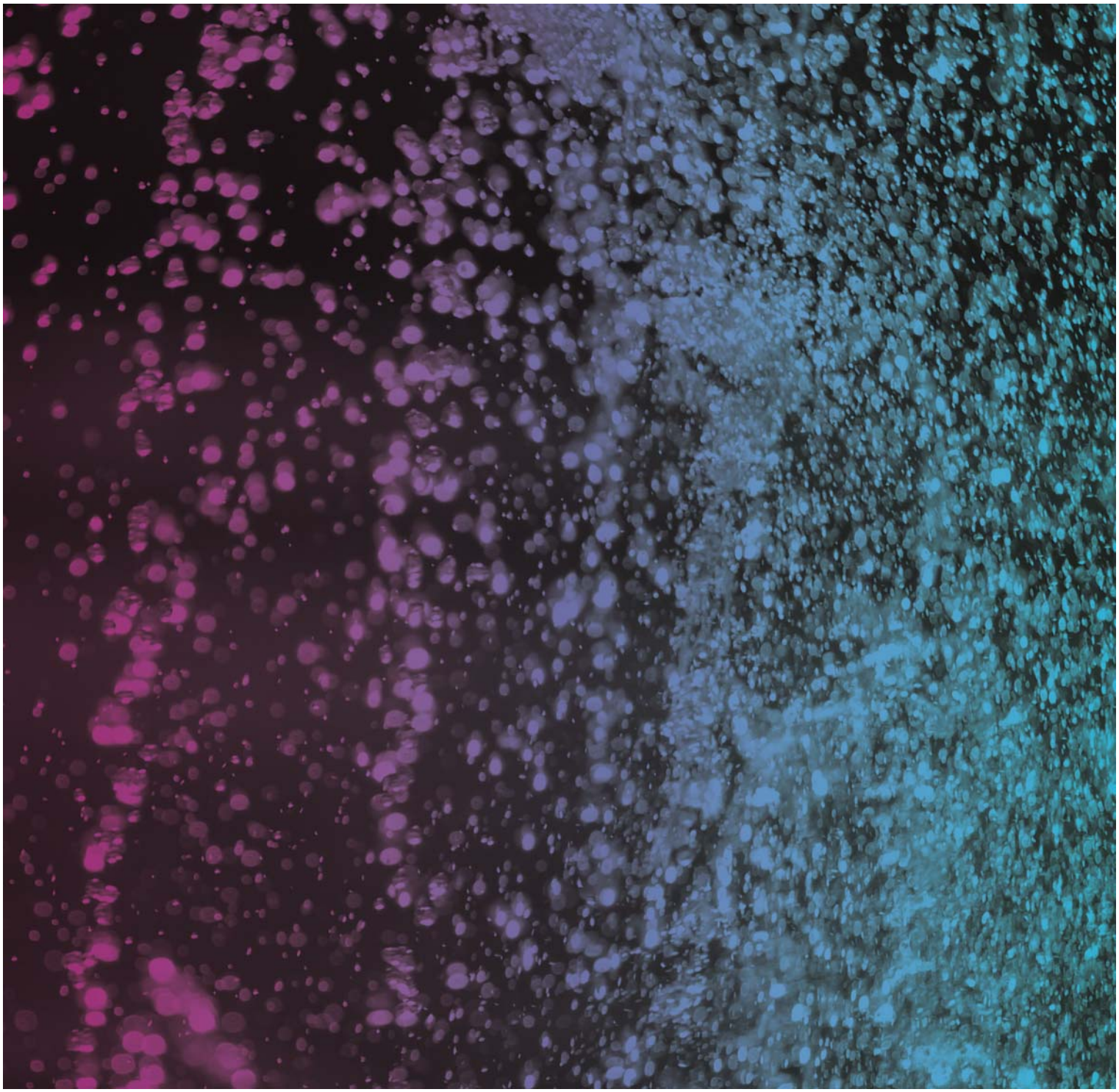
Byron Shire Central Hospital
Health Infrastructure
06-Aug-2014
Doc No. 60307108-ACRPT01.03

Byron Shire Central Hospital, 54 Ewingsdale Road, Ewingsdale

Noise and Vibration Impact Assessment



Byron Shire Central Hospital, 54 Ewingsdale Road, Ewingsdale

Noise and Vibration Impact Assessment

Client: Health Infrastructure

ABN: 89600377397

Prepared by

AECOM Australia Pty Ltd
Level 21, 420 George Street, Sydney NSW 2000, PO Box Q410, QVB Post Office NSW 1230, Australia
T +61 2 8934 0000 F +61 2 8934 0001 www.aecom.com
ABN 20 093 846 925

06-Aug-2014

Job No.: 60307108

AECOM in Australia and New Zealand is certified to the latest version of ISO9001, ISO14001, AS/NZS4801 and OHSAS18001.

Quality Information

Document Byron Shire Central Hospital, 54 Ewingsdale Road, Ewingsdale

Ref 60307108

Date 06-Aug-2014

Prepared by Leo Tsui / David Chau

Reviewed by Gayle Greer

Revision History

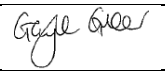
Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
00	15-Jul-2014	50% Issue for review	Gayle Greer Associate Director	GG
01	18-Jul-2014	95% Issue	Gayle Greer Associate Director	GG
02	25-Jul-2014	100% Issue	Gayle Greer Associate Director	GG
03	06-Aug-2014	100% Issue revised	Gayle Greer Associate Director	

Table of Contents

1.0 Introduction

1.1 Background information

AECOM Australia Pty Ltd (AECOM) has been commissioned by Health Infrastructure (HI), through Aurora Projects Pty Ltd (Aurora), to undertake an environmental noise and vibration impact assessment for the proposed Byron Shire Central Hospital (BSCH) at 54 Ewingsdale Road, Ewingsdale, NSW. BSCH has been designated as State Significant Development (SSD 6573) and this assessment has been prepared to meet the Department of Planning and Environment Secretary's Environmental Assessment Requirements (SEARs).

The proposed BSCH situated within the local government area of Byron Shire Council is required to address the statutory provisions contained within the following relevant environmental planning instruments.

- State Environmental Planning Policy (State & Regional Development) 2011
- State Environmental Planning Policy (Infrastructure) 2007
- State Environmental Planning Policy No 33 – Hazardous and Offensive Development
- State Environmental Planning Policy No. 55 – Remediation of Land
- Byron Shire Local Environmental Plan 2014

The following policies and guidelines are also relevant for this assessment.

- Environment Protection Authority (EPA) NSW Industrial Noise Policy (INP), 2000
- Department of Environment, Climate Change and Water (DECCW) NSW Road Noise Policy (RNP), 2011
- Department of Environment and Climate Change (DECC) NSW Interim Construction Noise Guideline (ICNG), 2009
- Department of Planning Development near Rail Corridors and Busy Roads – Interim Guideline, 2008
- Department of Environment and Conservation (DEC) Assessing Vibration: A technical guideline (AVATG), 2006

A glossary of acoustic terminology used in this report is presented within Appendix A.

1.2 Scope of work

The scope of this environmental noise and vibration impact assessment is to:

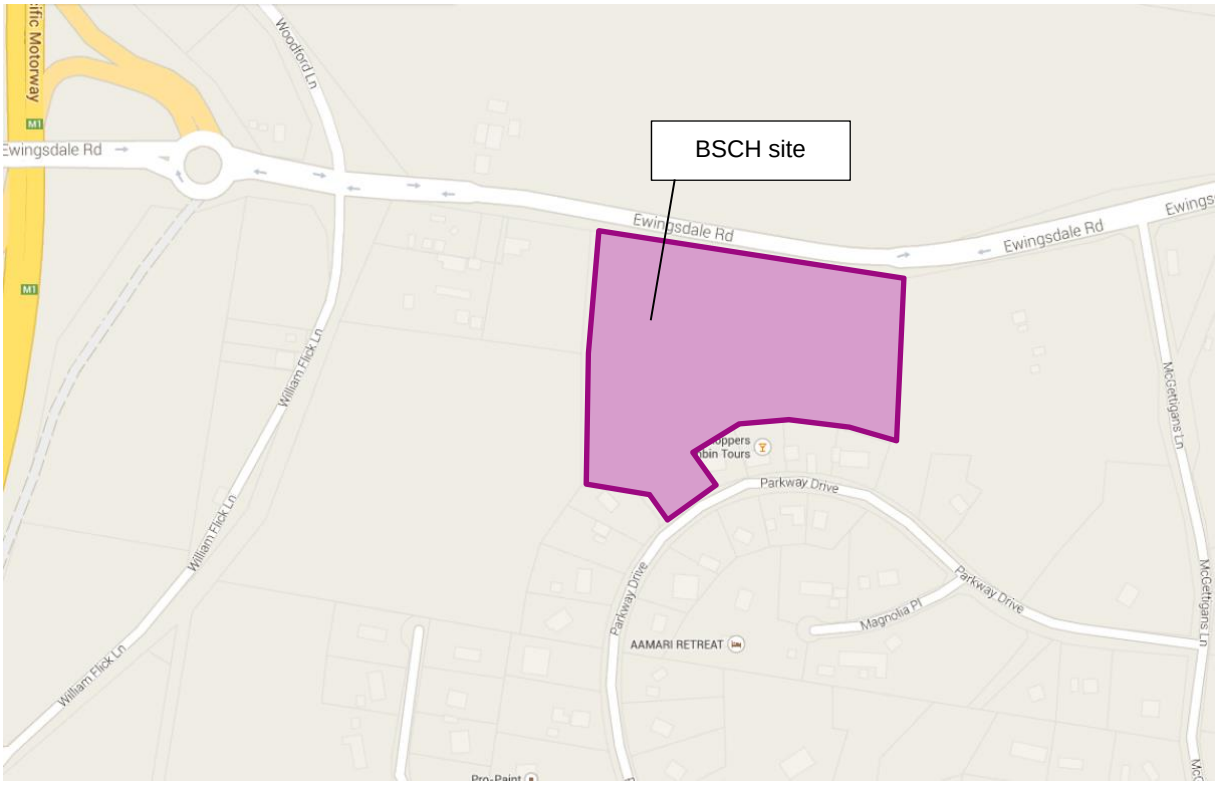
- Establish the existing background noise levels in the vicinity of the BSCH;
- Establish the environmental noise and vibration limits that would apply during the operational and construction phases from the proposed development;
- Predict environmental noise levels at nearby residential receivers due to the operation and the construction of the development;
- Predict noise levels from additional traffic generated by the operation and construction of the development;
- Review any sources of vibration that may have effects on buildings and human comfort; and
- Provide mitigation measures where necessary to reduce noise emission and vibration impacts from the development to comply with established noise and vibration limits.

1.3 Site and development description

Figure 1 shows the location of the development and its surrounding environment. BSCH is located at 54 Ewingsdale Road, Ewingsdale, NSW. The proposed BSCH site is bound by Ewingsdale Road to the north, the rear of residential properties on Parkway Drive to the south, and an energy substation and a concrete batching plant to the west. An existing ambulance station is located on the north eastern corner of the site.

The nearest residential receivers are the residential properties of 40 to 50, and 58 Parkway Drive, Ewingsdale, NSW.

Figure 1 Byron Shire Central Hospital and surrounding environment (image courtesy of Google Earth)



The proposed BSCH will comprise the following facilities.

- Main Entry/Admissions
- Emergency Unit
- Peri-operative Unit
- Birthing Unit
- Inpatient Unit
- Ambulatory Care, Allied Health and Community Health
- Clinical Support
- Non-clinical Support
- Mental Health Inpatient Unit

The proposed BSCH comprises three rectangular block buildings with a main corridor connecting all three buildings. The northern block of the three buildings is two storey while the central and southern blocks are single storey buildings.

2.0 Existing acoustic environment

AECOM completed unattended and attended noise monitoring around the proposed BSCH site to quantify and characterise the existing acoustic environment.

2.1 Environmental noise monitoring

2.1.1 Unattended noise measurements

AECOM conducted environmental noise monitoring at two (2) locations in the vicinity of the development site between Thursday 15 May 2014 and Thursday 22 May 2014. The loggers were set for sample periods of 15 minutes and continuously logged for monitoring period. Noise monitoring was conducted within the boundaries of the development site to determine existing background and traffic noise levels. The locations of the unattended noise logging are as follows and are also presented in Figure 2.

- Northern boundary of the site: adjacent to Ewingsdale Road. Local traffic noise from Ewingsdale Road dominant.
- Southern boundary of the site: adjacent to rear boundary of residence on Parkway Drive. Distant traffic noise dominant.

Figure 2 Location map of unattended noise logging (pink markers only) and operator attended measurements (pink and green markers)

The equipment used for site measurements is detailed below in Table 1.

Table 1 Environmental noise monitoring equipment

Location	Equipment	Serial Number
Northern boundary	Rion NL21	465445
Southern boundary	Rion NL21	354110

Calibration of the meters was checked on site with a sound calibrator at the beginning and end of the measurement periods. No significant drifts in calibration were observed. All the instrumentation employed during the noise measurements comply with the requirements of AS1259.2-1990 “Acoustics – Sound level meters – Part 2: Integrating – Averaging” and they carry appropriate calibration certificates. The noise measurements have been conducted in accordance with AS1055.1 – 1997.

The loggers measured the noise levels over the sample period and then determined L_{A10}, L_{A90}, L_{Amax}, and L_{Aeq} levels of the noise environment. The L_{A10} and L_{A90} levels are the levels exceeded for 10% and 90% of the sample period respectively. The L_{Amax} is indicative of the maximum noise levels due to individual noise events such as the pass-by of a heavy vehicle. The L_{A90} is taken as the background noise level. The L_{Aeq} level is the equivalent continuous sound level and has the same sound energy over the sample period as the actual noise environment with fluctuating sound levels.

The background noise level is defined by the EPA as 'the underlying level of noise present in ambient noise when all unusual extraneous noise is removed'. It can include sounds that are normal features of a location and may include birds, traffic, insects etc. The background noise level is considered to be represented by the L_{A90} descriptor. The noise levels measured at the proposed development site were analysed to determine a single assessment background level (ABL) for each day, evening and night period in accordance with the EPA's INP, for each monitoring location.

The graphical recorded outputs from the noise monitoring are given in Appendix B. The results used to develop the graphs given in Appendix B were also analysed to determine a single Assessment Background Level (ABL) for each day, evening and night period, in accordance with the NSW Industrial Noise Policy (INP).

The ABL is established by determining the lowest ten-percentile level of the L_{A90} noise data acquired over each period of interest i.e. day, evening and night. Table 2 presents individual ABLs for each day's assessment periods.

Table 2 Existing background (L_{A90}) and ambient (L_{Aeq}) noise levels

Measurement Date	L_{A90} Background Noise Levels, dB(A)			L_{Aeq} Ambient Noise Levels, dB(A)		
	Day	Evening	Night	Day	Evening	Night
Northern Boundary						
Thursday 15 May, 2014		44	37		64	60
Friday 16 May, 2014	50	44	38	67	63	58
Saturday 17 May, 2014	46	42	39	66	63	58
Sunday 18 May, 2014	46	42	34	65	61	58
Monday 19 May, 2014	48	42	35	66	63	59
Tuesday 20 May, 2014	47	42	37	66	62	59
Wednesday 21 May, 2014	48	43	35	66	62	59
RBL/Log Average	**47**	**42**	**37**	**66**	**63**	**59**
Southern Boundary						
Thursday 15 May, 2014		42	38		48	46
Friday 16 May, 2014	43	41	39	51	48	45
Saturday 17 May, 2014	39	40	40	51	49	45
Sunday 18 May, 2014	38	44	36	49	49	45
Monday 19 May, 2014	42	42	37	50	49	46
Tuesday 20 May, 2014	41	42	38	49	48	46
Wednesday 21 May, 2014	41	43	36	50	48	46
RBL/Log Average	**41**	**42**	**38**	**50**	**48**	**46**

Notes:

- Day is defined as 7:00 am to 6:00 pm, Monday to Saturday and 8:00 am to 6:00 pm Sundays and Public Holidays.
- Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday and Public Holidays.
- Night is defined as 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am Sundays and Public Holidays.

2.2 Attended noise measurements

Attended noise measurements were undertaken to supplement the unattended noise measurements at representative receiver locations. Attended noise measurements were undertaken on Thursday 15 May 2014 between 1:30 pm and 4:00 pm within the boundary of the proposed site. Attended noise measurement locations are indicated in Figure 2 above by the pink and green markers.

During the attended noise measurements, it was observed that the dominant noise source in the area is traffic along the Ewingsdale Road. Noise from the nearby transformer station and the concrete batching plant was also observed.

Attended noise measurements were undertaken using a SVAN 957 sound level meter (Serial number: 27542). The SVAN 957 sound level meter is designated as having Type 1 accuracy. All equipment used was calibrated before and after measurements with a drift in calibration not exceeding ± 0.5 dB. Additionally, all equipment used for this assessment were in their current National Association of Testing Authorities, Australia (NATA) certified in-calibration period (i.e. full 1/3 octave band calibration in the last 2 years).

The weather during the attended measurements was fine and did not affect the measurements.

A summary of the attended noise measurement results is presented in Table 3 below.

Table 3 Summary of attended noise measurements – Thursday 15 May 2014

Location	Time	Measured Noise Levels, dB(A)				Comments
		L_{eq}	L_1	L_{10}	L_{90}	
1 Northern boundary	1:45 pm – 2:00 pm	65	74	68	48	Noise was dominated by intermittent traffic along Ewingsdale Road. Traffic noise sources included heavy vehicles and motorcycles. No industrial noise was audible at this measurement location.
2 Southern boundary	2:15 pm – 2:30 pm	46	54	48	41	Noise was dominated by distant traffic along Ewingsdale Road. Distant traffic noise sources included heavy vehicles and motorcycles. No Industrial noise was audible at these locations.
3 South-western quadrant	2:45 pm – 3:00 pm	45	50	47	43	
4 Eastern boundary adjacent to Ambulance station	3:00 pm – 3:08 pm	50	55	53	47	
5 Western boundary adjacent to transformer station	3:30 pm – 3:38 pm	55	62	57	51	

2.3 Road traffic noise measurements

The noise logger located at the northern boundary of the site was representative of the noise levels produced by traffic using Ewingsdale Road.

The calculated noise levels for the daytime and night-time periods are listed in Table 4.

Table 4 Traffic noise levels over the measurement period

Location	Day – RNP Timebase	Night – RNP Timebase
	$L_{Aeq, 1hr}$, dB(A) (7am to 10pm)	$L_{Aeq, 1hr}$, dB(A) (10pm to 7am)
Northern boundary adjacent to Ewingsdale Road	67	65

3.0 Noise and Vibration Criteria

The proposed BSCH development has the potential to contribute to the existing external noise environment. Noise will be generated by the traffic movements of residents and visitors to the development and operation of mechanical services plant servicing the various components of the development. In order to ensure nearby residential properties on Parkway Drive are not adversely affected by noise emission, as described above, environmental noise limits are established and must be applied at the most affected residential boundary for mechanical services and industrial noise and at 1 metre from the affected building façade for road traffic noise.

This section will establish criteria in order to address the following acoustical issues:

- Internal mechanical services noise levels;
- Road traffic noise intrusion;
- External environmental noise emission levels for building services plant;
- Noise emitted from additional traffic associated with the development;
- BCA 2014 acoustic requirements; and
- Construction noise and vibration associated with the development.

3.1 Recommended ambient internal noise levels

The internal noise levels in the development will be generated by the air conditioning and mechanical ventilation plant servicing the development and by traffic noise intrusion.

3.1.1 Traffic noise intrusion

Internal noise levels due to traffic noise must comply with the State Environmental Planning Policy (Infrastructure) 2007 (SEPP 2007) and its guideline document 'Development near Rail Corridors and Busy Roads – Interim Guidelines'. The SEPP 2007 criteria for road traffic noise intrusion are 35 dB(A) for hospital wards and 45 dB(A) for other noise sensitive areas within the hospital.

3.1.2 Building services noise

Internal noise levels due to mechanical services noise are recommended to comply with Australian Standard AS/NZS 2107:2000 "Acoustics – Recommended design sound levels and reverberation times for building interiors" which recommends satisfactory and maximum internal noise levels for building interiors based on room designation and location of the development with respect to external noise sources. Where otherwise not specified, noise levels within occupied spaces as a result of the combined contributions of external noise intrusion and the normal operation of building services shall not exceed the 'maximum' values specified in Table 5.

Table 5 Recommended design sound levels AS/NZS 2107:2000

Type of Occupancy/Activity	Recommended Design Sound Level, L_{Aeq}, dB(A)	
	Satisfactory	Maximum
Corridors and lobby spaces	40	50
Consulting and interview rooms	40	45
Kitchen/service areas	50	55
Meeting rooms	30	40
Nurses stations	40	45
Open office areas	40	45
Private offices	35	40
Wards	35	40
Waiting rooms, reception areas	40	50

The recommended noise levels are given in terms of equivalent continuous A-weighted noise levels (L_{Aeq}).

3.1.3 Recommended reverberation times

A room's 'liveliness' can be quantified through the measurements of its 'reverberation time'. In layman terms, reverberation is the build up of sound within a room due to series of multiple reflections from the room's surfaces. The reverberation time is a measure of how long it takes for a burst of sound to decay 60 dB and is given the abbreviation of RT_{60}. A room which is considered acoustically 'lively' generally has a longer reverberation time (e.g. a tiled bathroom with lots of hard surfaces), and an acoustically 'dead' room typically has a shorter reverberation time (e.g. a carpeted office with mineral fibre ceiling tiles).

Reverberation control is necessary for two important reasons:

- Excessive reverberation makes speech more difficult to follow as the sounds of one word are blurred into the following word. In extreme cases it may render the speech to become unintelligible.
- A noise source, such as air conditioning equipment or even people talking, will generate greater sound pressure levels in a reverberant space because the sound energy takes longer to decay.

A noise source in a 'lively' room can be up to approximately 5-7 dB(A) louder than in an acoustically dead room. Therefore, it is important when designing 'quiet' spaces that the surface area of sound absorptive finishes is optimised.

Table 6 gives the recommended reverberation times for the different areas in the development based upon the recommendations given in AS/NZ 2107:2000.

Table 6 Recommended reverberation times AS/NZS 2107:2000

Type of Occupancy/Activity	Recommended Reverberation Time (s)
Corridors and lobby spaces	0.4 – 0.6
Consulting and interview rooms	0.4 – 0.6
Kitchen/service areas	0.6 – 0.8
Meeting rooms	0.6 – 0.8
Nurses' stations	0.4 – 0.7
Open office areas	0.4 – 0.7
Private offices	0.6 – 0.8
Wards	0.4 – 0.7
Waiting rooms, reception areas	0.4 – 0.7

3.2 Traffic noise criteria

Noise from traffic movements to and from the site including car and emergency vehicle movements will be assessed using the EPA's document *NSW Road Noise Policy* (RNP). The main vehicle access will be via Ewingsdale Road which provides access to car parking spaces and emergency vehicle access for the hospital. Ewingsdale Road is classified as an arterial road in the road categories prescribed in the RNP.

Table 7 presents the EPA's road traffic noise assessment criteria for land use developments with potential to create additional traffic on existing roads. The external criteria are assessed at 1 metre from the affected residential building façades and at a height of 1.5 metres from the floor.

Table 7 Road traffic noise assessment criteria for residential land uses

Road Category	Type of project/land use	Assessment criteria - dB(A)	
		Day (7am – 10pm)	Night (10pm – 7am)
Freeway/arterial /sub-arterial roads	3. Existing residences affected by **additional traffic** on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq(15hr)}$60	$L_{Aeq(9hr)}$55

Road Category	Type of project/land use	Assessment criteria - dB(A)	
		Day (7am – 10pm)	Night (10pm – 7am)
Local roads	6. Existing residences affected by **additional traffic** on existing local roads generated by land use developments	$L_{Aeq(1hr)}$55	$L_{Aeq(1hr)}$50

In cases where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

3.3 Environmental noise emission criteria

3.3.1 NSW Industrial Noise Policy (INP)

The NSW EPA's Industrial Noise Policy (INP) for the assessment and control of industrial noise sets out guidelines for industrial noise. These guidelines will apply to all mechanical plant installed at the development.

The assessment procedure for industrial noise sources has two components:

- Controlling intrusive noise impacts in the short term for residences; and
- Maintaining noise level amenity for particular land uses for residences and other land uses.

3.3.1.1 Intrusive noise impacts

The INP states that the noise from any single source should not intrude greatly above the prevailing background noise level. Industrial noise sources are generally considered to be acceptable if the equivalent continuous (energy-averaged) A-weighted level of noise from the source (L_{Aeq}), measured over a 15 minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB(A). This is often termed the Intrusiveness Criterion.

The 'Rating Background Level' (RBL) is the background noise level to be used for assessment purposes and is determined by the methods given in the INP. Adjustments are to be applied to the level of noise produced by the source that is received at the assessment point where the noise source contains annoying characteristics such as tonality or impulsiveness.

Table 8 Environmental noise emission intrusiveness criteria

Period	RBL (L_{A90}), dB(A)	Intrusiveness Criterion (RBL + 5), dB(A)
Southern Boundary – adjacent to rear boundary of residences on Parkway Drive		
Day	41	46
Evening	42	46[1]
Night	38	43

Note 1: The INP notes that the community generally expects greater control of noise during the more sensitive evening and night-time periods than the less sensitive daytime period. Therefore, it is generally recommended that the intrusive noise level for evening be set at no greater than the intrusive noise level for daytime.

3.3.1.2 Protecting noise amenity

To limit continuing increases in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in the INP. That is, the background noise level should not exceed the level appropriate for the particular locality and land use. This is often termed the Background Creep or Amenity Criterion. If receivers are subject to existing levels of industrial noise then the amenity criteria are to be adjusted in accordance with the INP. However, in this circumstance industrial noise was not audible at the sensitive receivers most likely to be affected by the development.

The residential receivers in this study have been regarded as 'Suburban'. For residential receivers in suburban areas, and other receiver types, the amenity criteria are shown in Table 9.

Table 9 Recommended L_{Aeq} noise levels from industrial noise sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level, dB(A)	
			Acceptable	Recommended Maximum
Residence	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
Industrial premises	All	When in use	70	75

A summary of the applicable intrusive and amenity criteria for nearby residential receivers is given in Table 10. These criteria must be applied at the most affected boundary, if this is more than 30 m from the residence, at the most-affected point within 30 m of the residence.

Table 10 Summary of environmental noise criteria

Period	RBL (L_{A90}), dB(A)	Intrusiveness Criterion (RBL+5)), dB(A)	Ambient, (L_{Aeq})	Amenity Criteria, dB(A)	Final Environmental Criterion, dB(A)
Day	41	46	50	50	46
Evening	42	46[1]	48	45	45
Night	38	43	46	40	40

Note 1: The INP notes that the community generally expects greater control of noise during the more sensitive evening and night-time periods than the less sensitive daytime period. Therefore, it is generally recommended that the intrusive noise level for evening be set at no greater than the intrusive noise level for daytime.

3.3.2 Operational noise limits – Emergency operations

Noise criteria for the site have been derived in accordance with the NSW INP. It is understood that brown-outs and black-outs are infrequent for the area and therefore the standby generator is unlikely to be in frequent use. In addition, all emergency plant and equipment be tested during the daytime period (i.e. 7 am to 6 pm). For these reasons and in the absence of any relevant NSW guideline for emergency generators and equipment, it is recommended that noise limits for intrusive noise for emergency plant equipment be relaxed by 5 dB(A). Therefore, the noise emission from emergency plant and equipment be set to 10 dB(A) above the background (RBL). Table 11 presents operational noise limits for emergency operations.

Table 11 Operational noise limits – Emergency operations

Type of Receiver	Time of Day	Noise Limits (RBL + 10 dB)	
		Level – dB(A)	Descriptor
Residence–[external]	Day	51	$L_{Aeq, 15\ minutes}$
	Evening	51[1]	$L_{Aeq, 15\ minutes}$
	Night	48	$L_{Aeq, 15\ minutes}$

Note 1: In similar manner to the INP criteria above, the community generally expects greater control of noise during the more sensitive evening and night-time periods than the less sensitive daytime period. Therefore, it is generally recommended that the intrusive noise level for evening be set at no greater than the intrusive noise level for daytime.

3.3.3 Sleep disturbance criteria

The INP was updated in June 2013 with application notes which discuss sleep disturbance and its objective assessment. To minimise the risk of sleep disturbance as a result of industrial type operations during the night-time period, the INP application notes reference the RNP.

The guidance provided in the RNP for assessing the potential for sleep disturbance recommends that to minimise the risk of sleep disturbance during the night-time period (10.00 pm to 7.00 am), the $L_{A1(1\ minute)}$ noise level outside a bedroom window should not exceed the $L_{A90\ (15\ minute)}$ background noise level by more than 15 dB(A). The EPA considers it appropriate to use this metric as a screening criterion to assess the likelihood of sleep disturbance. If this screening criterion is found to be exceeded then a more detailed analysis must be undertaken and include the extent that the maximum noise level exceeds the background noise level and the number of times this is likely to happen during the night-time period.

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

Based on the measured background noise levels during the night, the sleep disturbance criteria for the nearest noise sensitive residential receivers are presented in Table 12.

Table 12 Sleep disturbance criteria

Receiver	Background noise level (L_{A90}), dB(A)	Sleep Disturbance Criteria, $L_{A1(1\ minute)}$, dB(A)	
		Screening Level	Awakening Reaction
Residential	38	53	60 – 65

3.3.4 On site traffic associated noise

The proposed BSCH development will have onsite traffic associated with the operation of the hospital which includes car parking, loading zone, and ambulance bay. The car parking spaces surrounds the hospital buildings along three boundaries of the site.

- East: 76 Staff car parking, 27 fleet parking, 8 15-minutes parking, loading zone
- South: 30 Staff car parking
- West: 30 outpatient parking, 13 visitors parking, ambulance bay

Noise associated with the car park operation (e.g. engine starts, car acceleration, door slams, and patron noise) is assessed against the INP criteria in section 3.3.1.

3.4 Construction noise and vibration management levels

3.4.1 Construction noise management levels

The EPA's Interim Construction Noise Guidelines (ICNG) is the principal guidance for the assessment and management of construction noise in NSW. This document replaces the previous publication the Environmental Noise Control Manual and is used as the basis for establishing construction noise management levels.

The ICNG recommends that a quantitative assessment is carried out for all 'major construction projects that are typically subject to the EIA process'. Predicted noise levels at nearby receivers are compared to the levels provided in Section 4 of the ICNG. Where an exceedance of the management levels is predicted the ICNG advises that the proponent should apply all feasible and reasonable work practises to minimise the noise impact.

The Interim Construction Noise Guidelines defines what is considered to be feasible and reasonable as follows:

- *"Feasible*

  A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.

- *Reasonable*

  Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure."

The construction noise management levels for the residential and other sensitive land uses are detailed in Table 13.

Table 13 Setting and applying noise at residences

Time of Day	NML, $L_{Aeq,15min}$, dB(A)[1]	How to Apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 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 dB(A)	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 noisy activities can occur, taking into account: 1. 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 2. 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 dB(A) above the noise affected level, the proponent should negotiate with the community. - For guidance on negotiating agreements see section 7.2.2 (ICNG).

Notes:

1. Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Table 14 presents the NMLs applicable to residences nearby to this development.

Table 14 Construction noise management levels – Residential receivers

Logging Location	Period	RBL, L_{A90} dB(A)	Standard Hours Noise Management Levels, L_{Aeq} dB(A)	Out of Hours Noise Management Levels, L_{Aeq} dB(A)
Logger 1	Day	41	51	46
	Evening	42	N/A	47
	Night	38	N/A	43

Section 4.1.3 of the ICNG also defines the following industrial premises noise management levels:

- Industrial premises: external $L_{Aeq(15min)}$ 75 dB(A)

3.4.2 Construction vibration criteria

The relevant standards/guidelines for the assessment of construction vibration are summarised in Table 15 .

Table 15 Standards/guidelines used for assessing construction vibration

Item	Standard/guideline
Structural damage	German Standard DIN 4150 – Part 3 – Structural Vibration in Buildings – Effects on Structures (DIN 4150)
Human comfort (tactile vibration) [1]	Assessing Vibration: A Technical Guideline (AVATG)

Note 1: This document is based upon the guidelines contained in British Standard 6472:1992, "Evaluation of human exposure to vibration in buildings (1-80 Hz)". This British Standard was superseded in 2008 with BS 6472-1:2008 "Guide to evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting" and the 1992 version of the Standard was withdrawn. Although a new version of BS 6472 has been published, the Environment Protection Authority still requires vibration to be assessed in accordance with the 1992 version of the Standard at this point in time.

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

- Continuous vibration continues uninterrupted for a defined period and includes sources such as machinery and continuous construction activities for example, a tunnel boring machine.
- Impulsive vibration is a rapid build up to a peak followed by a damped decay. It may consist of several cycles at around the same amplitude, with durations of typically less than two seconds and no more than three occurrences in an assessment period. This may include occasional dropping of heavy equipment or loading activities.
- Intermittent vibration occurs where there are interrupted periods of continuous vibration, repeated periods of impulsive vibration or continuous vibration that varies significantly in magnitude. This may include intermittent construction activity, impact pile driving, jack hammers.

3.4.2.1 Structural damage

At present, no Australian Standards exist for the assessment of building damage caused by vibration.

DIN 4150 provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are presented in Table 16. DIN 4150 states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage.

Table 16 DIN 4150: Structural damage safe limits for building vibration

Group	Type of structure	Vibration velocity in mm/s			
		At foundation at a frequency of			Vibration at the horizontal plane of the highest floor
		Less than 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (eg buildings that are under a preservation order)	3	3 to 8	8 to 10	8

3.4.2.2 Human comfort

The assessment of intermittent vibration outlined in the NSW EPA guideline Assessing Vibration: A Technical Guideline is based on Vibration Dose Values (VDVs). The VDV accumulates the vibration energy received over the daytime and night-time periods.

Maximum and preferred VDVs for intermittent vibration arising from construction activities are listed in Table 17. The VDV criteria are based on the likelihood that a person would be annoyed by the level of vibration over the entire assessment period.

Table 17 Preferred and maximum vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime (7 am – 10 pm)		Night-time (10 pm – 7 am)	
	Preferred	Max	Preferred	Max
Critical areas	0.1	0.2	0.1	0.2
Residences	0.2	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.4	0.8	0.4	0.8
Workshops	0.8	1.6	0.8	1.6

4.0 Operational Noise Assessment

4.1 Noise emission assessment

4.1.1 Noise sources – Mechanical services

Based on the mechanical design documentation available at the time of preparing this report, the proposed BSCH will have major mechanical plant rooms with equipment which service the development located at the following locations.

Northern block - Lower ground floor

- Plant room 1: Eight (8) air handling units (AHUs)
- Plant room 2: Six (6) AHUs

Northern block - Lower ground floor under Maternity ward

- Chiller plant room
- Space heating & domestic hot water plant room
- Medical gas plant room

Northern block – Rooftop above Maternity ward

- Cooling tower compound: Three (3) cooling towers and process cooling equipment

Centre block - Ground floor

- Plant room 3: Four (4) AHUs

It has been determined through review of the equipment composition and their sound power levels, that the hot water plant room and chiller plant room will not have any noise impact on external receivers as these are located in the lower ground level of the buildings. Hence only noise impact assessments of the air handling unit plant rooms and the cooling tower compound are deemed to be necessary. Noise levels for the equipment within the air handling unit plant rooms, chiller plant room, and the cooling tower compound are shown below in Table 18. Sound power levels of equipment will be obtained from manufacturer specifications.

Table 18 Major noise sources of mechanical services

Label	Sound Power Levels								
	63 Hz	125 Hz	250 Hz	500 Hz	1kHz	2kHz	4kHz	8kHz	dB(A)
Plant room 1									
AHU-IPU-L01-IZ-01	61	70	75	77	84	81	77	70	87
AHU-IPU-L01-EZ-01	61	70	75	77	84	81	77	70	87
AHU-BOH-L00-NZ-01	-	83	87	88	84	80	76	71	89
AHU-IPU-L01-IZ-02	63	71	75	78	86	83	79	71	89
AHU-IPU-L01-SZ-01	-	83	87	88	84	80	76	71	89
AHU-IPU-L01-NZ-01	-	85	85	88	84	74	66	57	88
AHU-IPU-L01-NZ-02	-	85	85	88	84	74	66	57	88
AHU-IPU-L01-SZ-02	-	85	85	88	84	74	66	57	88
AHU-ED-L01-NZ-01	61	70	75	77	84	81	77	70	87
AHU-ED-L01-NZ-02	61	70	75	77	84	81	77	70	87
AHU-ED-L01-IZ-01	61	70	75	77	84	81	77	70	87
Plant room 2									
AHU-BOH-L00-SZ-01	61	70	75	77	84	81	77	70	87
AHU-ED-L01-IZ-02	61	70	75	77	84	81	77	70	87
AHU-ED-L01-IZ-03	61	70	75	77	84	81	77	70	87
AHU-BOH-L00-IZ-01	61	70	75	77	84	81	77	70	87
AHU-ED-L01-SZ-01	61	70	75	77	84	81	77	70	87
AHU-BOH-L00-SZ-02	61	70	75	77	84	81	77	70	87
Plant room 3									
AHU-AMB-L01-IZ-01	61	70	75	77	84	81	77	70	87
AHU-AMB-L01-IZ-02	61	70	75	77	84	81	77	70	87
AHU-AMB-L01-IZ-03	61	70	75	77	84	81	77	70	87
AHU-AMB-L01-NZ-01	61	70	75	77	84	81	77	70	87
AHU-AMB-L01-NZ-02	61	70	75	77	84	81	77	70	87
AHU-AMB-L01-SZ-01	61	70	75	77	84	81	77	70	87
Chiller plant room									
Chiller 1	77	77	79	80	84	80	73	77	87
Chiller 2	77	77	79	80	84	80	73	77	87
Chiller 3	77	77	79	80	84	80	73	77	87
Cooling tower compound									
CT 1	97	95	92	90	86	85	81	78	93
CT 2	97	95	92	90	86	85	81	78	93
CT 3	97	95	92	90	86	85	81	78	93

4.1.2 Normal operation

While the BSCH is in its normal operation, the air-handling plants and cooling towers will be operating. AECOM anticipates that noise generated by other minor plant in addition to the above will not contribute further to the noise emission.

As all of the louvre openings for the three plant rooms are either shielded by the retaining walls or the hospital building, noise emission impacts from the AHU plant rooms and chiller plants to the nearby residences on Parkway Drive will be minimal. However, the cooling tower compound on the rooftop of the maternity ward is exposed and will be the dominant noise contributor at the residences.

Based on the distance of 130 m between the cooling tower compound and the nearest residential receiver, the resultant noise level at the NSR will be 47 dB(A) and does not comply with the INP noise criteria presented in section 3.3.1. AECOM advises that by introducing a solid noise barrier which extends 400 mm above the top of the cooling towers on the southern side of the cooling tower compound, the resultant noise level at the NSR can be reduced to 38 dB(A) and comply with the relevant environmental noise emission criteria. It should be noted that this assumes all plant is operating at 100% capacity, which is unlikely during the night-time period, therefore this assessment is considered conservative. An alternate option may be to select “quieter” cooling towers with operation noise levels lesser than the specified ones in Table 18. Alternate cooling tower selections shall be reviewed and approved by an acoustic consultant to ensure compliance with the relevant INP noise criteria.

Although not necessary for the noise emission impact at the residences, noise breakout from the plant rooms will need to be controlled to minimise negative impact within adjacent spaces of the hospital. Plant room noise breakout treatment includes the use of acoustic louvres, plant room internal wall absorptive linings, and typical treatment to discharges such as duct lining and/or attenuators which will be incorporated during the detailed design phase of the project if required.

AECOM recommends that the final detailed designs for all mechanical equipment be assessed and approved by a suitably qualified acoustic consultant at the detailed design phase of the project.

It can be seen that noise emissions associated with the operation of the proposed BSCH is likely to comply with the established INP operational criteria.

4.1.3 Standby generator operation

In order to maintain the minimum necessary hospital operations during power outage, it is understood that a standby generator will be installed on site. A 400 kVA standby generator is proposed to be located at the northern end of the staff car park on the east side of the development site about 45 m set back from Ewingsdale Road.

The proposed standby generator is a Kohler KV440C2 model Three-phase Generator Set with acoustic enclosure and has a manufacturer specified sound power of 96 dB(A). Based on a distance separation of approximately 130 m between the proposed standby generator and the boundary of the nearest residential receiver, the resultant noise level at the nearest residential boundary from the operation of the standby generator will be approximately 43 dB(A) and complies with the operational noise limits for emergency operations in Table 11.

4.1.4 Sleep disturbance assessment

The night-time noise emissions from the mechanical services plant servicing the proposed BSCH would generally be associated with relatively constant activities. Therefore no significant peak noise events would be expected.

The separation between the site and the nearest receivers means that the maximum external noise levels due to the night-time operations of the proposed BSCH are likely to comply at all assessment locations during the night-time period.

4.1.5 Traffic noise generation assessment

Based on information provided in the Traffic study by Taylor Thomson Whitting (TTW) for the proposed BSCH development, AECOM understands that an anticipated additional 120 vehicle trips will be generated during the peak hour. Previous traffic count information indicated that the average daily traffic (ADT) is 16,480 (2012 data) and 16,159 (2010 data) per day, and the peak hour traffic flow on Ewingsdale Road is approximately 1,330 (11am-12noon, 2010 data) vehicles per hour.

The 120 vehicle trips increase due to the proposed development represents a 9% increase in the total traffic movements. This will result in an insignificant increase in road traffic noise and is not expected to adversely impact the acoustic amenity of nearby residential premises and would comply with RNP requirements.

4.1.6 Car park associated noise emission

AECOM has undertaken calculations of the likely noise level at the nearest residential receiver resulting from activities associated with the use of the car park at BSCH. Typical car park associated activities include car accelerating, engine starts, car door closing and patrons talking. Calculations indicate that the worst case scenario resultant noise level at the rear boundary of nearest residential receiver on Parkway Drive from simultaneous activities is approximately 43 dB(A) during the peak hour. AECOM advises that this noise level complies with the daytime and evening criteria. It is likely that car movements will be at least 50% lower during the night-time period and therefore the likely noise level from car parking activities will be up to 40 dB(A). The calculations have been based on the nearest car park which is the 30 staff car parking on the southern end of the site. The majority of the car parks are located further away from the nearest residential receiver. Therefore this assessment is considered conservative, however it is recommended that following good practices are implemented:

1) Introduction of low speed limit for traffic within the car park;
2) Management of the car parking locations such that the parking bays furthest away from the nearest residential receivers are filled first before occupying the parking bays closest to the residences; and
3) Installation of signage around the car park which promotes “minimising noise and respecting the amenities of neighbours”, “no car door slamming”, etc.

4.2 Traffic noise intrusion

In order to meet the requirements of the SEPP(Infrastructure), detailed in Section 3.1, architectural façade recommendations have been provided below.

Based on the unattended and attended noise measurements results, the northern façade facing Ewingsdale Road will be the most critical façade, particularly for the bedrooms in the In-Patient Unit (IPU). Therefore, the northern façade of the building fronting Ewingsdale Road shall have a minimum R_w (weighted sound reduction index) of 35. For external glazing, a single layer of 10.38 mm laminated glass will provide the R_w 35 rating required. Standard glazing construction will be sufficient for all other facades.

The roof and ceiling construction will also be required to be complementary of the acoustic performance of the façade to ensure the acoustic integrity of the overall building envelope system.

5.0 Construction noise and vibration assessment

As a detailed construction plan has not yet been completed at this date, the construction noise and vibration assessment has been based on a typical equipment list and phases. The results provided within this assessment are intended to be preliminary, the future contractor involved with construction of this development should provide a more detailed assessment in the form of a Construction Noise and Vibration Management Plan (CNVMP).

5.1 Construction phases

In consultation with the structural engineer, three distinct stages of construction have been assumed to occur for the construction of this this development. These stages are defined as follows:

1) Excavation and earthworks
2) Road works
3) Construction

The equipment list for these three stages is shown in Table 19.

Construction is assumed to be undertaken during recommended standard hours on week days only. As such the impacts of construction activities on sleep disturbance have not been assessed.

5.2 Construction noise assessment

5.2.1 Construction noise sources

Noise sources and their respective sound power levels for each phase of construction are shown in Table 19. Sound power levels were obtained from AECOM's data base and published datasets by the UK Department for Environmental, Food and Rural Affairs (DEFRA).

Table 19 Construction staging and equipment sound power levels

Item no.	Construction Activities	Equipment	Sound Power Level, dB(A)
1	Excavation and earthworks	Compactor	104
		Crane	105
		Dump truck	95
		Flatbed truck w crane	98
		Grader	109
		Light delivery vehicle	90
		Low-bed truck	98
		Material Delivery Truck	98
		Water Cart	100
		Roller	109
		Scraper	112
2	Road works – New car park	Asphalt Paver	106
		Asphalt Spreader	98
		Compressor	109
		Dozer	109
		Road Planar	110
		Trucks	98
		Vibratory roller	109
		Wheeled Excavator	99
3	Construction	Concrete Mixer	93
		Concrete Pump	106
		Concrete Truck	106
		Electric Hand Tools	108
		Excavator 40t	98
		Generator	101
		Material Delivery Truck	90
		Mobile Crane	104
		Mobile Electric Welding Set	101

5.2.2 Modelling and conditions

Modelling of the construction stages have been performed using SoundPLAN 7.3. Neutral weather conditions were applied. The SoundPLAN General Prediction Method noise propagation algorithms have been used to calculate the predicted noise levels at the receivers. This algorithm was chosen due to most of the receivers being within a distance of 100 metres to the source and this algorithm being accepted in the industry as being most appropriate under these circumstances. The model takes into account building structures, ground terrain, ground absorption, air absorption, and the distances between sources and receivers.

It can be expected that there may be differences between predicted and measured noise levels due to variations in instantaneous operating conditions, plant in operation during the measurement and also the location of the plant equipment. The acoustic shielding calculated in the model due to fixed building structures will also vary as the construction equipment moves around the site.

Figure 3 Construction noise modelling map

5.2.3 Results

The results for the construction noise assessment are shown below in Table 20. Where construction noise levels exceed the construction noise management levels they are shown as bold text. Construction noise contours are also presented in Appendix C.

Table 20 Construction noise assessment results

Receiver	Type	NML, $L_{Aeq,15min}$ dB(A)	Predicted noise level, $L_{Aeq,15min}$ dB(A)		
			Earthworks	Road works	Construction
11 Ewingsdale Rd	Commercial	75	60	60	50
16 Ewingsdale Rd	Commercial	75	61	61	56
30 Parkway Drive	Residential	51	**61**	**61**	**56**
40 Parkway Drive	Residential	51	**68**	**68**	**61**
42 Parkway Drive	Residential	51	**69**	**69**	**62**
48 Parkway Drive	Residential	51	**70**	**70**	**63**
50 Parkway Drive	Residential	51	**68**	**68**	**63**
58 Parkway Drive	Residential	51	**62**	**61**	**59**
60 Parkway Drive	Residential	51	**58**	**58**	**55**
66 Parkway Drive	Residential	51	**55**	**55**	**52**

The results show that exceedances of varying magnitude are expected at all residential receivers during all construction stages. Construction noise levels are less than the 'highly noise affected' level of 75 dB(A) at all receivers. Predicted noise levels will comply with the construction noise levels at all commercial receivers.

It should be noted that the results above represent the worst case 15 minute period noise, which assumes all equipment operating at the worst-case location within the development site. Although this is possible, it is unlikely to happen for significant periods of time as construction equipment is generally scattered and construction methodologies involving the equipment are generally sequential. In addition, as the construction scenario evolves the structures on the site will provide shielding for construction equipment. However, the available construction information is not currently detailed enough to allow accurate modelling of this.

When construction staging and methodologies are further developed it is recommended that the Building Contractor determine and adopt all feasible and reasonable mitigation measures to reduce noise and vibration impacts and handle residents' complaints in an efficient and effective manner. Indicative mitigation measures, based on preliminary construction staging and methodologies, have been detailed in section 5.5.

5.3 Construction traffic noise assessment

Based on information provided in the traffic study by TTW, the amount of traffic generated by the construction of the BSCH is anticipated to be approximately 30 vehicular trips during each AM and PM peak period. The existing daytime peak hours traffic and the predicted traffic number with additional construction traffic on Ewingsdale Road are presented in Table 21. The figures indicate that the traffic increase due to construction works will be minimal. Only day time volumes have been presented as there are no works proposed outside of standard construction hours.

It is recommended that heavy vehicles use an entry/exit point located on Ewingsdale Road as the main route in and out of the site. Main corridors should be used where available. Additional mitigation measures are provided in section 5.5.

Table 21 Construction traffic assessment

Peak hours during daytime	Existing day traffic (September 2010 data)	Predicted traffic from additional construction traffic	Increase in traffic noise, dB(A)
AM peak (8am – 9am)	1,110 vehicles	1,140 vehicles	0.1
PM peak (4pm – 5pm)	1,289 vehicles	1,319 vehicles	0.1

5.4 Construction vibration assessment

Vibration intensive works are proposed to occur as part of the construction of the BSCH. The works may include the use of vibratory rollers. Typical safe working distances for different ratings of vibratory rollers are provided below in Table 22. These safe working distances are based upon the criteria presented in section 3.4.2.

Maps showing the distances of houses away from the alignments are provided within Appendix D. The maps have been provided to indicate where vibration intensive works are likely to result in compliance with the appropriate criteria at receiver locations. The maps are intended to be used as a tool to assist construction planning. Where elevated vibration levels may occur at a building, alternative methods of construction should be used.

Table 22 Recommended safe working distances for vibration intensive plant

Plant	Rating/Description	Minimum Safe Working Distance (m)		
		Cosmetic Damage		Human Response
		Residential	Industrial	
Vibratory roller	< 50 kN (Typically 1-2t)	5	2	15-20
	< 100 kN (Typically 2-4t)	6	2	20
	< 200 kN (Typically 4-6t)	12	4	40
	< 300 kN (Typically 7-13t)	15	5	100
	> 300 kN (Typically 13-18t)	20	6	100
	> 300 kN (> 18 t)	25	8	100

For this development, the nearest residential receiver is located 37 m away. This setback could be within the buffer distances for human comfort for vibratory rollers, depending on the rating of the vibratory roller.

Appendix C should be used to manage and avoid any adverse impacts which may occur due to the use of vibratory equipment.

5.5 Mitigation measures

To reduce the number of exceedances of the noise and vibration management levels and to manage the impact of noise and vibration on the sensitive receivers it is recommended that a CNVMP is developed.

5.5.1 Construction noise and vibration management plan

The Construction Noise and Vibration Management Plan (CNVMP) would include the following:

- Identification of nearby residences and other sensitive land uses.
- Description of approved hours of work.
- Description and identification of all construction activities, including work areas, equipment and duration.
- Description of what work practices (generic and specific) would be applied to minimise noise and vibration.
- A complaints handling process.
- Noise and vibration monitoring procedures.
- Overview of community consultation required for identified high impact works.

5.5.2 Community consultation and complaints handling

All residents impacted by noise from the proposed works which are expected to exceed the construction noise management levels (NML) or have their vibration buffer zones encroached should be consulted about the project prior to the commencement of the particular activity, with the highest consideration given to those that are predicted to be most affected as a result of the works.

The information provided to the residents should include:

- Programmed times and locations of construction work.
- The hours of proposed works.
- Construction noise and vibration impact predictions.
- Construction noise and vibration mitigation measures being implemented on site.

Community consultation regarding construction noise and vibration would be detailed in the Community Involvement Plan for the construction of the project and would include a 24 hour hotline and complaints management process.

5.5.3 Work practices

Induction and training would be provided to relevant staff and sub-contractors outlining their responsibilities with regard to noise.

5.5.4 Construction hours and work scheduling

Details of any necessary out-of-hours work required would form part of the Construction Noise and Vibration Management Plan.

Noisy work would be scheduled to be undertaken during the standard hours as far as possible. Noisy activities that cannot be undertaken during standard construction hours are to be scheduled as early as possible during the evening and / or night-time periods.

Particularly noisy activities such as the use of scraping, asphalt grading or vibratory rolling should be scheduled where feasible and reasonable around times of high background noise to provide masking.

Deliveries would be carried out during standard construction hours only where feasible and reasonable.

5.5.5 Plant and equipment selection and location

The selection of plant and equipment can have a significant impact on construction noise levels. Appropriate plant would be selected for each task to minimise the noise contributions.

Alternative works methods such as use of hydraulic or electric-controlled units in place of diesel units would be considered and implemented where feasible and reasonable. The use of alternative machines that perform the same function (such as rubber wheeler plant) would be considered in place of steel tracked plant.

Equipment would be regularly inspected and maintained to ensure it is in good working order.

Plant should be located on site with as much distance as possible between the plant and noise sensitive receivers. Noisy equipment would be orientated away from residential receivers where feasible and reasonable. The use of barriers would be considered to shield noisy plant from potentially noise affected neighbours.

5.5.6 Construction traffic

The site car parking would be located with maximum offset from sensitive receivers. Truck drivers would be advised of designated vehicle routes, parking locations, acceptable delivery hours or other relevant practices (ie minimising the use of engine brakes, and no extended periods of engine idling). Site access and egress points would be located away from residences and other sensitive land uses, where feasible and reasonable. Construction sites would be arranged to limit the need for reversing associated with regular / repeatable movements (eg trucks transporting spoil) to minimise the use of reversing alarms. Where feasible and reasonable, non-tonal reversing alarms would be used, taking into account the requirements of the Workplace Health and Safety legislation.

5.5.7 Vibration management

The works will have to be carefully managed to mitigate the effects of vibration. For vibration intensive activities that occur within the buffer zones, management methods to mitigate the impacts would include the use of less noise and vibration intensive equipment and respite periods.

5.5.8 Noise and vibration monitoring

Noise monitoring program would be implemented to assist in confirming and controlling the site specific potential for disturbance at particularly sensitive localities at the commencement of activities and periodically during the construction program as the works progress. The results would be reviewed to determine if additional mitigation measures are required. All measurements would be undertaken in accordance with Australian Standard 1055.1-1997 – Acoustics – Description and measurement of environmental noise, Part 1: General procedures.

A noise monitoring program would be presented in the Construction Noise and Vibration Management Plan.

6.0 Conclusion

This report presents the results of an environmental noise and vibration impact assessment of the proposed Byron Shire Central Hospital development located at 54 Ewingsdale Road, Ewingsdale, NSW.

Noise emission from the proposed development has been assessed. The environmental noise emission for the development is based upon the requirements of the SEARs, EPA, and the measured ambient noise levels at the site.

This acoustic assessment indicates that standard noise amelioration strategies will sufficiently treat noise emission to minimise possible acoustic impacts on neighbouring areas.

Predicted traffic noise increases generally comply with the applicable criteria outlined by the Road Noise Policy.

Environmental noise emission from the site can be controlled at all neighbouring residential premises by standard noise control techniques.

The recommended glazing system will adequately attenuate road traffic noise levels to meet the internal noise criteria detailed in SEPP (Infrastructure) 2007.

Based upon the assessment documentation there are no undue acoustic impacts and applicable criteria will be complied with at the nearest sensitive receivers.

The impact of construction noise and vibration has been assessed. It is likely that construction noise management levels will be exceeded at times and to address this issue, preliminary feasible and reasonable mitigation measures have been presented. Mitigation measures should be reviewed and refined at the detailed design and construction certificate stage.

Appendix A

Acoustic Terminology

Appendix A Acoustic Terminology

The following is a brief description of acoustic terminology used in this report.

Sound power level	The total sound emitted by a source
Sound pressure level	The amount of sound at a specified point
Decibel [dB]	The measurement unit of sound
A Weighted decibels [dB(A)]	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows:
	0dB(A) Threshold of human hearing
	30dB(A) A quiet country park
	40dB(A) Whisper in a library
	50dB(A) Open office space
	70dB(A) Inside a car on a freeway
	80dB(A) Outboard motor
	90dB(A) Heavy truck pass-by
	100dB(A) Jackhammer/Subway train
	110 dB(A) Rock Concert
	115dB(A) Limit of sound permitted in industry
	120dB(A) 747 take off at 250 metres
Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Equivalent continuous sound level [L_{eq}]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
L_{max}	The maximum sound pressure level measured over the measurement period
L_{min}	The minimum sound pressure level measured over the measurement period
L_{10}	The sound pressure level exceeded for 10% of the measurement period. For 10% of the measurement period it was louder than the L10.
L_{90}	The sound pressure level exceeded for 90% of the measurement period. For 90% of the measurement period it was louder than the L90.

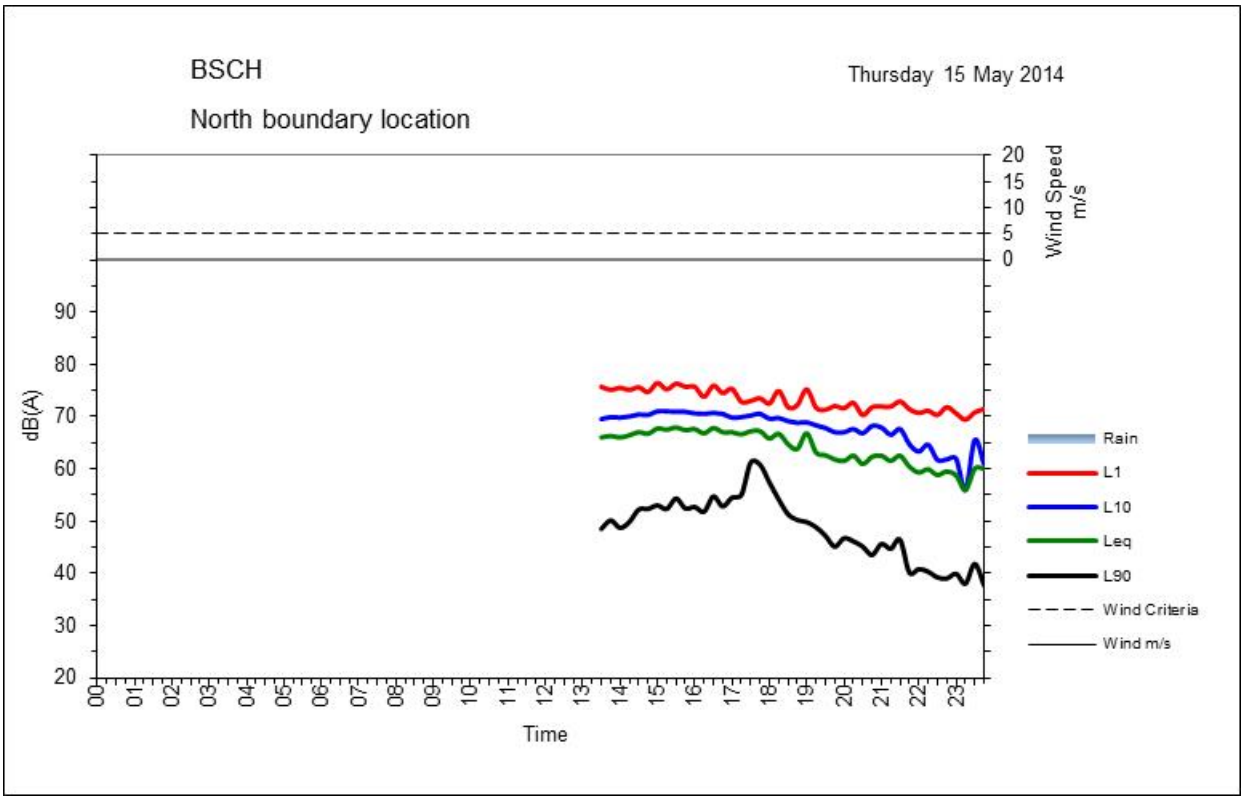
Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.
Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L90 sound pressure level is used to quantify background noise.
Traffic noise	The total noise resulting from road traffic. The Leq sound pressure level is used to quantify traffic noise.
Day	The period from 0700 to 1800 h Monday to Saturday and 0800 to 1800 h Sundays and Public Holidays.
Evening	The period from 1800 to 2200 h Monday to Sunday and Public Holidays.
Night	The period from 2200 to 0700 h Monday to Saturday and 2200 to 0800 h Sundays and Public Holidays.
Assessment background level [ABL]	The overall background level for each day, evening and night period for each day of the noise monitoring.
Rating background level [RBL]	The overall background level for each day, evening and night period for the entire length of noise monitoring.

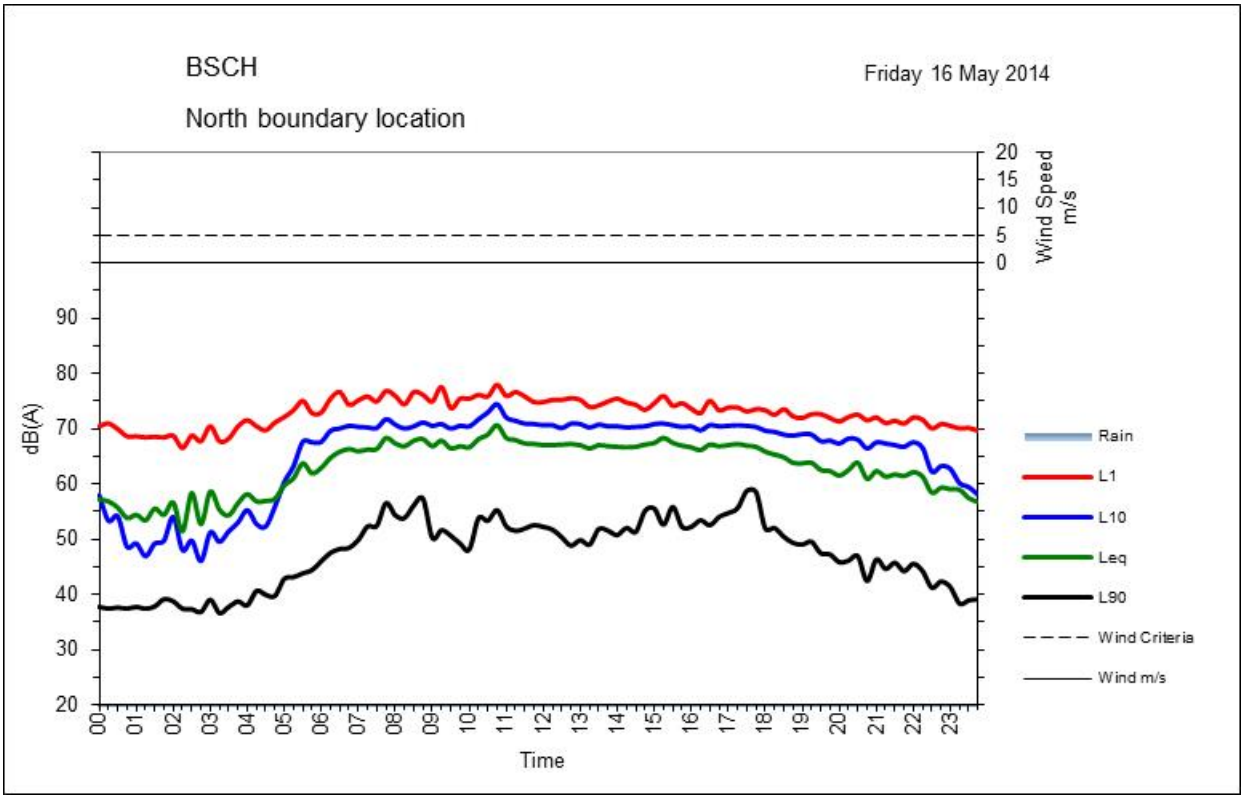
*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 “Acoustics – Glossary of terms and related symbols”, the EPA’s NSW Industrial Noise Policy and Road Noise Policy.

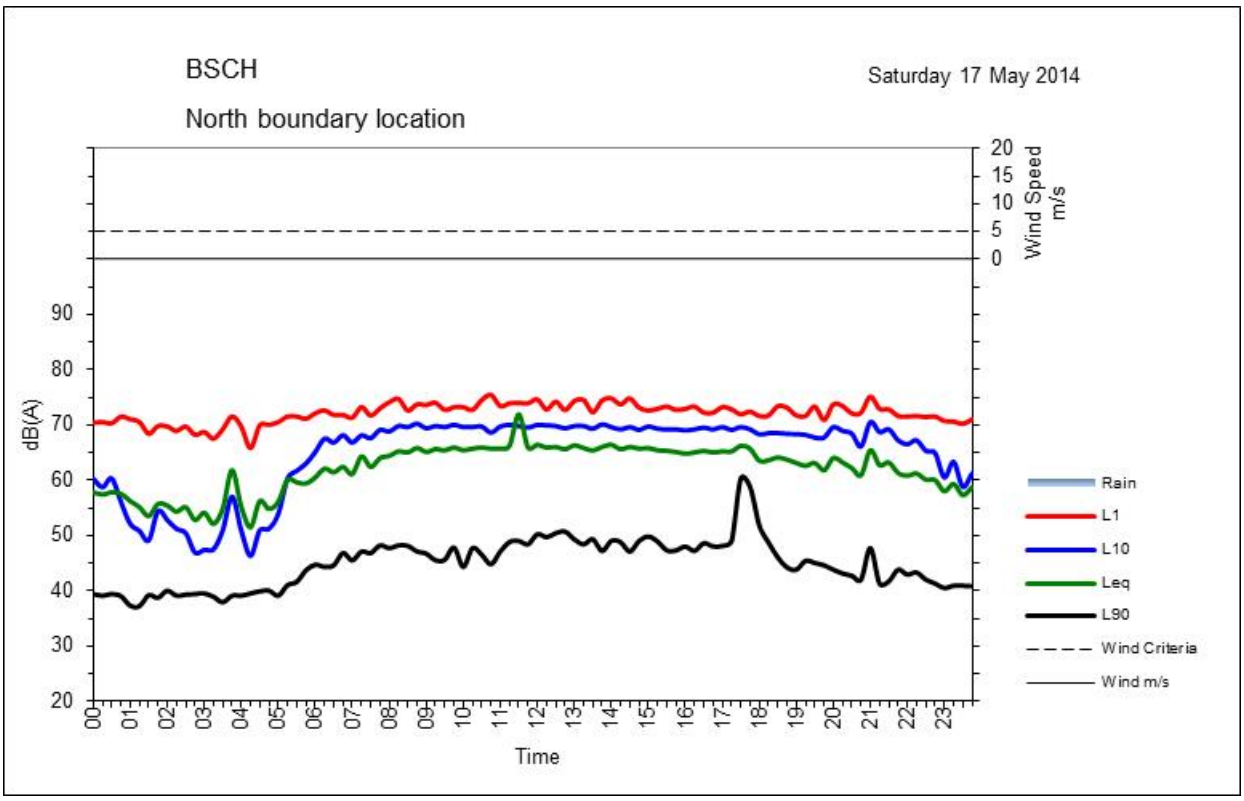
Appendix B

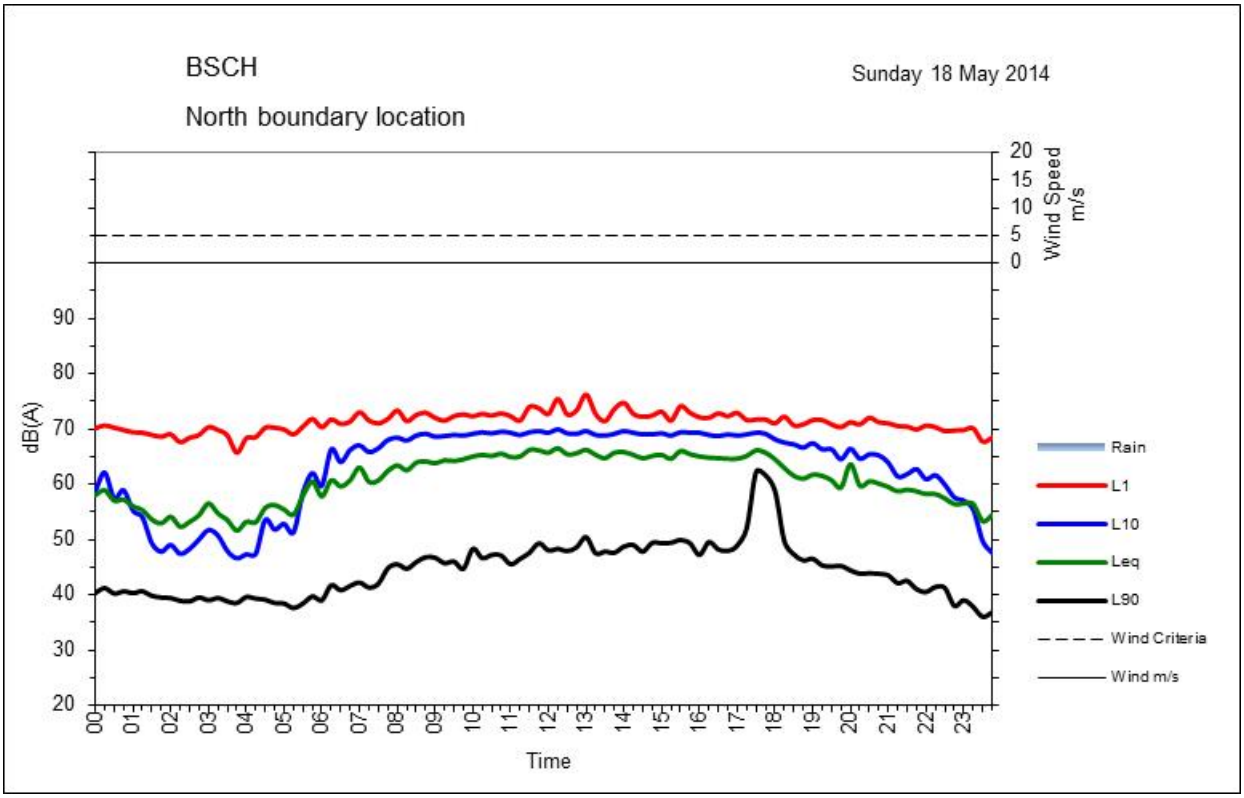
Ambient noise monitoring graphs

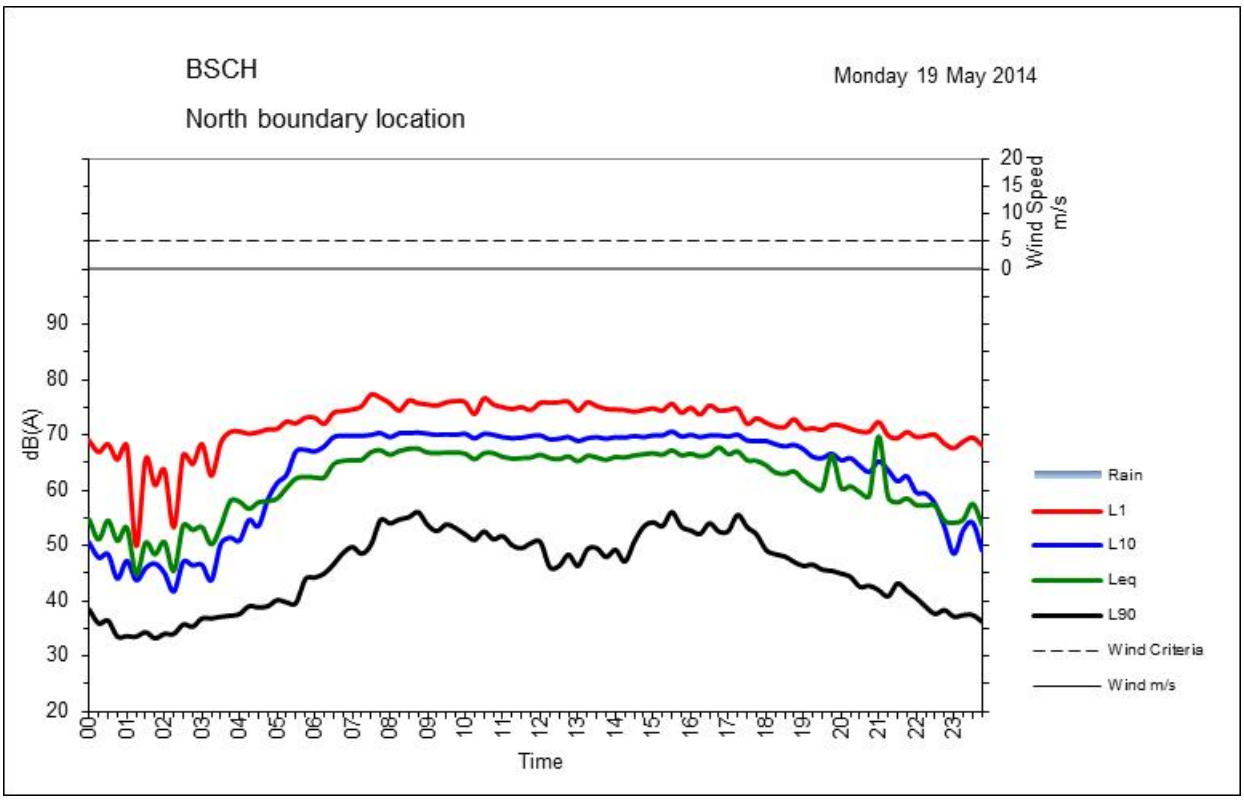
Appendix B Ambient noise monitoring graphs

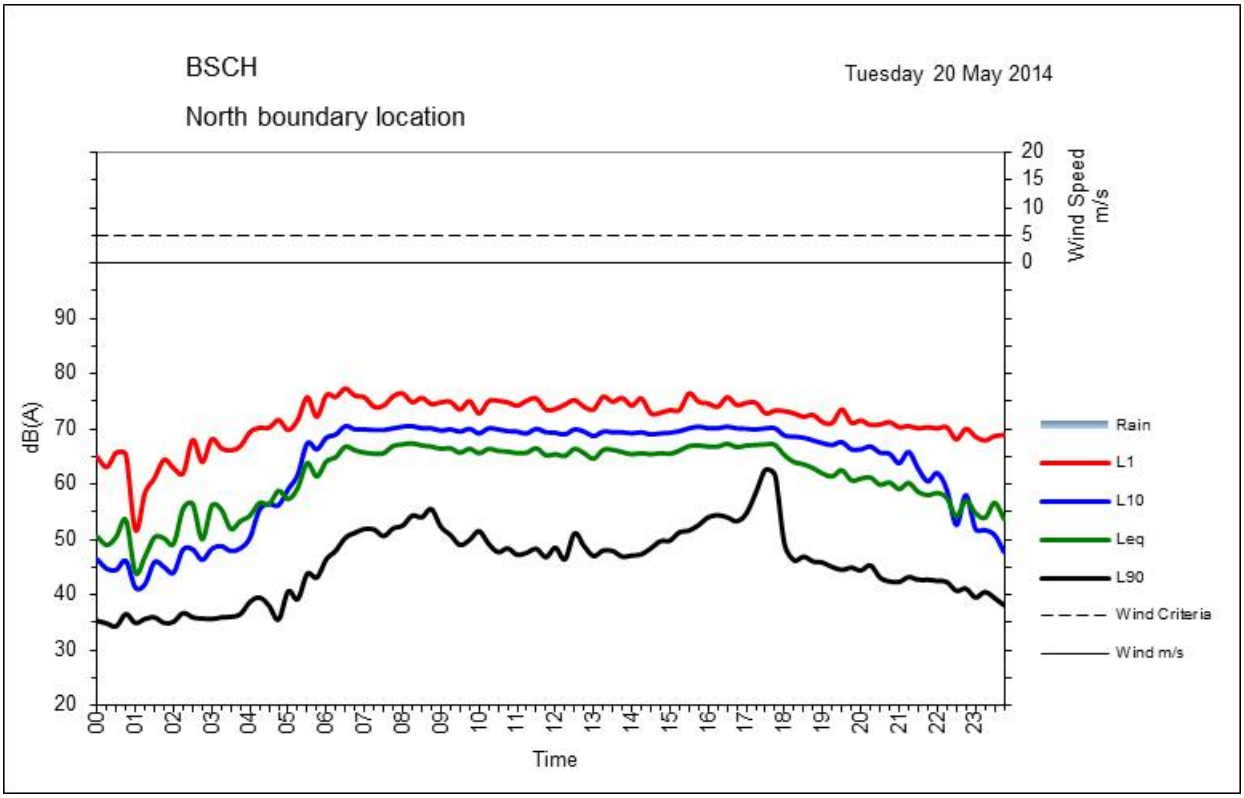


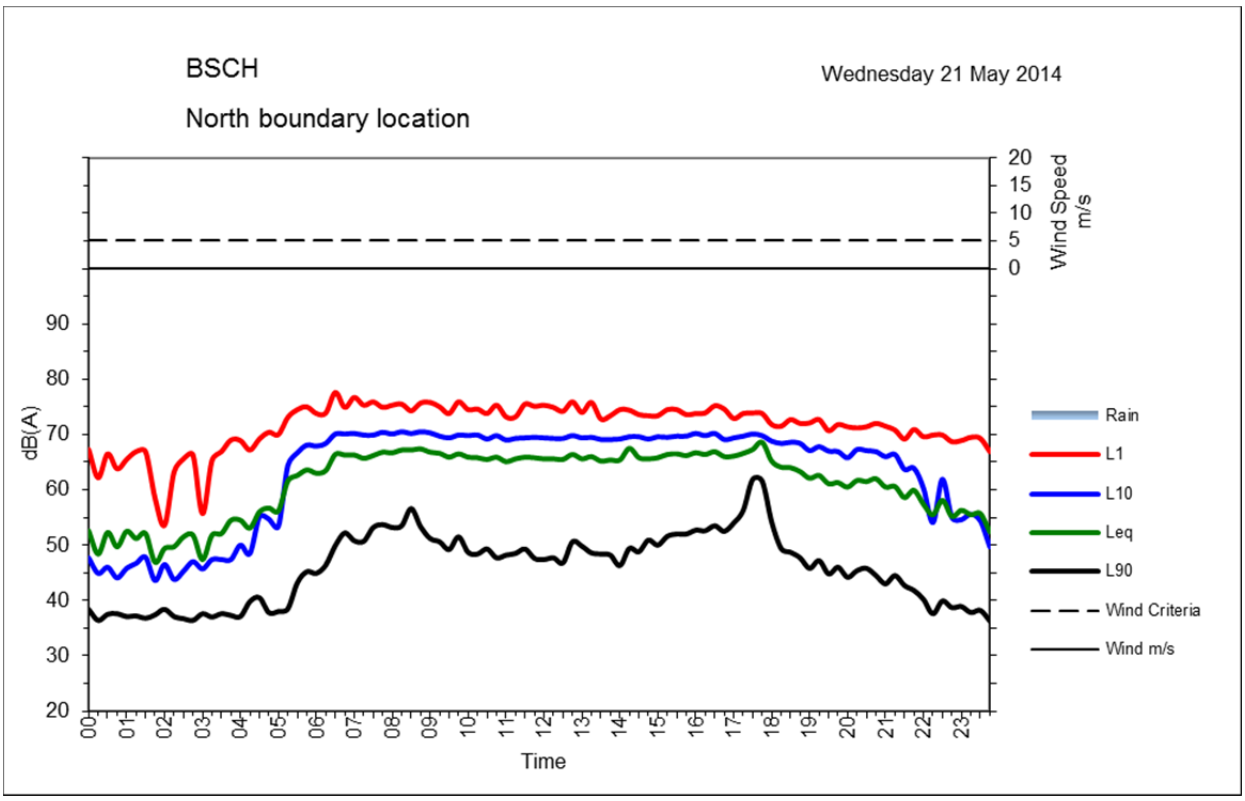


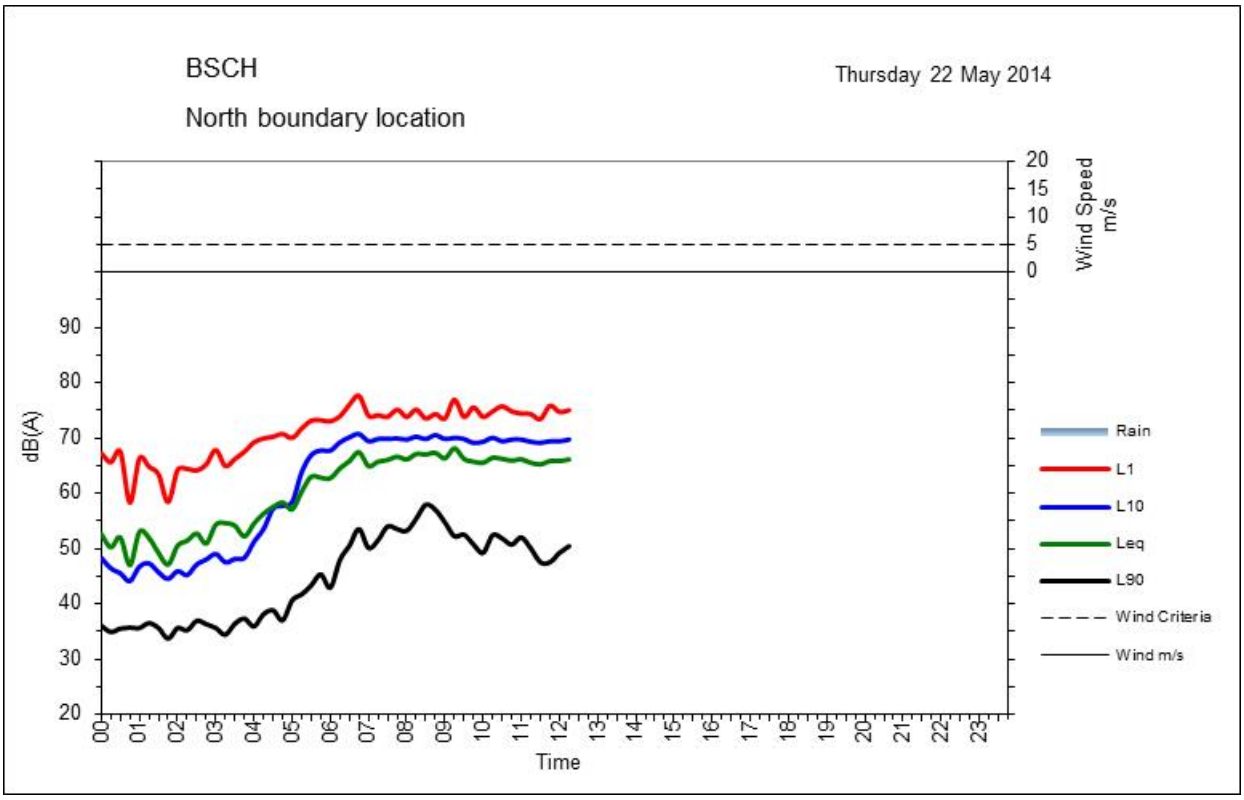

BSCH
Saturday 17 May 2014
North boundary location
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

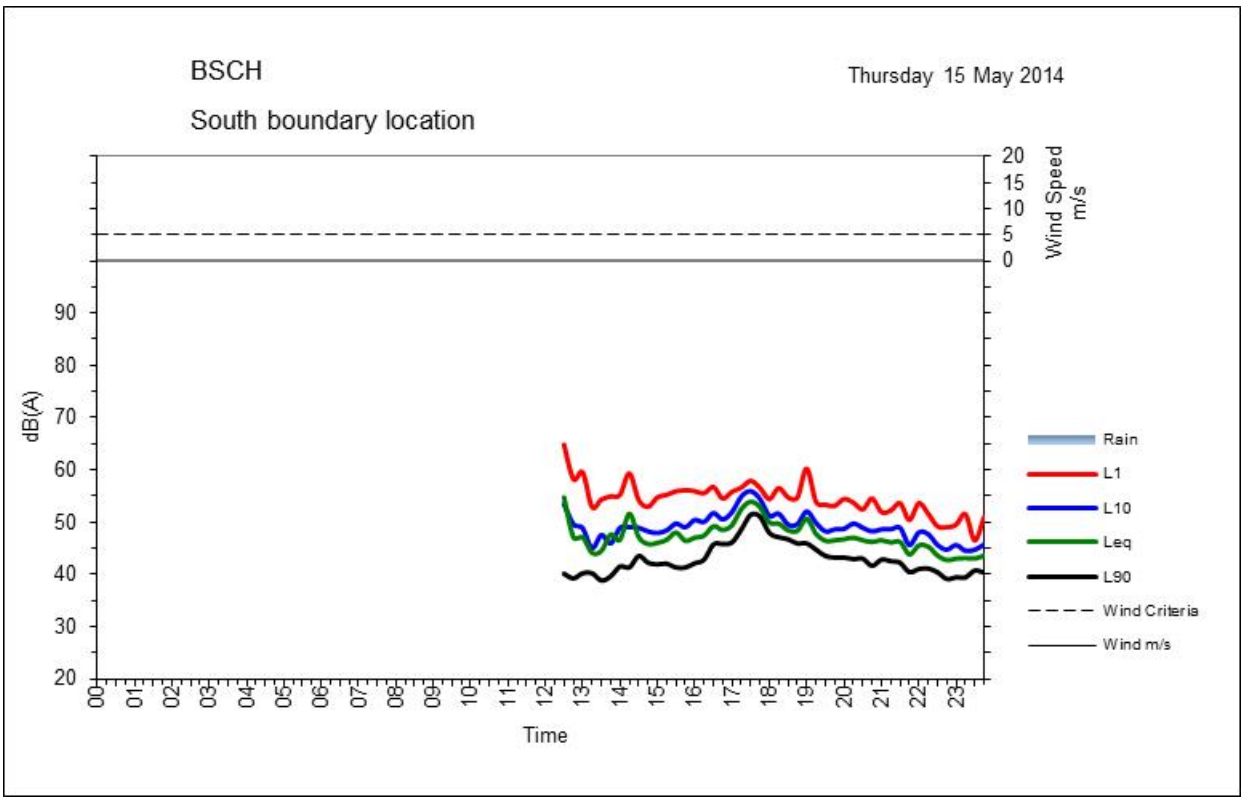

BSCH
Sunday 18 May 2014
North boundary location
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

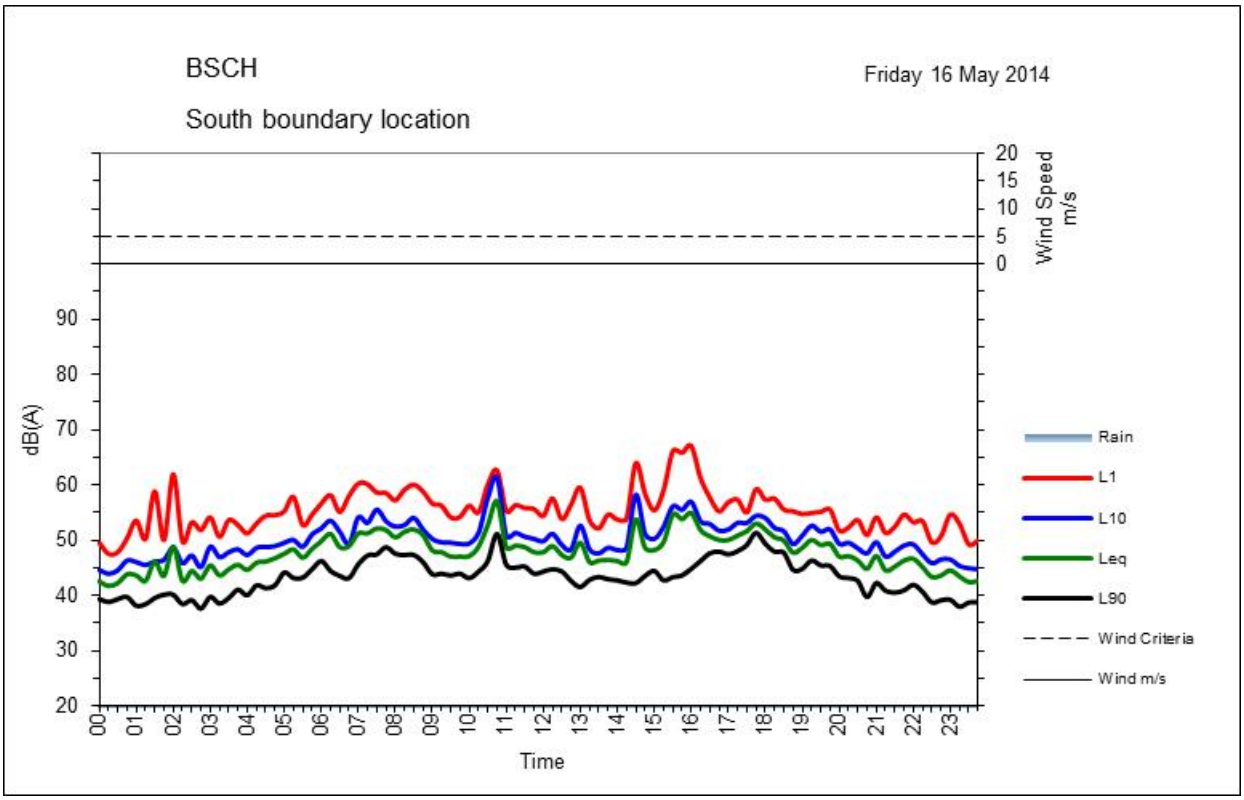

BSCH
Monday 19 May 2014
North boundary location
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

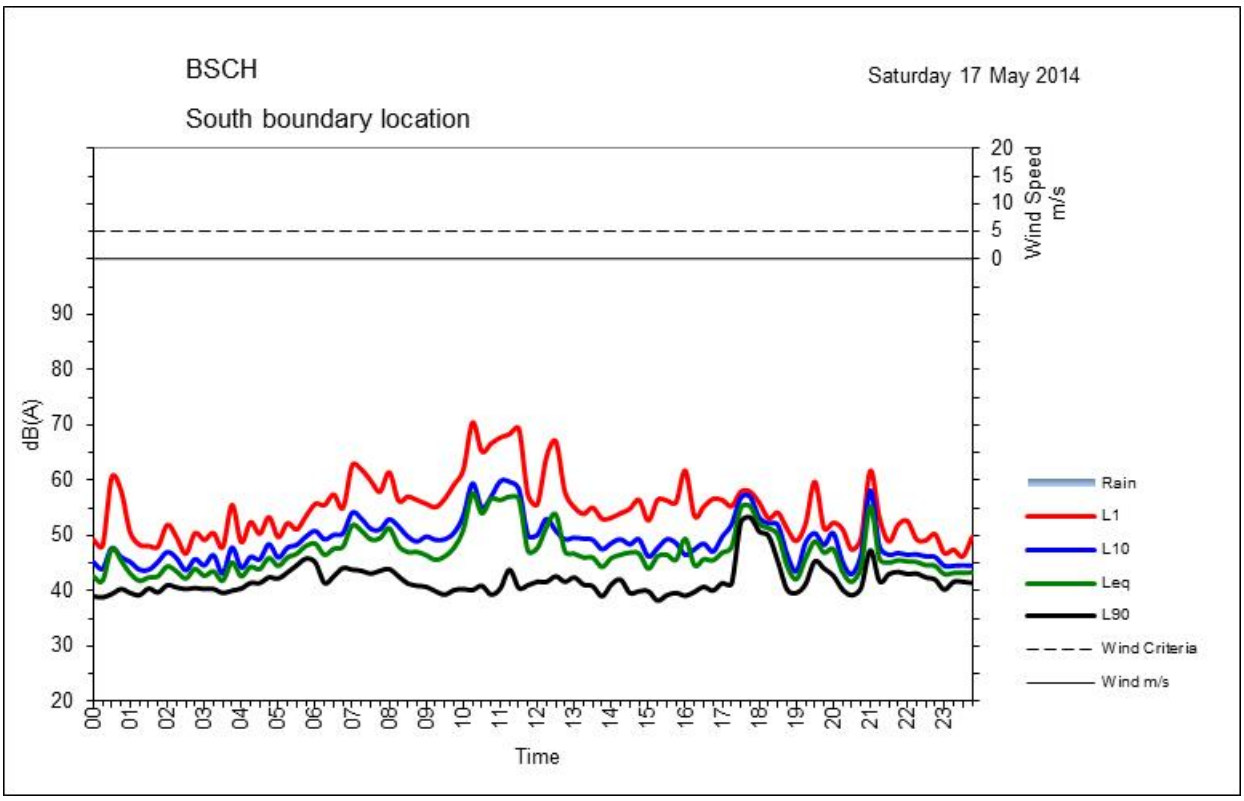

BSCH
Tuesday 20 May 2014
North boundary location
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

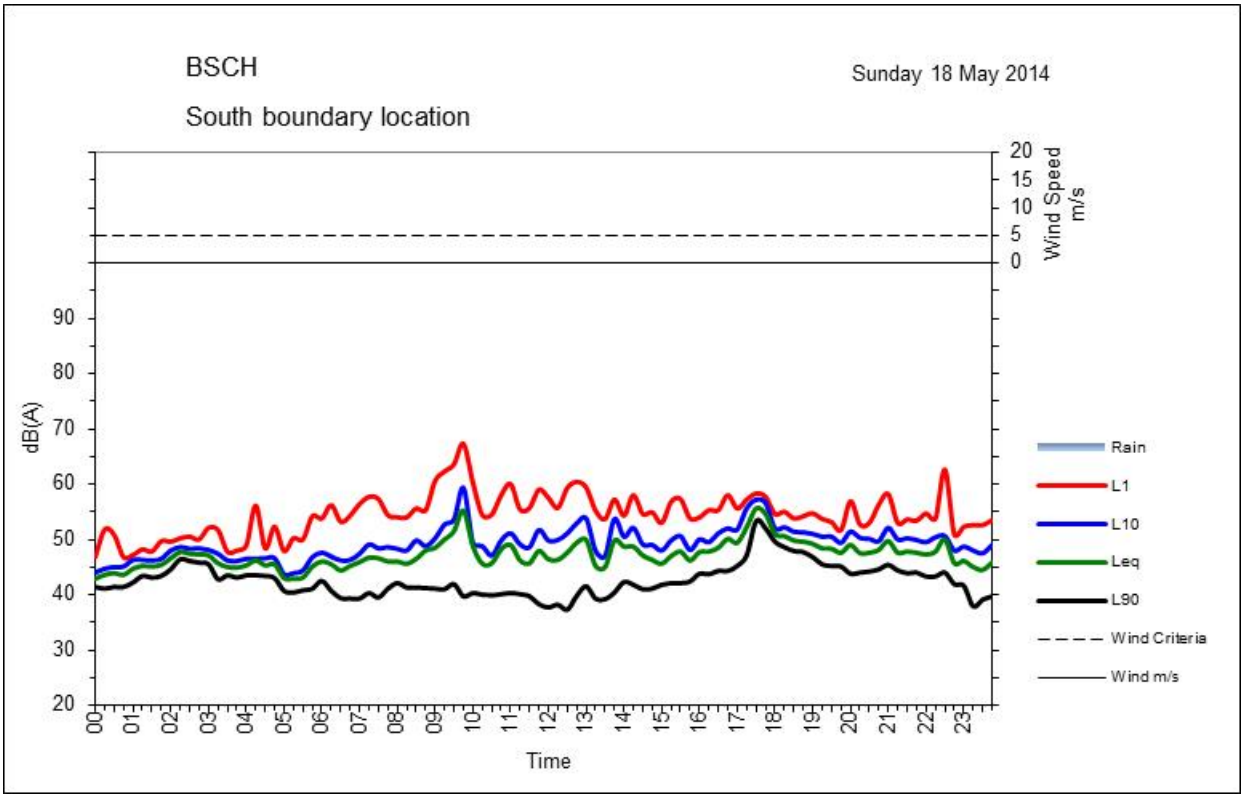

BSCH
Wednesday 21 May 2014
North boundary location
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

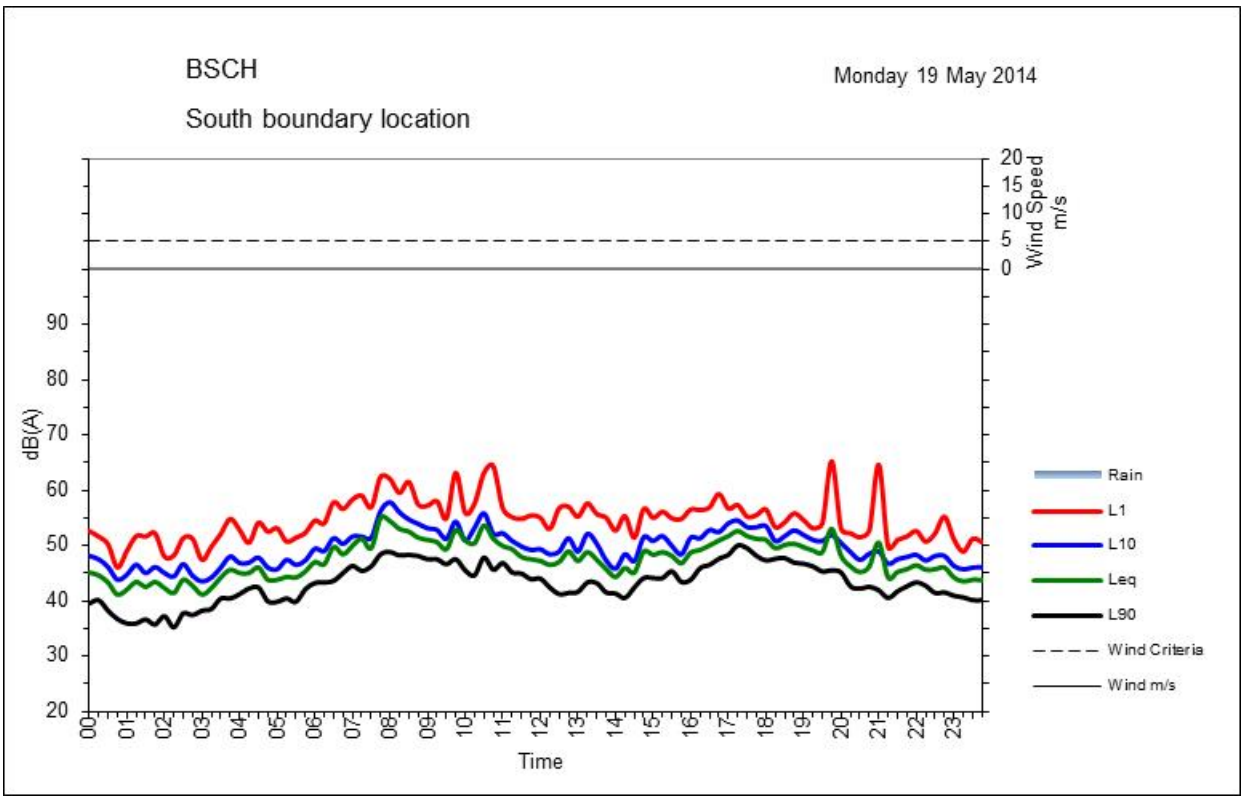

BSCH
Thursday 22 May 2014
North boundary location
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

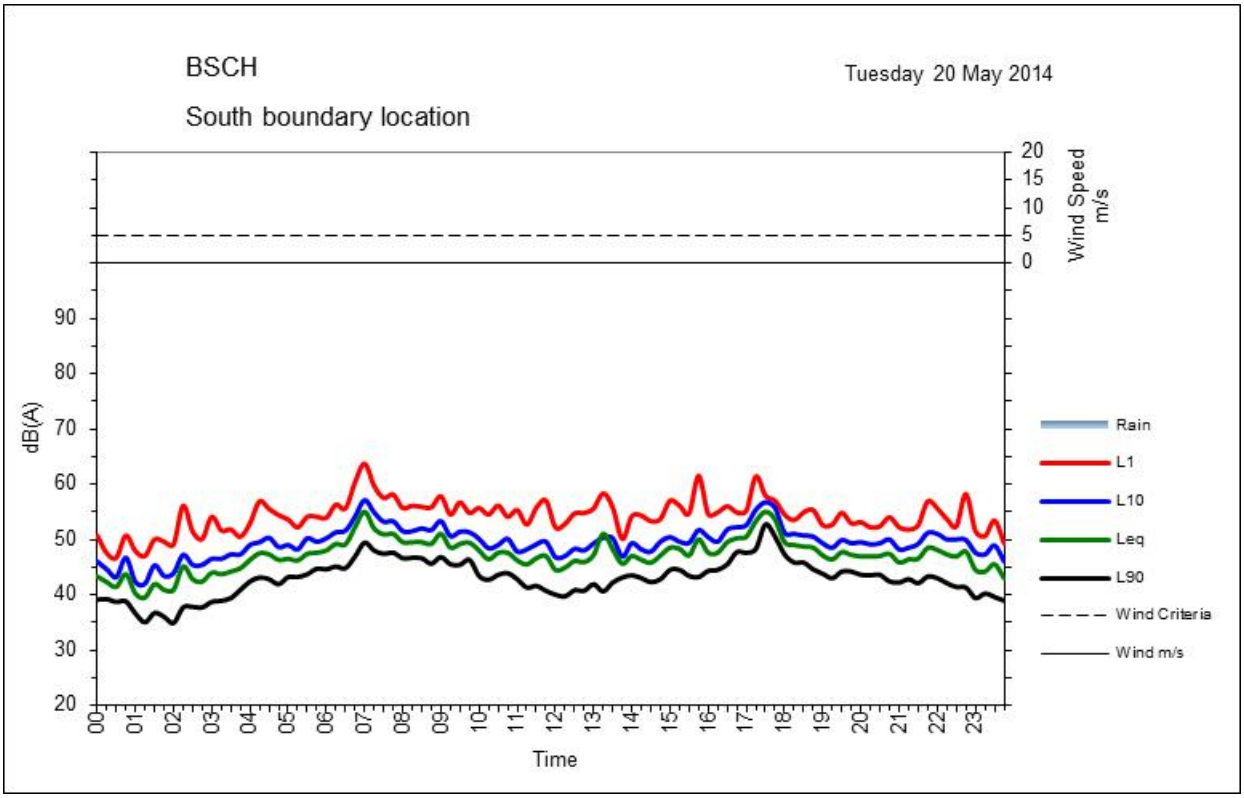

BSCH
Thursday 15 May 2014
South boundary location
Wind Speed m/s
20
15
10
5
0
dB(A)
90
80
70
60
50
40
30
20
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

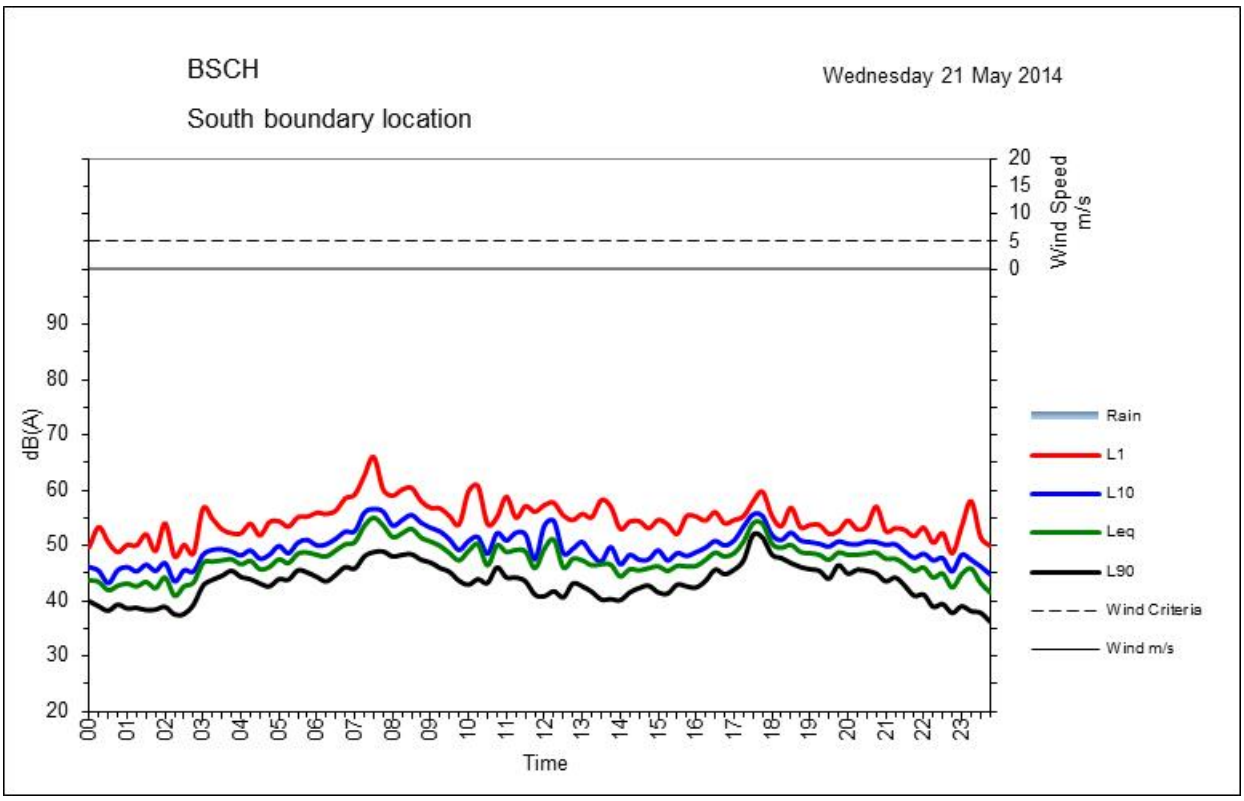

BSCH
Friday 16 May 2014
South boundary location
Wind Speed m/s
20
15
10
5
0
dB(A)
90
80
70
60
50
40
30
20
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

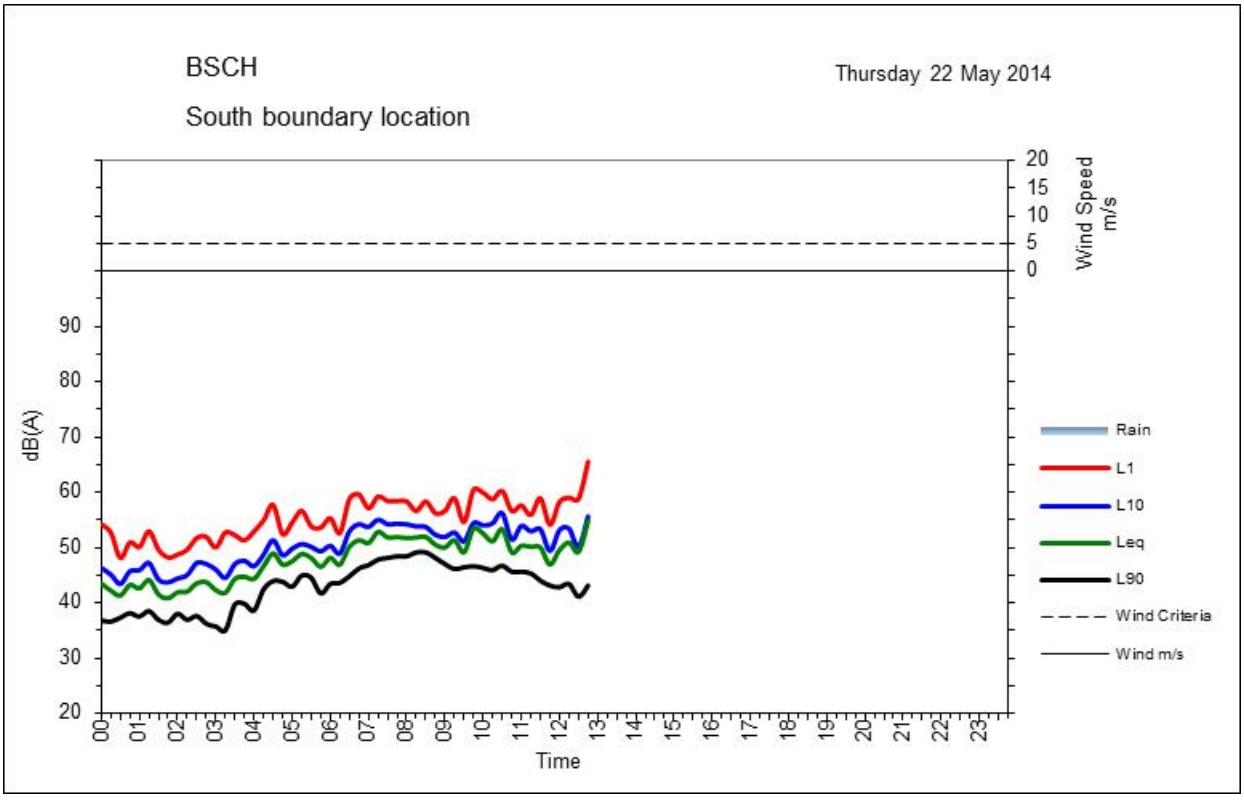

BSCH
Saturday 17 May 2014
South boundary location
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


BSCH
Sunday 18 May 2014
South boundary location
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


BSCH
Monday 19 May 2014
South boundary location
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

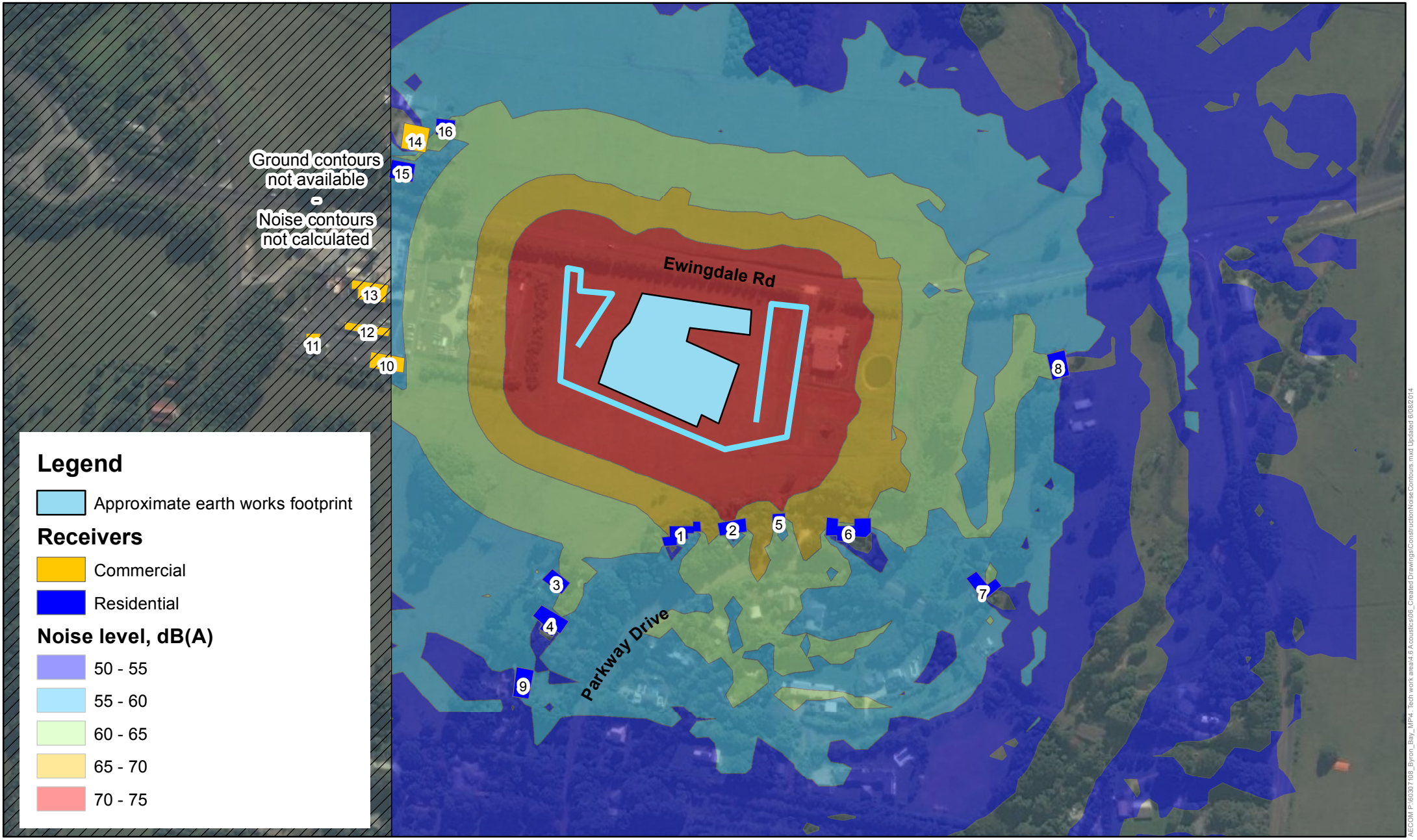

BSCH
Tuesday 20 May 2014
South boundary location
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


BSCH
Wednesday 21 May 2014
South boundary location
Wind Speed m/s
20
15
10
5
0
dB(A)
90
80
70
60
50
40
30
20
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time


BSCH
Thursday 22 May 2014
South boundary location
Wind Speed m/s
20
15
10
5
0
dB(A)
90
80
70
60
50
40
30
20
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time

Appendix C

Construction noise contours



Byron Shire Central Hospital

Earth works noise contours

Source: ESRI Imagery

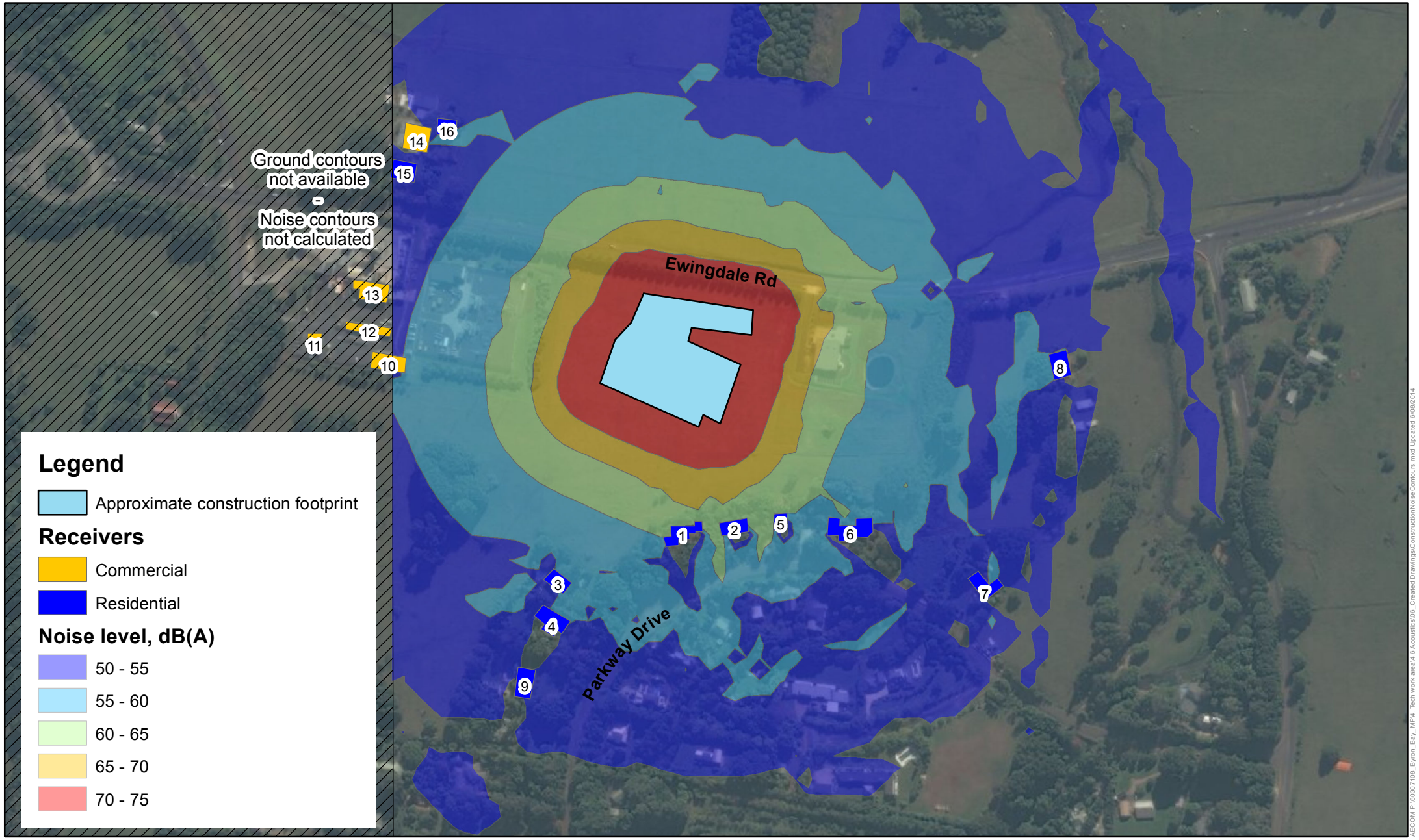
0 0.04 0.08 0.16 km

N

AUG 2014

60307108

Fig. **1**



Byron Shire Central Hospital

Construction noise contours

Source: ESRI Imagery

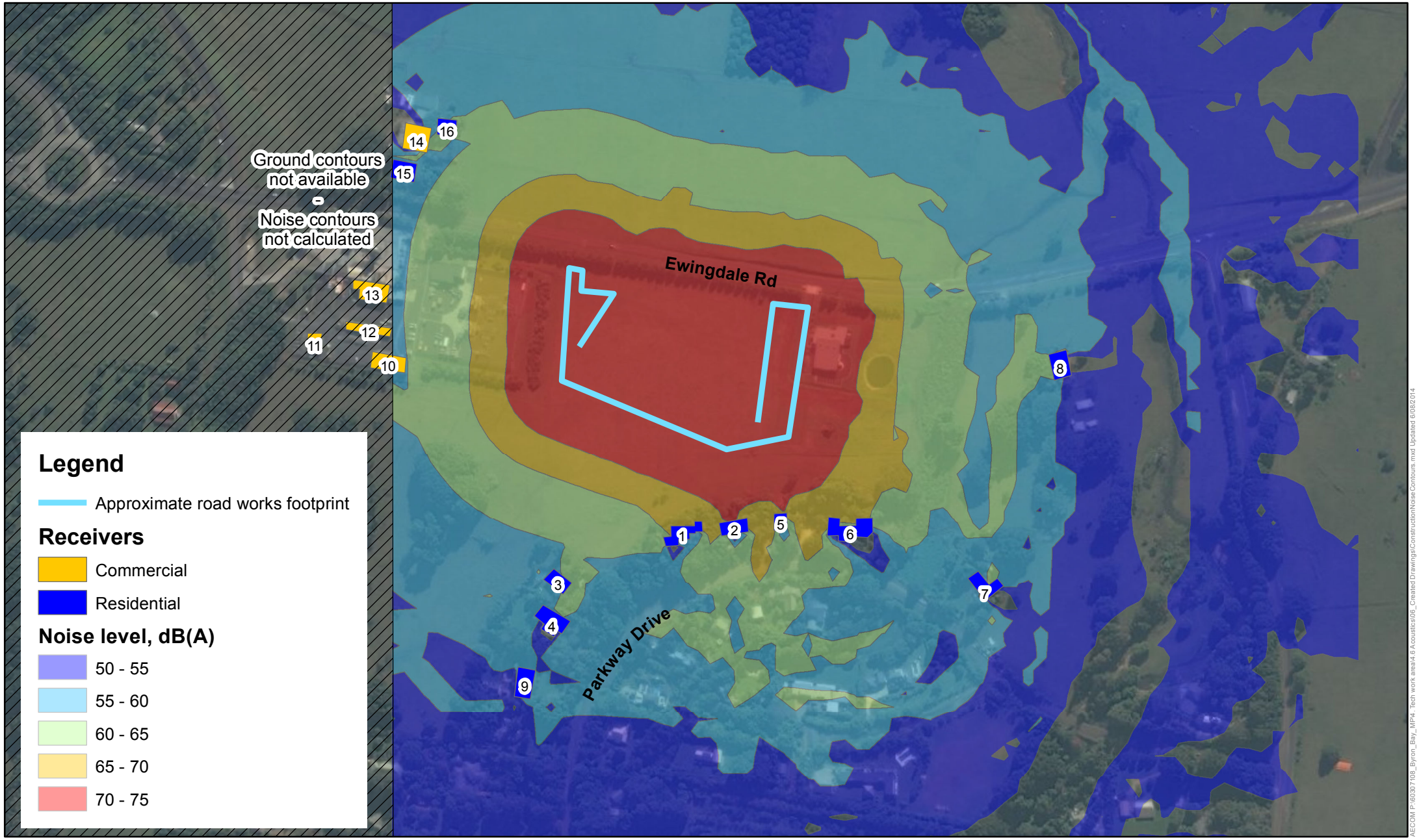
0 0.04 0.08 0.16 km

N

AUG 2014

60307108

Fig. **2**



Byron Shire Central Hospital

Road works noise contours

Source: ESRI Imagery

0 0.04 0.08 0.16 km

N

AUG 2014

60307108

Fig. **3**

Appendix D

Construction vibration assessment

Appendix D Construction vibration assessment