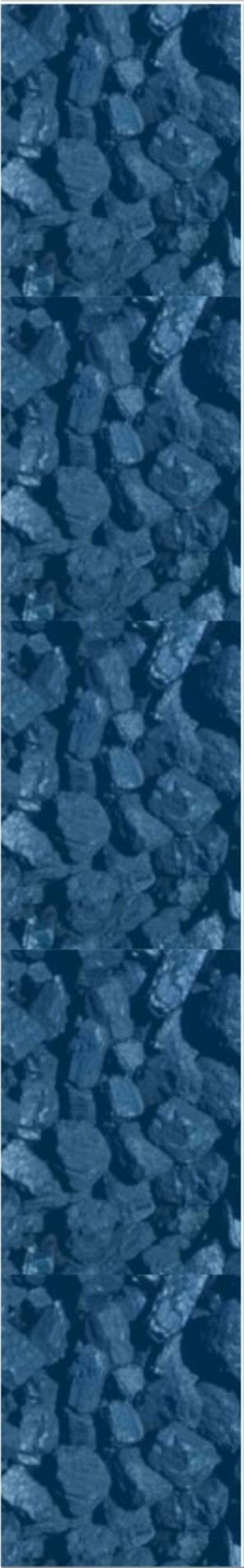
Adani Mining Pty Ltd



Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project: Technical Report

Rail Noise and Vibration Report 25215-D-RP-0018

20 September 2012

Revision 2

This Carmichael Coal Mine and Rail Project: Rail Noise and Vibration Report ("the Report") has been prepared by GHD Pty Ltd ("GHD") on behalf of and for Adani Mining Pty Ltd ("Adani") in accordance with an agreement between GHD and Adani.

The Report may only be used and relied on by Adani for the purpose of informing environmental assessments and planning approvals for the proposed Carmichael Coal Mine and Rail Project (Purpose)and may not be used by, or relied on by any person other than Adani.

The services undertaken by GHD in connection with preparing the Report were limited to those specifically detailed in Section 1.2 of the Report.

The Report is based on conditions encountered and information reviewed, including assumptions made by GHD, at the time of preparing the Report. Assumptions made by GHD are listed within Section 3 of the Report and contained through the Report.

To the maximum extent permitted by law GHD expressly disclaims responsibility for or liability arising from:

- *any error in, or omission in connection with assumptions, or*
- *reliance on the Report by a third party, or use of this Report other than for the Purpose.*

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Abbreviations and Glossary

Project Specific Terminology	
Abbreviation	**Term**
the EIS	Carmichael Coal Mine and Rail Project Environmental Impact Statement - refers to the particular document that GHD is preparing to facilitate approval of the Project
the Proponent	Adani Mining Pty Ltd
the Project (Mine)	Carmichael Coal Mine and Rail Project: Mine Component
the Project (Rail)	Carmichael Coal Mine and Rail Project: Rail Component
Generic Terminology	
Abbreviation	**Term**
Adani	Adani Mining Pty Ltd
CadnaA	Computer Aided Noise Abatement
DERM	Former Queensland Department of Environment and Resource Management
dB	Decibel is the unit used for expressing the sound pressure level or power level in acoustics.
dB(A)	Frequency weighting filter used to measure 'A-weighted' sound pressure levels, which conforms approximately to the human ear response, as our hearing is less sensitive at very low and very high frequencies.
EP Act	*Environmental Protection Act 1994*
EPP Noise	Environmental Protection (Noise) Policy 2008
GHD	GHD Pty Ltd
$L_{Aeq(period)}$	Equivalent sound pressure level: the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
$L_{A90(period)}$	The sound pressure level that is exceeded for 90 per cent of the measurement period.
L_{Amax}	The maximum sound level recorded during the measurement period.
Rating Background Level	RBL or min$L_{A90,1hour}$ is the overall single-figure background noise level representing each assessment period (day/evening/night) over the whole monitoring period (as opposed to over each 24 hour period used for the assessment background level). This is the level used for assessment purposes. It is defined as the median value of: ◗ All the day assessment background levels over the monitoring period for the day (7:00 am to 6:00 pm) ◗ All the evening assessment background levels over the monitoring period for the evening (6:00 pm to 10:00 pm)

	◗ All the night assessment background levels over the monitoring period for night (10:00 pm to 7:00 am)
Blasting	The use of explosives to fracture rock, coal or other materials for later recovery.
Airblast overpressure	The energy transmitted from the blast site within the atmosphere in the form of pressure waves. The maximum excess pressure in this wave is known as the peak air overpressure, generally measured in decibels using linear frequency weighting.
Generic Terminology	
Abbreviation	**Term**
Peak particle velocity	PPV is a measure of the ground vibration magnitude and is the maximum instantaneous particle velocity at a point during a given time interval in mm/s.
MIC	Maximum instantaneous charge
Mtpa	Million Tonnes Per Annum
Noise Sensitive Place/Receptor	With consideration to the *Environmental Protection (Noise) Policy 2008* and of relevance to the Project (Rail) a noise sensitive place (that is a potential sensitive receptor) is defined as (amongst others): ◗ A dwelling. ◗ A library, childcare centre, kindergarten, school, college, university or other educational institution. ◗ A hospital, surgery or other medical institution. ◗ A protected area, or an area identified under a conservation plan as a critical habitat or an area of major interest under the *Nature Conservation Act 1992*. ◗ A marine park under the *Marine Parks Act 1982*. ◗ A park or garden that is open to the public (whether or not on payment of money) for use other than for sport or organised entertainment.
Nordic	Nordic Rail Traffic Noise Prediction Method
Vibration Dose Value	VDV: As defined in BS6472 – 2008, VDV is given by the fourth root of the integral of the fourth power of the frequency weighted acceleration.
Vibration	The variation of the magnitude of a quantity which is descriptive of the motion or position of a mechanical system, when the magnitude is alternately greater and smaller than some average value or reference. Vibration can be measured in terms of its displacement, velocity or acceleration. The common units for velocity are millimetres per second (mm/s).

Executive Summary

Adani Mining Pty Ltd is proposing to develop a 60 million tonne (product) per annum thermal coal mine in the north Galilee Basin, Central Queensland. The Carmichael Coal Mine and Rail Project (the Project) comprises of two major components; the Project (Mine) and the Project (Rail).

This Report has been prepared to assess potential noise and vibration impacts relevant to the construction and operation of the Project (Rail) and will form part of an Environmental Impact Statement for the Project.

Noise and vibration impacts from construction and operation of the Project (Rail) have been assessed against relevant Queensland legislation and guidelines as well as recognised international standards and guidelines, where required.

A desktop assessment of construction noise and vibration impacts was undertaken, including an assessment of impacts from blasting activities.

Careful consideration was given to the location of sensitive receptors in the route selection process, in order to avoid or minimise potential impacts.

Calculations indicate that construction activities such as impact piling generate the highest sound pressure levels at distance. However, given the separation distance between construction work and the nearest sensitive receptors (greater than 1,500 metres) it is unlikely that any adverse noise or vibration impacts will occur during construction works. Recommendations for noise control during construction of the Project (Rail) have been provided in this Report.

Noise and vibration levels from potential blasting during construction works have also been predicted to comply with the adopted blasting criteria. Mitigation measures have been provided to assist in reducing the noise and vibration impact during blasting. In particular, it is recommended that blast monitoring be considered during the initial blasts to assess compliance and confirm the predictions in this Report.

Operational rail noise was assessed against Queensland Rail's Code of Practice for Railway Noise Management (QR, 2007). Acoustic modelling was undertaken based on the proposed rail movements and alignment. The assessment indicates that rail noise levels from the proposed corridor are expected to meet the 65 dB(A) $L_{Aeq,24hrs}$ and 87 dB(A) L_{max} noise targets at all identified sensitive receptors. Similarly, operational vibration targets have been predicted to be readily met at all identified receptors.

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1. Introduction

1.1 Project Overview

Adani Mining Pty Ltd (Adani) is proposing to develop a 60 million tonne (product) per annum (Mtpa) thermal coal mine in the north Galilee Basin approximately 160 kilometres (km) north-west of the town of Clermont, Central Queensland. All coal will be railed via a privately owned rail line connecting to the existing QR National rail infrastructure, and shipped through coal terminal facilities at the Port of Abbot Point and the Port of Hay Point (Dudgeon Point expansion). The Carmichael Coal Mine and Rail Project (the Project) will have an operating life of approximately 90 years.

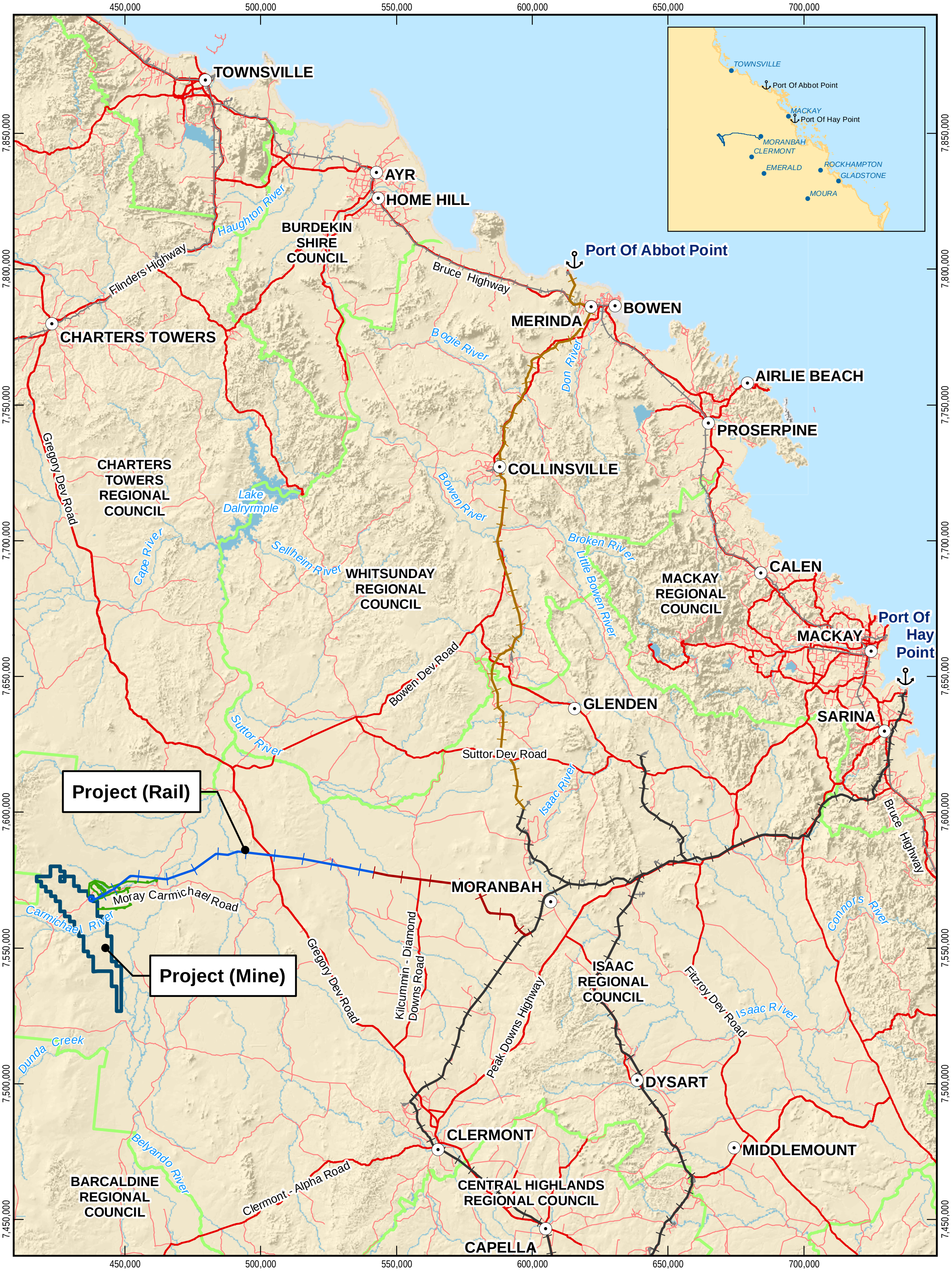
The Project comprises of two major components:

- The Project (Mine): a greenfield coal mine over EPC1690 and the eastern portion of EPC1080, which includes both open cut and underground mining, on mine infrastructure and associated mine processing facilities (the Mine) and the Mine (offsite) infrastructure including:
  - A workers accommodation village and associated facilities
  - A permanent airport site
  - Water supply infrastructure
- The Project (Rail): a greenfield rail line connecting the Mine to the existing Goonyella and Newlands rail systems to provide for the export of coal via the Port of Hay Point (Dudgeon Point expansion) and the Port of Abbot Point, respectively; including:
  - Rail (west): a 120 km dual gauge portion from the Mine site running west to east to Diamond Creek
  - Rail (east): a 69 km narrow gauge portion running east from Diamond Creek connecting to the Goonyella rail system south of Moranbah

The Project has been declared a ‘significant project’ under the *State Development and Public Works Organisation Act 1971* and as such, an Environmental Impact Statement (EIS) is required for the Project. The Project is also a ‘controlled action’ and requires assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999*.

The Project EIS has been developed with the objective of avoiding or mitigating all potential adverse impacts to environmental, social and economic values and enhancing positive impacts. Detailed descriptions of the Project are provided in Volume 2 Section 2 Project Description (Mine) and Volume 3 Section 2 Project Description (Rail).

Figure 1-1 shows the Project location.



LEGEND

Town	State Road	Project (Rail)	Project (Mine)
Major Port	Local Road	Rail (West)	Mine (Offsite)
Other Rail Network	Watercourse	Rail (East)	
Goonyella System	Local Government Area		
Newlands System			

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Job Number 41-25215
Revision L
Date 28-08-2012

Project Location

Figure: 1-1

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Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: © Commonwealth of Australia (Geoscience Australia): Town, Railways, Watercourses (2007); DERM: LGA, (2011), Hillshade (2009); DMR: State Roads (2008); Gassman/Hyder: Mine (Offsite) (2012);
DME: EPC1690 (2010), EPC1080 (2011); Adani: Alignment Opt9 Rev3 (2012). Created by: BW, JVC

1.2 Scope of Reporting

This report addresses those elements of noise and vibration relevant to the Project (Rail) during construction and operation. Assessment of noise and vibration relevant to the Project (Mine) is provided in Volume 2, Section 9 and Volume 4, Appendix U. A summary of compliance with the terms of reference of the Project EIS is provided in Table 1-1. Further details are provided in Appendix A.

Table 1-1 Terms of Reference Cross Reference

Terms of Reference Requirement/Section Number	Section of this report
3.7 Noise and Vibration	
Section 3.7.1 Existing noise and vibration environment	Section 2
Section 3.7.1 Identify sensitive noise receptors	Section 2.1
Section 3.7.1 Discuss potential sensitivity of such receptors.	Section 2.1
Section 3.7.1 Map of sensitive receptor locations	Section 2.1 Figure 1-2
Section 3.7.1 Legislation, guidelines and criteria	Section 1.3
Section 3.7.2 Construction noise and vibration impacts	Section 3.2, Section 3.3 and Section 3.4
Section 3.7.2 Operational noise and vibration impacts	Section 3.5 and Section 3.6
Section 3.7.2 Mitigation measures	Section 3.2.2, Section 3.3.2, Section 3.4.2 and Section 3.5.2

1.3 Legislation, Policies and Guidelines

1.3.1 The Environmental Protection Act 1994

The *Environmental Protection Act 1994* (EP Act) provides for protection of environmental values, including environmental values relating to maintenance of public amenity. In relation to noise, the EP Act is supported by the Environmental Protection (Noise) Policy 2008 (EPP Noise).

The key environmental values for the acoustic environment are outlined within Section 7 of the EPP Noise as below:

> *The environmental values to be enhanced or protected under this policy are-*
>
> *a) The qualities of the acoustic environment that are conducive to protecting the health and biodiversity of ecosystems; and*

b) *The qualities of the acoustic environment that are conducive to human health and wellbeing, including by ensuring a suitable acoustic environment for individuals to do any of the following –*

   (i) *Sleep;*

   (ii) *Study or learn;*

   (iii) *Be involved in recreation, including relaxation and conversation; and*

   (iv) *The qualities of the acoustic environment that are conducive to protecting the amenity of the community.*

To further assist in determining noise levels consistent with the identified environmental values, the EPP Noise sets out acoustic quality objectives. However, in accordance with Clause 8(4)(a) of the policy, acoustic quality objectives for sensitive receptors do not apply to (amongst others) noise from a warning signal for a railway crossing and noise from the ordinary use of rail transport infrastructure.

As such, operational noise associated with the Project (Rail) is not assessed against the EPP Noise acoustic quality objectives. Alternatively, Queensland Rail's Code of Practice for Railway Noise Management (QR, 2007) is used for assessment purposes (refer Section 1.3.2).

1.3.2 Queensland Rail's Code of Practice for Railway Noise Management

Queensland Rail's Code of Practice for Railway Noise Management (QR, 2007) gives consideration to the assessment of railway airborne noise emissions and outlines operational "planning levels" applicable to the Project (Rail) as shown in Table 1-2.

Table 1-2 Rail Noise Criteria

External design level	Description
65 dB(A)	Assessed as the 24 hour L_{Aeq} average equivalent continuous A-weighted sound pressure level
87 dB(A)	Assessed as a single event maximum sound pressure level (L_{Amax}) - defined as the arithmetic average of maximum levels from the highest 15 single events over a given 24 hour period

These levels are to be assessed one metre in front of the most exposed part of an affected noise sensitive place. Where maintenance activities are undertaken during night periods, the code recommends that these activities are not carried out at locations within 500 metres (m) of a noise sensitive place.

The code further stipulates that construction activities that may generate noise at noise sensitive places should, where possible and practicable be confined to 'standard day-time working hours', which is between 7:00 am and 6:00 pm from Monday to Friday; and between 7:00 am and 1:00 pm on Saturdays (QR, 2007).

The requirement to meet indoor design level noise criteria to achieve an average maximum sound level between 10:00 pm and 6:00 am of 45 decibels (dBA) is not considered applicable to the Project (Rail) as this criterion applies only to new sensitive land uses, that is development around infrastructure (such as rail), rather than for infrastructure around the development. This approach has been used in recent similar projects in Queensland and has been recognised and accepted by the State.

1.3.3 Planning for Noise Control Guideline

The methods and procedures described in the Planning for Noise Control Guideline (Ecoaccess, 2004) are applicable for setting conditions relating to noise emitted from industrial premises, commercial premises and mining operations, and are intended for planning purposes.

The Planning for Noise Control Guideline is considered not applicable to this Project as planning for noise control is relevant to mining, industrial and commercial facilities only. Although they apply to noise from rail infrastructure on the site of one of these categories of development, noise from rail infrastructure outside these sites is covered separately.

1.3.4 Construction Noise Criteria

For construction work occurring during normal daytime hours, provided all mechanical powered plant is fitted with appropriate mufflers, specific noise limits are generally not warranted in Queensland. In this regard, it may be noted that the EPP Noise does not include construction noise limits.

In Queensland, it is generally accepted that construction activities should be in accordance with general building work hours as described under Section 440R – “Building Work” of the EP Act. Under the EP Act, no audible noise is permitted:

- 6:30 pm to 6:30 am – Monday to Saturday
- Sundays and public holidays

The time restrictions are designed to strike a balance between protecting noise amenity and the need to start construction activities early in the morning.

Noise impacts are usually minimised by limiting the hours of operation and, in particular circumstances, scheduling the noisiest activities to occur at times when they would generate least disruption. For construction works extending outside normal working hours, particular noise limits should be applied. As such, the World Health Organisation (WHO) Guidelines for Community Noise (1999) recommend, for quality of sleep, maximum internal noise levels should not exceed 45 dB(A). This guideline is recommended for construction work occurring inside the hours listed above.

1.3.5 Sleep Disturbance

As stated in Section 1.3.4, construction work extending outside normal working hours, has the potential to cause sleep disturbance.

Based on a typical building façade noise reduction of 10 dB(A) through a partially open window, an external criterion of 55 dB(A) is recommended for sleep disturbance from construction activity, assessable at four metres from the building façade.

1.3.6 Low Frequency Noise

The Assessment of Low Frequency Noise Guideline (Ecoaccess, 2006) is considered to address noise sources with inherent dominant infrasound or (very) low frequency noise characteristics.

This is not the case for the transient rail noise sources under investigation in this assessment and therefore no further assessment, or discussion of mitigation measures, will be undertaken against the Low Frequency Noise Guideline.

1.3.7 Blasting Overpressure and Vibration

Section 440ZB Blasting of the EP Act provides criteria for the assessment of blasting impacts.

The EP Act states that blasting must not be conducted if:

(a) the airblast overpressure is more than 115dB Z Peak for 4 out of any 5 consecutive blasts;
(b) the airblast overpressure is more than 120dB Z Peak for any blast; or
(c) the ground vibration is —
  (i) for vibrations of more than 35Hz--more than 25 mm a second ground vibration, peak particle velocity.
  (ii) for vibrations of no more than 35Hz--more than 10 mm a second ground vibration, peak particle velocity.

Additional blasting criteria are referred to in the Noise and Vibration from Blasting (EPA 2006) guideline. The guideline recommends that blasting should generally only be permitted during the hours of 9:00 am to 3:00 pm, Monday to Friday, and from 9:00 am to 1:00 pm on Saturdays. Blasting should not generally take place on Sundays or public holidays. Blasting outside these recommended times should be undertaken only where:

- Blasting during the preferred times is clearly impracticable (in such situations blasts should be limited in number and stricter airblast overpressure and ground vibration limits should apply).
- There is no likelihood of persons in a noise-sensitive place being affected because of the remote location of the blast site.

The guideline provides assessment criteria for blasting noise and vibration limits as shown in Table 1-3. The guideline values have been adopted for this assessment.

Table 1-3 Guideline Blasting Limits

Airblast Overpressure	Ground Vibration
115 dB(lin) peak	5 mm/s PPV
Must not be more than 115 dB(lin) peak for nine out of any ten consecutive blasts initiated, regardless of the interval between blasts, but never over 120 dB(lin) peak for any blast.	Must not exceed a PPV of 5 mm/s for nine out of any ten consecutive blasts initiated, regardless of the interval between blasts, but never over 10 mm/s for any blast.

1.3.8 Human Comfort Vibration Criteria

In the absence of any specific Queensland or Australian guidelines relating to human comfort criteria for vibration, criteria have been adopted with consideration to the British Standard (BS) 6472: 2008, *Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting,* and is recognised as the preferred standard for assessing the “human comfort criteria” for residential building types.

Typically, rail activities generate ground vibration of an intermittent nature. Under BS 6472-1: 2008, intermittent vibration is assessed using the vibration dose value (VDV). Table 1-4 includes acceptable values of vibration dose for residential receptors for daytime and night-time periods.

These values represent the best judgement available at the time the standard was published and may be used for both vertical and horizontal vibration, providing that they are correctly weighted. Because there is a range of values for each category, it is clear that the judgement can never be precise.

Table 1-4 Vibration Dose Value Ranges and Probabilities for Adverse Comment to Intermittent Vibration ($m/s^{1.75}$)

Location	Low probability of adverse comment[1]	Adverse comment possible	Adverse comment probable[2]
Residential buildings 16 hour day (0700 – 2300 hrs)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hour night (2300 to 0700 hrs)	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

Notes:

1 Below these ranges adverse comment is not expected.

2 Above these ranges adverse comment is very likely.

Whilst the assessment of response to vibration in BS 6472-1:2008 is based on VDV and weighted acceleration, for construction related vibration, it is considered more appropriate to provide guidance in terms of PPV, since this parameter is likely to be more routinely measured based on the more usual concern over potential building damage.

Humans are capable of detecting vibration at levels which are well below those causing risk of damage to a building. The degrees of perception for humans are suggested by the vibration level categories given in BS 5228-2:2009, *Code of practice for noise and vibration on construction and open sites – Part 2: Vibration,* as shown in Table 1-5.

Table 1-5 Guidance on the Effects of Vibration Levels

Approximate Vibration Level	Degree of Perception
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction.
0.30 mm/s	Vibration might be just perceptible in residential environments.

Approximate Vibration Level	Degree of Perception
1.0 mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

1.3.9 Structural Vibration Criteria

Currently, there is no Australian Standard that sets the criteria for the assessment of building damage caused by vibration. Guidance of limiting vibration values is attained from reference to German Standard 4150-3: 1999, *Structural Vibration – Part 3: Effects of vibration on structures.* Table 1-6 presents the short-term vibration guideline values.

Table 1-6 Guideline Values for Vibration Velocity to be Used When Evaluating the Effects of Short-Term Vibration on Structures

Guideline Values for Velocity, vi(t)[1] [mm/s]				
Line	Type of Structure	Vibration at the Foundation at a Frequency of		
		1Hz to 10 Hz	10Hz to 50Hz	50Hz to 100Hz[2]
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design.	20	20 to 40	40 to 50
2	Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10

Notes: 1 The term vi refers to vibration levels in any of the x, y or z axes; 2 At frequencies above 100Hz the values given in this column may be used as minimum values.

Vibration due to the construction process has the potential to affect services such as buried pipes, electrical and telecommunication cables. German Standard DIN 4150-2: 1999 provides guidance on safe vibration levels for buried pipe work. Table 10 within DIN 4150-2 details the limits for short-term vibration, as presented in Table 1-7. The levels apply on the wall of the pipe. For long-term vibration the guideline levels presented in Table 1-7 should be halved. Recommended vibration criteria for electrical cables and telecommunication services such as fibre optic cables range from between 50 mm/s and 100 mm/s.

Table 1-7 DIN 4150 Part 3 – Damage to Buried Pipes – Guidelines for Short-term Vibration

Pipe Material	Guideline values for velocity measured on the pipe (mm/s)
Steel (including welded pipes)	100
Clay, concrete, reinforced concrete, metal (with or without flange)	80
Masonry, plastic	50

1.4 Approach and Methodology

1.4.1 Overview

The construction and operation of the Project (Rail) has the potential to cause noise and vibration impacts on the surrounding environment. This report provides an assessment of potential impacts associated with noise and vibration generated during the construction and operation of the Project (Rail), by:

- Reviewing the existing noise and vibration environment
- Addressing the acoustic requirements detailed in the Project terms of reference in relation to the construction and operational phases of the Project (Rail)
- Evaluating the potential construction and operational noise and vibration impacts at sensitive locations in terms of planning levels identified in the EPP Noise, Queensland Rail Code of Practice and other standards and guidelines as applicable.
- Defining noise and vibration goals by which potential construction and operational noise and vibration impacts at sensitive locations may be evaluated and assessed
- Evaluating and assessing the extent of resulting impacts and the scope for the reduction of these impacts through reasonable and feasible mitigation strategies
- Recommending appropriate impact mitigation measures

1.4.2 Noise Monitoring Methodology

In order to meet the terms of reference requirements for the Project (Rail) background and ambient noise monitoring was conducted as part of this assessment. Background noise levels were assessed using a combination of unattended and attended noise monitoring. Monitoring was conducted at two locations in the vicinity of the Project (Rail). Noise monitoring site locations are provided in Figure 1-2, together with the locations of potential sensitive receptors. A brief description of each monitoring site is provided in Table 1-8. Photographs of the monitoring sites are provided in Plate 1-1 and Plate 1-2.

Table 1-8 Noise Survey Location Details

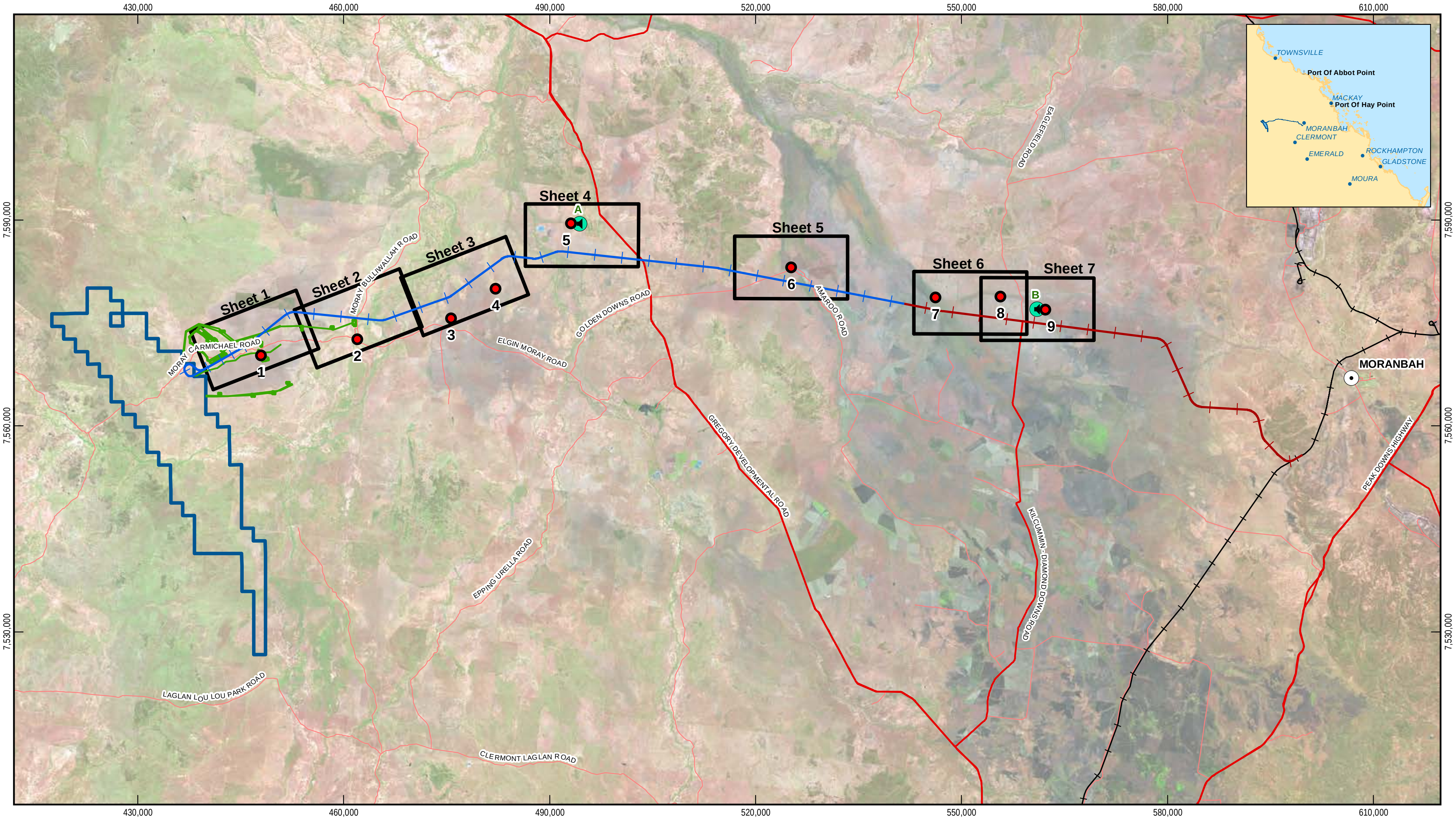
Monitoring Location	GPS coordinates	Description of noise survey location	Monitoring period
A	21^{o} 48.030' S 146^{o} 56.848' E	◗ Disney Homestead ◗ 4.2 km away from Project (Rail)	26 August – 6 September 2011
B	21^{o} 50.014' S 147^{o} 32.466' E	◗ Mullawa Homestead ◗ 1.9 km away from Project (Rail)	26 August – 7 September 2011

Plate 1-1 Monitoring Location A

Plate 1-2 Monitoring Location B

Locations selected are considered representative of the acoustic environment for the nearest potential sensitive receptors located in the vicinity of the Project (Rail). The monitoring locations were also chosen as being a safe and secure place for staff and unattended equipment, minimising the risk of theft, vandalism, or damage by natural causes. Land access permission was also another factor that contributed to the final selection of the locations.

Unattended noise logging was conducted to establish typical noise levels in the area of the potentially most affected receptors. Attended monitoring was also completed at these locations to better understand the noise sources contributing to overall existing noise levels.



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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LEGEND

- Potential Sensitive Receptor
- Potential Noise Logger
- Town
- State Road
- Local Road
- Other Rail Network
- Rail (West)
- Rail (East)
- Mine (Onsite)
- Mine (Offsite)

GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project
Project (Rail)
Predicted Rail Noise Contours, Potential Sensitive Receptors and Monitoring Locations

Job Number	41-25215
Revision	E
Date	20-09-2012

Figure 1-2

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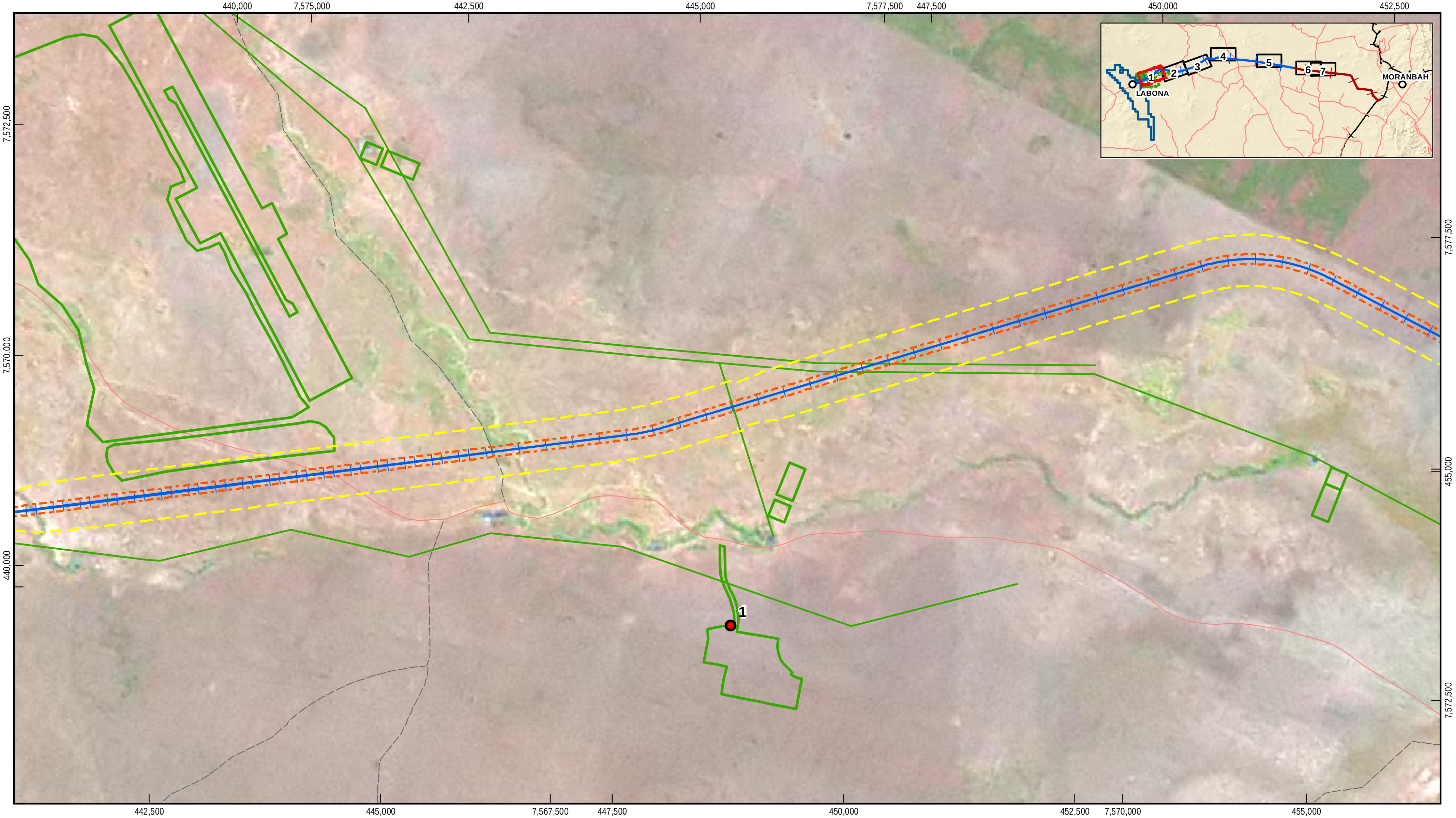
Data source: GHD: Noise Logger/Sensitive Receptor Locations (2012); DERM: DEM (2008); DME: PC1690 (2010), EPC1080 (2011); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads (2007); Adani: Alignment Opt9 Rev3 (SP1&2) (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: AF, JVC



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Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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LEGEND

- Potential Sensitive Receptor
- Potential Noise Logger
- State Road
- Local Road
- Track
- Other Rail Network
- Rail Noise Contour
  - QR LAeq (24 hour) 65 dB
  - QR LAmax 87 dB
- Rail (West)
- Rail (East)
- Mine (Onsite)
- Mine (Offsite)

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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project
Project (Rail)
Predicted Rail Noise Contours, Potential Sensitive Receptors and Monitoring Locations

Job Number	41-25215
Revision	D
Date	20-09-2012

Figure 1-2
Sheet 1

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Data source: GHD: Noise Logger/Sensitive Receptor Locations (2012), Noise Contours (2012); DERM: DEM (2008), DCDB (2010); DME: PC1690 (2010), EPC1080 (2011); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads (2007);
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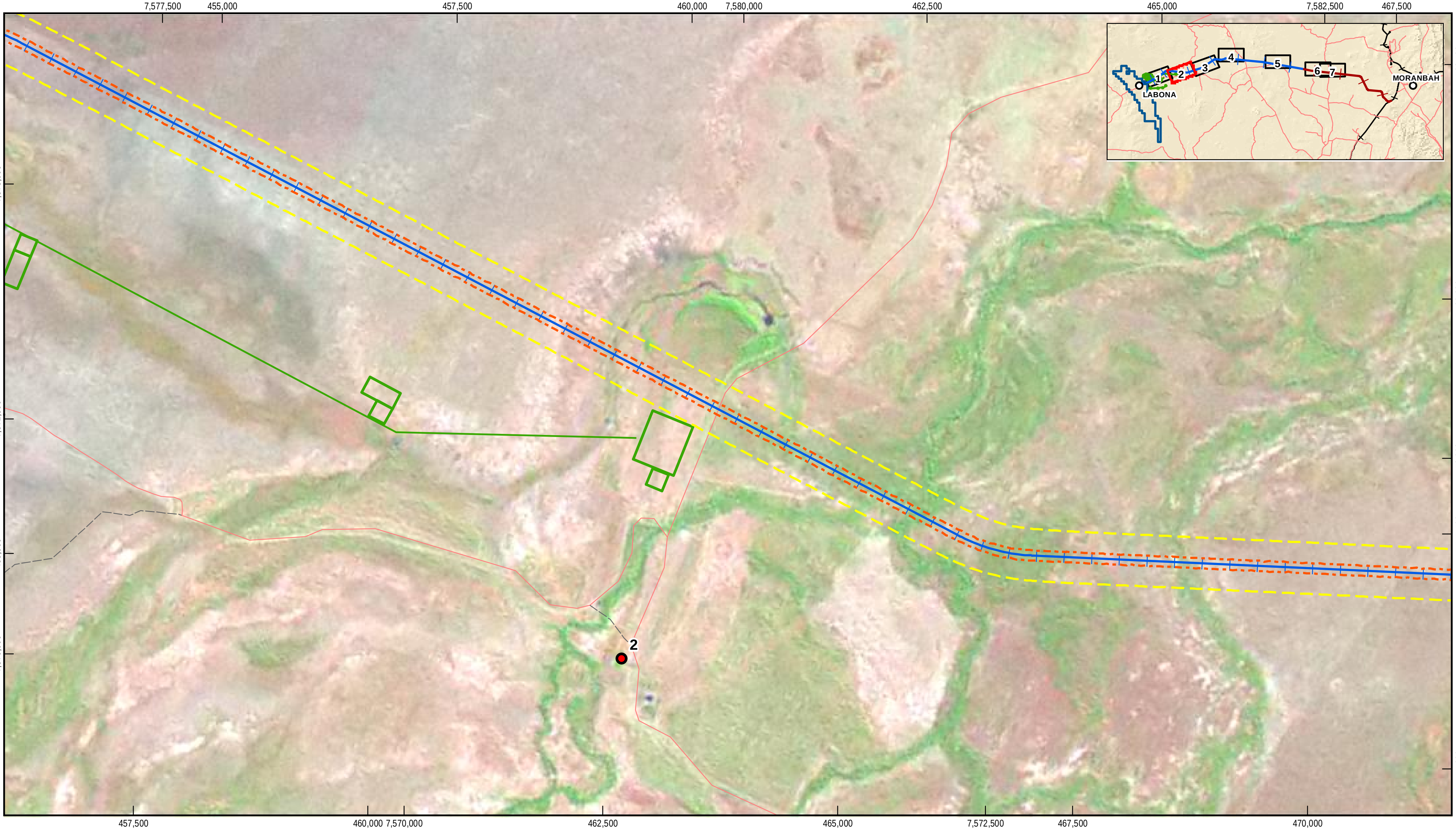

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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

LEGEND

- Potential Sensitive Receptor
- Potential Noise Logger
- State Road
- Local Road
- Track
- Other Rail Network
- Rail Noise Contour
  - QR LAeq (24 hour) 65 dB
  - QR LAmax 87 dB
- Rail (West)
- Rail (East)
- Mine (Onsite)
- Mine (Offsite)

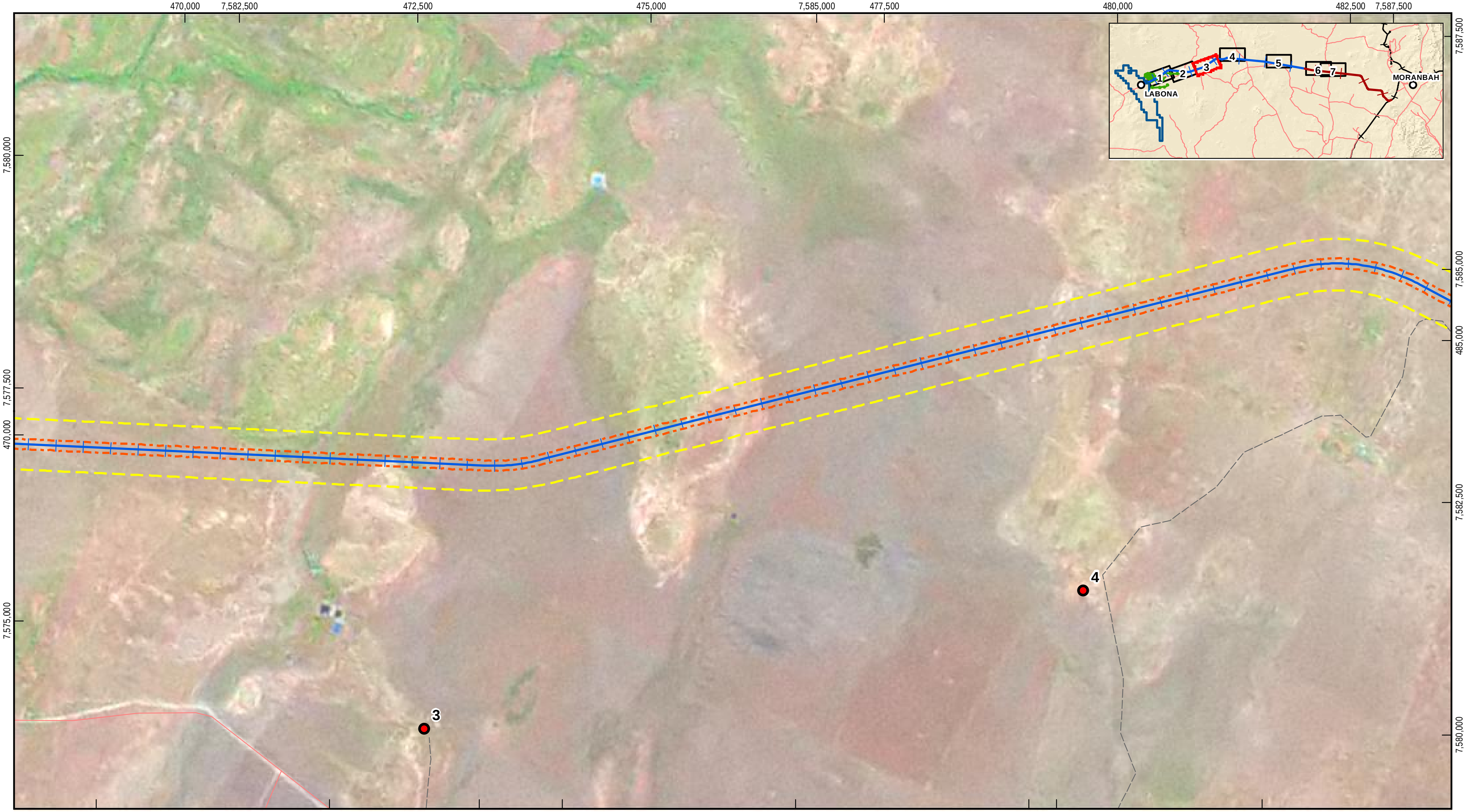
Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project
Project (Rail)
Predicted Rail Noise Contours, Potential Sensitive Receptors and Monitoring Locations

Job Number	41-25215
Revision	D
Date	20-09-2012

Figure 1-2
Sheet 2

G:\41\25215\GIS\Maps\MXD\700_Environment\41-25215_709_MapBook_rev_d.mxd Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: GHD: Noise Logger/Sensitive Receptor Locations (2012), Noise Contours (2012); DERM: DEM (2008), DCDB (2010); DME: PC1690 (2010), EPC1080 (2011); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads (2007);
Adani: Alignment Opt9 Rev3 (SP1&2) (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: AF, JVC



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
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Predicted Rail Noise Contours, Potential Sensitive Receptors and Monitoring Locations

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Figure 1-2
Sheet 3

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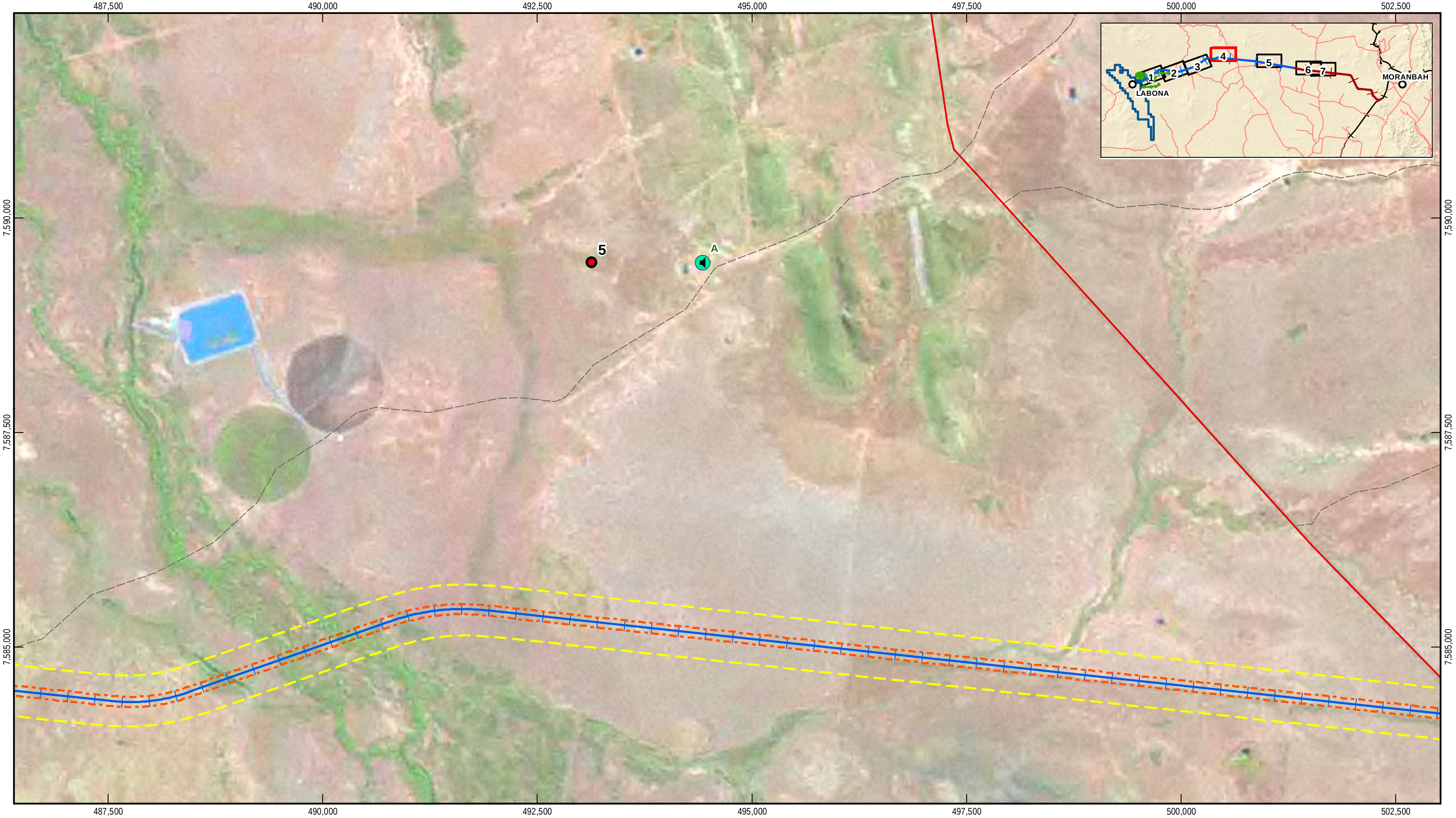

1:60,000 (at A4)

0 0.5 1 1.5 2 2.5

Kilometres

Map Projection: Universal Transverse Mercator
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N

LEGEND

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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project
Project (Rail)

Job Number	41-25215
Revision	D
Date	20-09-2012

Predicted Rail Noise Contours, Potential Sensitive Receptors and Monitoring Locations

Figure 1-2
Sheet 4

G:\41\25215\GIS\Maps\MXD\700_Environment\41-25215_709_MapBook_rev_d.mxd Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

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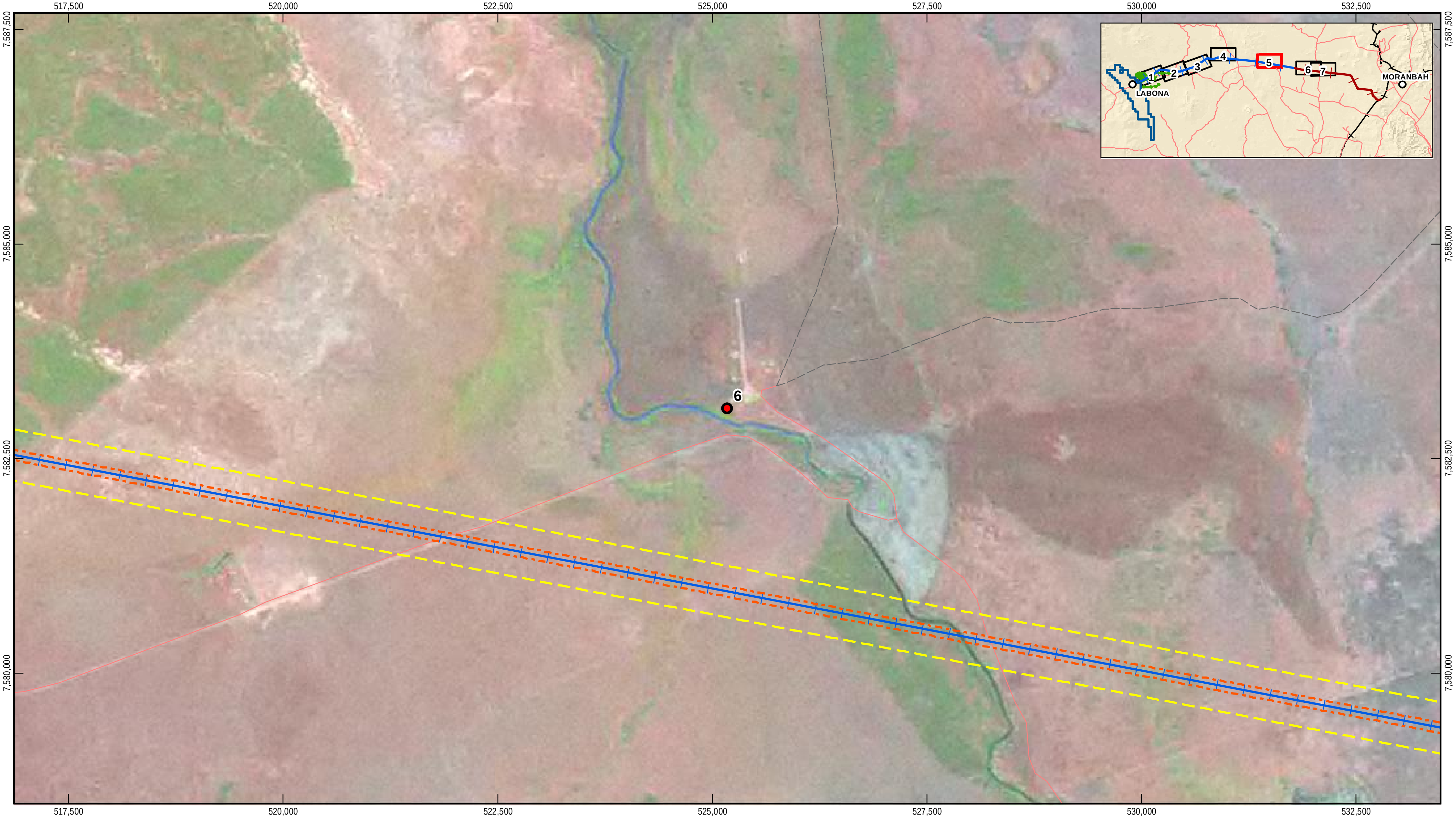

1:60,000 (at A4)

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Kilometres

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N

LEGEND

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Rail Noise Contour

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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project
Project (Rail)
Predicted Rail Noise Contours, Potential Sensitive Receptors and Monitoring Locations

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Figure 1-2
Sheet 5

G:\41\25215\GIS\Maps\MXD\700_Environment\41-25215_709_MapBook_rev_d.mxd Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

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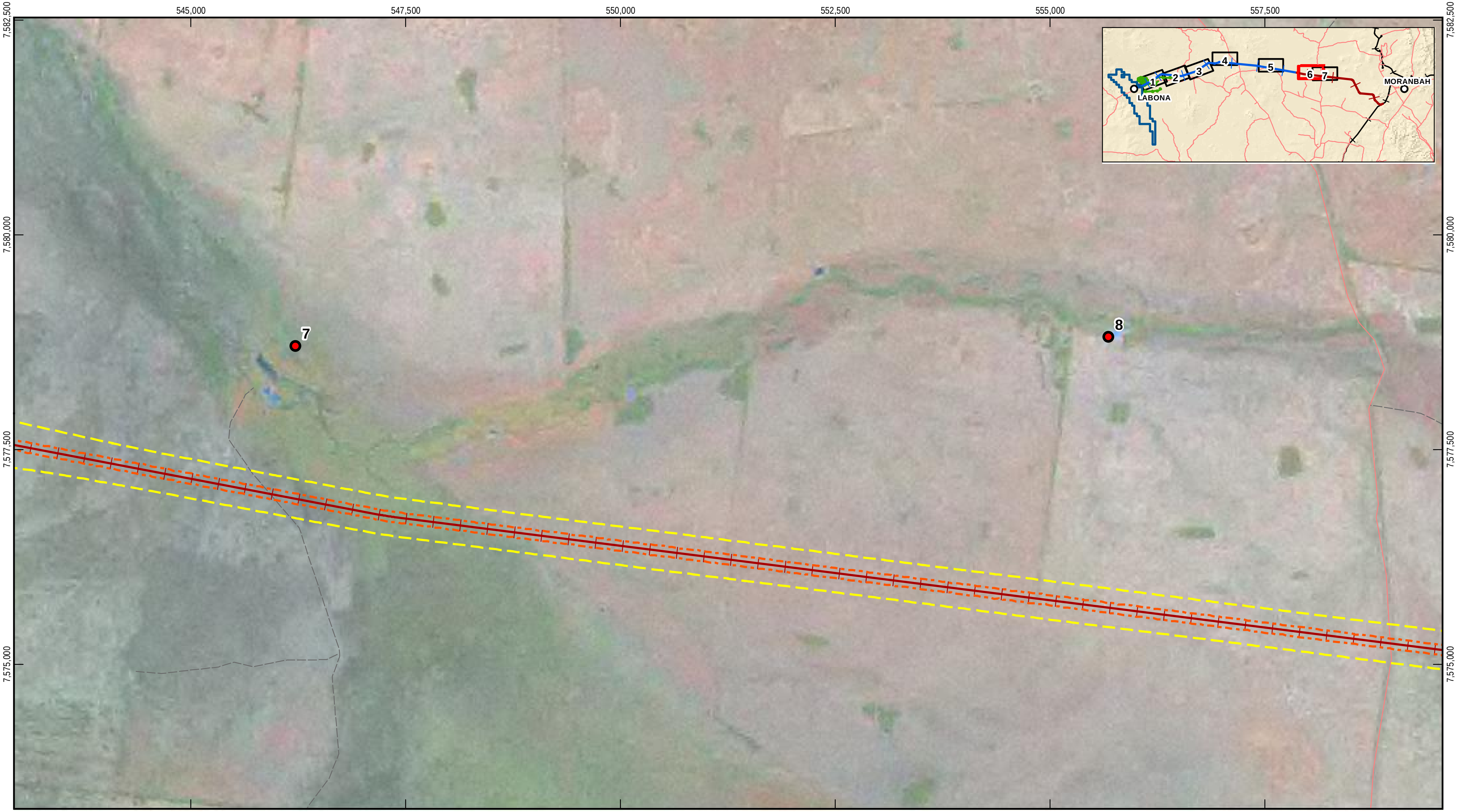

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Kilometres

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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project
Project (Rail)
Predicted Rail Noise Contours, Potential Sensitive Receptors and Monitoring Locations

Job Number	41-25215
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Figure 1-2
Sheet 6

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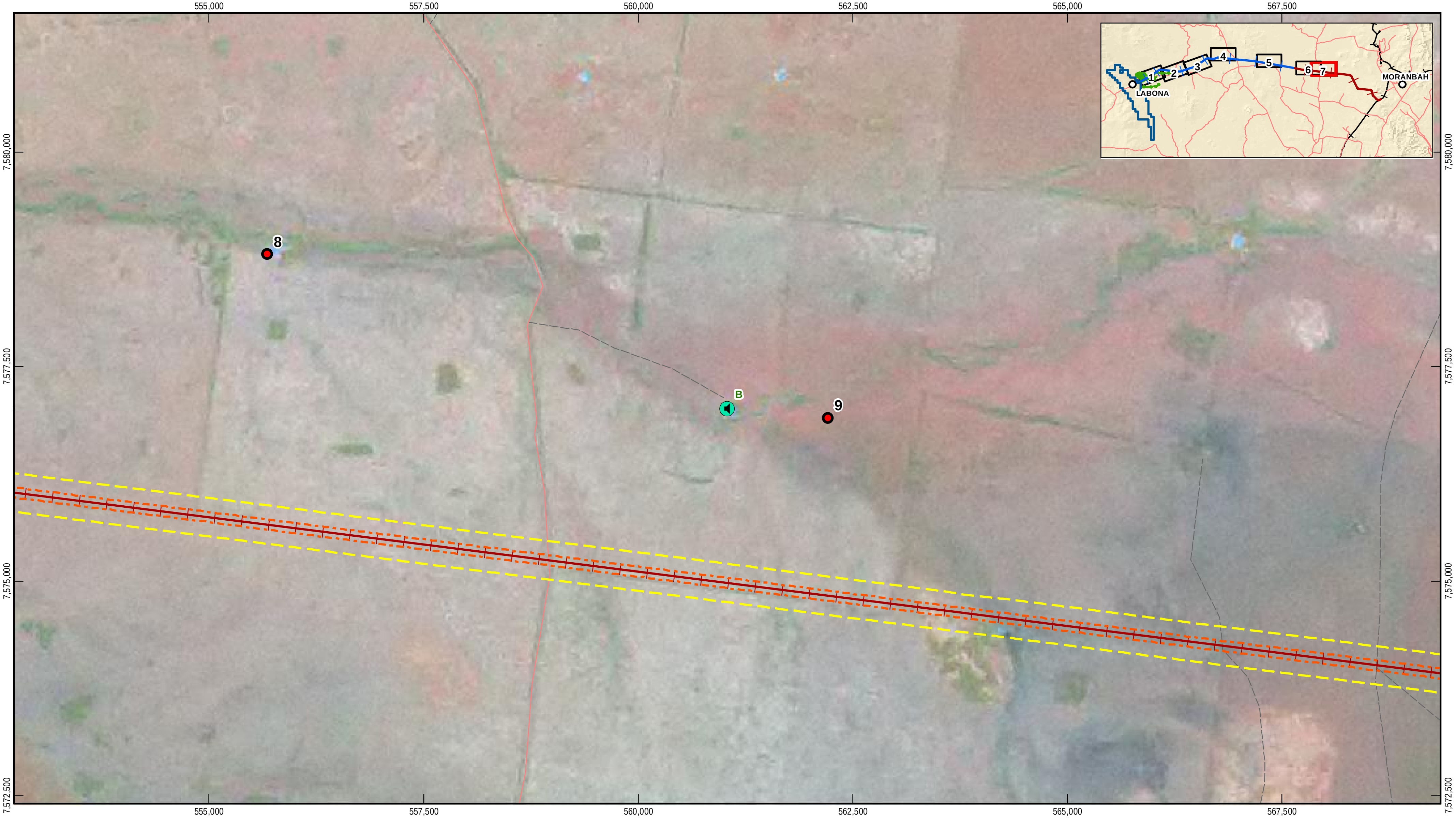

1:60,000 (at A4)

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Kilometres

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Figure 1-2
Sheet 7

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Unattended noise monitoring was undertaken using two Rion NL-21 environmental noise loggers between 26 August and 6 - 7 September 2011 at two locations within the vicinity of the Project (Rail). These loggers are capable of measuring continuous sound pressure levels and are able to record L_{A90}, L_{A10} and L_{Aeq} noise descriptors. The instruments were programmed to accumulate environmental noise data continuously over sampling periods of 15 minutes for the entire monitoring period.

Prior to deployment, the loggers were calibrated with a sound pressure level of 94 dB at 1 kHz using a Rion NC-73 calibrator. At completion of the monitoring period, the loggers were retrieved and calibration was rechecked. The difference was less than +/- 0.5 dB.

The data collected by the loggers was downloaded and analysed, and any invalid data removed. Invalid data generally refers to periods of time where average wind speeds were greater than 5 m/s, or when rainfall occurred. Weather data over the monitoring period was collected from the Bureau of Meteorology Emerald Airport Automatic Weather Station. All sampling activities were undertaken with consideration to the specifications outlined in AS1055 (1997) and the Description and Measurement of Environmental Noise and the Noise Measurement Manual (EPA, 2000).

Table 1-9 provides details of the noise loggers at each monitoring location.

Table 1-9 Unattended Noise Logger Details

Monitoring location	Logger serial No.	Measurement started	Measurement ceased	Pre Cal	Post Cal	Frequency weighting	Time response
Location A	365349	26/08/11	07/09/11	93.9	93.8	A	Fast
Location B	365350	26/08/11	05/09/11	94.0	94.5	A	Fast

Attended measurements were taken at noise monitoring locations A and B to supplement logger data. Attended noise measurements were conducted on 26 August 2011 using a Rion NL-21 sound level meter. This sound level meter capable of measuring continuous sound pressure levels and is able to record L_{Amin}, L_{A90}, L_{A10}, L_{Amax} and L_{Aeq} noise descriptors. Prior to deployment, the meter was calibrated using a Rion NC-73 calibrator with a sound pressure level of 94 dB at 1 kHz. Calibration was checked prior to the commencement of measurements and at completion of the measurements. The difference was less than +/- 0.5 dB.

1.4.3 Vibration Monitoring Methodology

Vibration measurements were undertaken at two locations in the vicinity of the Project (Rail) as shown in Figure 1-2 (as per the noise monitoring locations A and B - refer to Section 1.4.2). Vibration measurements were conducted using an Instantel Minimate Plus vibration logger with a tri-axial geophone to monitor ground vibration PPV in each axial direction. The Minimate unit has an inbuilt data logger, downloadable to PC where analysis can be performed using Blastware software.

The geophone was adhered to a granite paver and positioned on relatively flat ground. Vibration monitoring was undertaken utilising a Minimate Plus (serial: BE12721), calibration expiry August 2012 recording in histogram mode. Histograms at one minute intervals were recorded with concurrent site observations. The Minimate Plus has a range of 31.7 mm/s with a sampling rate of 2,048 /s.

1.4.4 Construction Noise Assessment Methodology

Construction Methods

Civil works during construction will comprise the following activities: earthworks; drainage construction; haul road and access track construction and maintenance; and bridgework construction. Track construction will include: track laying; signalling installation; and communications installation.

Construction of the civil works for the Project (Rail) is expected to be undertaken on a number of construction fronts (up to five proposed), with progressive handover to enable track construction to follow closely behind, thus minimising delay.

Construction material such as borrow material, capping material, ballast and construction water may have to be sourced from outside the Project (Rail) area. Approximately 30 quarries and borrow pits are proposed within and outside the rail corridor for sourcing of material for ballast and borrow material (fill) for sub-grade-formation earthworks.

The primary access roads for transportation of construction staff and equipment to the Project (Rail) are:

- Kilcummin Diamond Downs Road / Eaglefield Road
- Gregory Developmental Road
- Moray Bulliwallah Road

A construction access and haulage track has also been allowed for to run parallel adjacent to the Project (Rail) alignment within the proposed nominal 95 m wide rail corridor. This track will subsequently serve as the permanent access/maintenance road for the operational Project (Rail). The final design, location and standard of the maintenance access track will be determined as part of the detail design, but will largely be confined to the northern side of the Project (Rail).

Construction Equipment

The following construction equipment is likely to be required for the Project (Rail):

- For civil works: dozers, graders, excavators, front end loaders, scrapers, dump trucks, rollers, backhoes, water carts, pipe layers, cranes and piling rigs
- For track works: sleeper layer, track layer, ballast wagons, rail welding machine, tamper, water carts, excavators and backhoes
- For quarries and borrow pits: dozers, excavators, water carts and dump trucks

It is anticipated that the bulk earthworks will be undertaken using scrapers for short hauls and with excavators and dump trucks for long distance earthmoving. It is intended that the majority of the general fill will be obtained from the cutting excavations. The design will be optimised during detailed design to account for likely quantities of unsuitable material obtained from detailed geotechnical investigations.

There are also expected to be concrete batching plants located at a number of points along the alignment. It is likely that the location of the concrete batching plants will change throughout the construction works, and as such their impacts have been assessed along the entire alignment.

Track laying on the mainline is likely to be undertaken using a track layer. Laying of passing loops and construction of the maintenance facility is likely to be undertaken using more conventional equipment. The civil works are required to be completed and handed over such that there is no delay to the track laying.

Typical noise levels produced by construction equipment anticipated to be used for the Project (Rail) were sourced from the following:

- BS5228-1:2009 *Code of Practice for Noise and Vibration on Construction and Open Sites Part 1: Noise*
- AS2436: 2010 *Guide to Noise Control on Construction, Maintenance and Demolition Sites*
- United States Department of Transportation Federal Highway Administration – Construction Equipment Noise Levels and Ranges
- Other databases as appropriate

An indicative list of construction equipment/plant that may be used during construction and corresponding sound power levels is provided in Table 1-10.

Table 1-10 Indicative Construction Plant and Equipment

Task	Equipment	Estimated Sound Power Level L_{Aeq} dB
Civil Works	Dozer D9	114
	Grader	105
	30 tonnes excavator	109
	Scraper 20 tonnes	108
	Dump trucks and articulated dump trucks	109
	Front End Loader	106
	Rollers 18 tonnes	101
	Backhoe	96
	Water cart	107
	Mobile cranes/pipe layers	99
	Auger Piling Rig	110
	Impact Piling Rig	133
	Concrete batching plant	115
Track Works	Sleeper/Track Layer Plant[1]	114
	Ballast Regulator	114
	Rail Welding Machine (Generator)	107
	Ballast Tamper	115
	Water Cart	107
	20 tonnes excavator	109
	Backhoe	96

Task	Equipment	Estimated Sound Power Level L_{Aeq} dB
Quarries and borrow pits[2]	Dozer	114
	Excavator	109
	Water cart	107
	Dump truck	109

1 No noise data available for sleeper/track laying plant, therefore the sound power level has been conservatively estimated.
2 Equipment lists for quarries and borrow pits are indicative only

Construction Noise Sources

Construction noise at potential sensitive receptors was calculated based on distance loss from the source to the receptor. The calculations do not take into consideration the mitigating or enhancing effects of terrain, screening or meteorological conditions which may be present, therefore providing a measure of conservatism. These factors may be relevant features during some areas or time periods of construction activity. Due to the conservative nature of the prediction method however, it is expected that maximum noise impacts have been predicted

The magnitude of noise impacts associated with construction is dependent upon a number of factors including:

- The intensity of construction activities
- The location of construction activities
- The type of equipment used
- Existing local noise sources
- Intervening terrain
- The prevailing weather conditions

It has been considered that, mobile machinery would likely move about, variously altering the directivity of the noise source with respect to individual receptors. During any given period the machinery items to be used onsite would operate at maximum sound power levels for only brief stages. At other times the machinery may produce lower sound levels while carrying out activities not requiring full power. It is considered unlikely that all construction equipment would be operating at their maximum sound power levels at any one time. Finally, certain types of machinery would be present onsite for only brief periods during construction.

1.4.5 Construction Vibration Assessment Methodology

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

- The efficiency of the energy transfer mechanism of the equipment (i.e. impulsive, reciprocating, rolling or rotating equipment)
- The frequency content
- The impact medium stiffness

- The type of wave (surface or body)
- The ground type and topography

Due to the above factors, there is inherent variability in ground vibration predictions without site-specific measurement data. The New South Wales Roads and Maritime Services Environmental Noise Management Manual provides typical construction equipment ground vibration levels at 10 m, shown in Table 1-11 .

Table 1-11 Typical Vibration Level of Construction Plant Items

Plant Item	Range of PPV at 10 m (mm/s)[1]
Piling	12 – 30
15 tonne roller	7 – 8
Dozer	2.5 – 4
7 tonne compactor	5 – 7
Pavement breaker[2]	4.5 – 6
Backhoe	1

Source: Roads and Maritime Services Environmental Noise Management Manual 2001.

1. Mean PPV value adopted for this assessment.
2. Given the material properties, a pavement breaker is considered to slightly underestimate vibration levels caused by a rock breaker. A PPV of 7 mm/s at 10 m was adopted for a rock breaker.

The rate of vibration attenuation can be calculated from the following regression analysis formula:

- $V = kD^{-n}$, where:
  - V = PPV
  - k = Velocity (PPV) at D=1 unit of distance
  - D = Distance
  - n = attenuation exponent. The value of n generally lies between 0.8 and 1.6 with a relatively common value of 1.5[1]

1.4.6 Blasting Impacts Assessment Methodology

A general assessment of construction blasting has been undertaken to assess potential adverse impacts on the surrounding residential receptors in the unlikely event that blasting is required. Blasting estimations have been undertaken with consideration to AS2187.2 – 2006 *Explosives – Storage and use Part 2: Use of explosives* and have been based on available information. Blasting is non-linear in nature, and variability in ground type and meteorological conditions makes it difficult to accurately predict ground vibration and airblast overpressure without site specific measurement data therefore the blasting predictions should only be used as a guide.

[1] Construction Vibrations: State of the Art, John Wiss, 1981

Airblast overpressure can be estimated using the following equation:

- $P = K_a \left(\frac{R}{Q^{1/3}} \right)^a$, where:
  - P is the pressure (kPa)
  - R is the distance from charge (m)
  - Q is the charge mass (kg)
  - Ka is the site constant. AS2187.2 recommends for confined blasthole charges values are commonly in the range of 10 to 100. A value of 50 has been adopted for this assessment.
  - a site exponent. AS2187.2 recommends for confined blasthole charges a good estimate of a = -1.45.

Airblast overpressure propagation can be increased with unfavourable meteorological conditions and decreased with topographic shielding. Unconfined surface charges will considerably increase the airblast overpressure propagation.

Ground vibration has been estimated using the following equation:

- $V = K_G \left(\frac{R}{Q^{1/2}} \right)^{-1.6}$, where:
  - V is the peak vector sum ground vibration ppv (mm/s)
  - R is the distance from charge (m)
  - Q is the maximum instantaneous charge (MIC) (kg)
  - K_G is the ground constant. AS2187.2 gives a site constant for a free face in average field conditions of 1140 which has been used for the predictions. This value can vary between 240 and 4,400 times depending on ground conditions and other factors.

Reducing the charge mass or increasing the distance reduces the airblast overpressure and ground vibration.

Details of the blast configuration and design are indicative and will be confirmed through ongoing design and planning. Based on the type of blasts that would likely be required, it is not expected that a MIC of greater than 100 kg would be required and a charge of 50 kg or less is likely to be appropriate.

As ground vibration generally attenuates faster than airblast overpressure, the airblast overpressure is generally the critical factor which controls the distance in which blasting can occur.

1.4.7 Noise Model Configuration

Acoustic modelling was undertaken using Computer Aided Noise Abatement (CadnaA) to predict the effects of rail traffic noise from the Project (Rail).

CadnaA is a computer program for the calculation, assessment and prognosis of noise propagation. Ground absorption, reflection, terrain and relevant shielding objects are taken into account in the calculations.

Rail traffic noise modelling was conducted using the Nordic Rail Traffic Noise Prediction Method (Nordic). The Nordic prediction method is capable of calculating both the L_{Amax} and L_{Aeq} noise levels.

The proposed development has been modelled based on available data at the time of the assessment, and as such, should be used for comparison purposes only. In particular, the model reflects the status of the design at the time of the assessment[2].

Ground Contours and Rail Alignment

Digital terrain contours, cadastral data and rail alignment were sourced from the geospatial database for the Project.

Pending final earthworks and rail track design details it has been assumed, for the purposes of modelling, that the land immediately adjacent to the rail track will be level with the rail alignment extending 15 metres on each side of the track.

Embankments included in the design of the alignment were not available in digital form at the time of the assessment and have not been included in the noise model. This is considered to be a conservative approach. Based on previous experience, embankments have the potential to reduce noise levels at any particular receptor by up to 10 dB depending on their height and the relative receptor location.

Model Configuration

The following assumptions were made with regard to the model configuration:

- A general ground absorption coefficient of 0.5 was used throughout the model
- Atmospheric conditions of 20°C and 70 per cent humidity were used
- Neutral weather conditions. Noise enhancing weather conditions, such as night-time temperature inversions, are not required to be assessed as part of the Queensland Rail's Code of Practice Guidelines.

Modelled Scenario

A 100 Mtpa scenario was modelled for Rail (west) and a 60 Mtpa scenario was modelled for Rail (east).

Rail Traffic Assumptions

Current design calls for 32 tonne axle loads for rollingstock, consistent with other heavy haul coal railways around the world.

Current design plans are for the transportation of up to 100 Mtpa of coal at peak production, equating to 18 trains per day to be required on average, one way (36 train movements each day). The design plans for 100 Mtpa include rail usage by third parties.

A number of locomotive types have been selected for potential rail haulage, namely diesel-electric hauled and diesel hauled. It is understood that the diesel locomotives may be used at various stages of the Project (Rail) and to achieve operational capacity of up to 100 Mtpa and have been selected to be included in the assessment. The diesel locomotives are also the louder of the two options and provide a conservative approach. Wagons with a bottom dump coal hopper will be used for the transport of coal. Relevant train specifications include:

[2] Option 9, Revision 3 rail alignment used for noise modelling purposes.

- Builder: GE / EMD
- Model: Narrow gauge: PH37 / GT46AC (under development)

  Standard gauge: ES44AC
- Power Output: 3,300 kW (4,400 hp)
- Number of locomotives per train: 4
- Number of wagons per train: up to 240
- Maximum empty train speed: 100 km/hr
- Maximum loaded train speed: 80 km/hr
- Total length of train: approximately 4 km

The following assumptions were made with regard to the modelled rail movements and configuration:

- Expected coal train movements per day for peak capacity (100 Mtpa on Rail (west) and 60 Mtpa on Rail (east)) are 18 trains in each direction (train movements spread out evenly over a 24-hour period).
- Trains on Rail (west) were modeled with 240 wagons for a total train length of approximately 4 km
- Trains on Rail (east) were modeled with 164 wagons for a total train length of approximately 2.8 km
- Design speed assumed to be 80 km/h for loaded trains (mine-to-port) and 100 km/hr for un-loaded trains (port-to-mine)
- Trains within the mine load-out loop were modelled at 30 km/hr in the loop section and at 1 km/hr within the load-out section

Trains were modelled using the Nordic prediction method based on measurements conducted on similar types of trains for United Group Rail Limited by GHD Pty Ltd (GHD). The sound power level per linear metre used in the model is shown in Table 1-12.

Table 1-12 Class 83 locomotive and wagons Sound Power Level1

Source	Octave Band Centre Frequency (Hz) dB(Lin)							Sound power per linear metre dB(A)
	63	125	250	500	1k	2k	4k	
GE Locomotive ES44AC	86	89	91	93	88	86	80	94

2. Existing Environment

2.1 Potential Sensitive Receptors

The land use in the vicinity of the Project (Rail) is rural in nature. Potential sensitive receptors identified within approximately 5 km of the Project (Rail) are listed in Table 2-1 and the locations shown in Figure 1-2 (refer Section 1.4.2).

Table 2-1 Potential Sensitive Receptors

Potential Receptors	Easting	Northing	Approximate Distance from the Project (Rail) (m)	Description/Comment
1	448007	7570210	2,450 (south)	Project (Mine) workers accommodation village
2	462027	7572602	3,300 (south)	Homestead
3	475674	7575617	3,000 (south)	Homestead
4	482139	7579957	3,000 (south)	Homestead
5*	494429	7589482	4,200 (north)	Homestead
6	525174	7583086	2,000 (north)	Homestead
7	546218	7578704	1,600 (north)	Homestead
8	555680	7578811	3,000 (north)	Homestead
9*	561038	7577015	1,900 (north)	Homestead

*Denotes monitoring location.

As Figure 1-2 shows, the area in the vicinity of the proposed Project (Rail) is sparsely populated with few identified potential sensitive receptors. The nearest identified potential sensitive receptor in relation to the Project (Rail) is approximately 1.6 km away.

While the locations of quarries and borrow pits have not yet been finalised, preliminary plans indicate that they will be at least 1 km from the nearest sensitive receptor. In most cases, they are likely to be several kilometres from the nearest sensitive receptor.

2.2 Background Noise

A locality map of monitoring locations is provided in Figure 1-2. A description of the monitoring locations and monitoring methods is provided in Section 1.4.2.

Unattended monitoring results are provided in Table 2-2 and Table 2-3 and summarised in Table 2-4. The results are presented in graphical format in Appendix B. Data was removed from the tabulated data during periods in which wind speeds were over 5 m/s or rainfall occurred, as per the methodology defined in Section 1.4.2.

Table 2-2 Unattended Noise Monitoring Results – Monitoring Location A

Date	Background L_{A90} dB(A)			Ambient L_{Aeq} dB(A)		
	Day (7:00 am - 6:00 pm)	Evening (6:00 pm – 10:00 pm)	Night (10:00 pm – 7:00 am)	Day (7:00 am – 6:00 pm)	Evening (6:00 pm – 10:00 pm)	Night (10:00 pm – 7:00 am)
26-Aug-11	24	-	23	-	-	53
27-Aug-11	24	32	21	43	50	45
28-Aug-11	24	24	21	46	45	35
29-Aug-11	23	23	24	44	47	40
30-Aug-11	25	28	21	43	44	37
31-Aug-11	24	30	21	45	49	41
01-Sep-11	27	29	19	46	46	41
02-Sep-11	26	26	28	49	47	39
03-Sep-11	32	30	20	45	48	43
04-Sep-11	25	25	20	43	48	38
05-Sep-11	26	21	26	43	45	39
06-Sep-11	24	-	-	46	-	-
RBL and Leq Overall	**25**	**27**	**21**	**45**	**47**	**44**

(-) denotes data not available

Table 2-3 Unattended Noise Monitoring Results – Monitoring Location B

Date	Background L_{A90} dB(A)			Ambient L_{Aeq} dB(A)		
	Day (7:00 am – 6:00 pm)	Evening (6:00 pm – 10:00 pm)	Night (10:00 pm – 7:00 am)	Day (7:00 am – 6:00 pm)	Evening (6:00 pm – 10:00 pm)	Night (10:00 pm – 7:00 am)
26-Aug-11	27	27	25	44	40	41
27-Aug-11	27	26	28	42	37	43
28-Aug-11	27	26	31	46	41	44
29-Aug-11	28	30	33	48	42	45
30-Aug-11	29	31	32	46	42	41
31-Aug-11	31	33	31	52	40	45
01-Sep-11	30	32	25	47	40	42
02-Sep-11	33	32	28	47	44	42

Date	Background L_{A90} dB(A)			Ambient L_{Aeq} dB(A)		
	Day (7:00 am – 6:00 pm)	Evening (6:00 pm – 10:00 pm)	Night (10:00 pm – 7:00 am)	Day (7:00 am – 6:00 pm)	Evening (6:00 pm – 10:00 pm)	Night (10:00 pm – 7:00 am)
03-Sep-11	39	32	25	51	45	43
04-Sep-11	34	31	22	50	42	42
05-Sep-11	33	30	24	49	38	44
06-Sep-11	33	30	21	48	40	42
07-Sep-11	33	-	-	-	-	-
RBL and Leq Overall	**31**	**31**	**27**	**48**	**41**	**43**

(-) denotes data not available

Noise monitoring results at both locations are typical of a rural environment with low background noise levels, during day (7:00 am to 6:00 pm), evening (6:00 pm to 10:00 pm) and night (10:00 pm to 7:00 am) periods.

It is evident from the results that background noise levels during night-time periods consistently fall to below 25 dB(A) at Monitoring Location A and to a lesser extent at Monitoring Location B. The RBL for each day/evening/night period at Monitoring Location A is 25 dB(A), 27 dB(A) and 21 dB(A), respectively. At Monitoring Location B the RBL for each day/evening/night period, respectively, is 31 dB(A), 31 dB(A) and 27 dB(A).

The ambient noise level (L_{Aeq}) for each day/evening/night period, respectively, at Monitoring Location A was recorded as 45 dB(A), 47 dB(A) and 44 dB(A). At Monitoring Location B the ambient noise level for each day/evening/night period, respectively, was recorded as 48 dB(A), 41 dB(A) and 43 dB(A).

Attended noise monitoring results are summarised in Table 2-5 and indicate that generally higher noise levels at Monitoring Location B can be attributed to the influence of birdlife and wind in foliage. Noise levels at Monitoring Location A were influenced by intermittent noise associated with cattle.

Table 2-4 Summary of Unattended Noise Monitoring Results

Monitoring Location	Background L_{A90} dB(A)[1]			Ambient L_{Aeq} dB(A)[1]		
	Day (7:00 am – 6:00 pm)	Evening (6:00 pm – 10:00 pm)	Night (10:00 pm – 7:00 am)	Day (7:00 am – 6:00 pm)	Evening (6:00 pm – 10:00 pm)	Night (10:00 pm – 7:00 am)
A	25	27	21	45	47	44
B	31	31	27	48	41	43

Note 1: Rounded to nearest integer

Table 2-5 Summary of Attended Noise Survey Results

Monitoring Location	Period Date	Duration (mins)	Time	dB(A) L90	dB(A) Leq	Comments (instantaneous Noise Levels dB(A))
A	26/08/11	15	12:20	23.8	31.3	◗ Air conditioning unit barely audible (< 30) ◗ Insects (23-45) ◗ Cattle (27-41)
B	26/08/11	15	15:30	28.5	37.0	◗ Birds (<30-40) ◗ Insects (<30-32) ◗ Cattle (35-37) ◗ Wind in foliage (34-41) ◗ Dog bark (45-46)

2.3 Background Vibration

Measured ground vibration results indicate very low ground vibration levels (in the order of 0.1 mm/s) at all locations which confirms the lack of perceivable vibration at all sites.

Baseline vibration results are tabulated in Table 2-6. Similar levels of existing ground vibration are expected along the length of the Project (Rail).

Table 2-6 Vibration Measurement Results – Peak Particle Velocity (mm/s)

Monitoring Location	Date/Time	Direction			Sum	Observations
		Trans	Vert	Long		
Location A	06/09/2011 08:22	0.0794	0.0635	0.0794	0.0926	No perceivable ground vibration
Location B	06/09/2011 07:25	0.0952	0.0794	0.0794	0.0966	No perceivable ground vibration

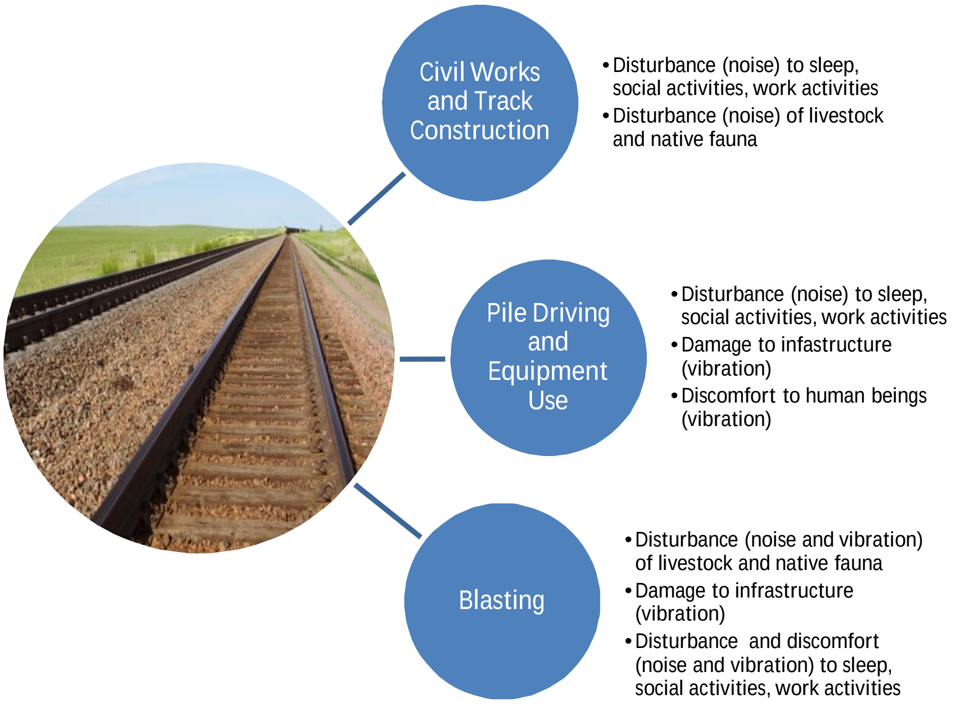
3. Potential Impacts and Mitigation

3.1 Overview

The construction and operation of the Project (Rail) have the potential to cause noise and vibration impacts on the surrounding environment.

Potential construction impacts have been identified and analysed on the basis of a desktop analysis considering the construction methods and equipment proposed to be used. Figure 3-1 provides a conceptual overview of the potential construction impacts of the Project (Rail).

Figure 3-1 Conceptual Overview of Potential Construction Impacts



Potential and predicted operational impacts have been identified and analysed on the basis of a desktop analysis combined with acoustic modelling based on the terrain, train configuration and daily movements. With regard to the Project (Rail) operational phase, haulage, and thus train movement, is the primary aspect influencing noise and vibration.

Potential noise impacts arising during the operational phase may include: disturbance to sleep, social activities and work activities; and disturbance to livestock and native fauna. Potential vibration impacts arising during the operational phase may include: disturbance to sleep, social activities and work activities.

3.2 Civil Works and Track Construction

3.2.1 Potential Noise Impact

Construction activities, such as civil works including: earthworks, drainage construction, haul road and access track construction, maintenance and bridgework construction as well as track construction (including track laying, signalling installation and communications installation) have the potential to adversely impact on noise sensitive places through:

- Disturbance to sleep, social activities and/or work activities
- Disturbance of native fauna and livestock

Predicted construction noise for combined plant operation during each activity has been calculated at increasing distances from the Project (Rail) and is shown in Table 3-1. It is evident that noise generated by construction plant dissipates over distance. Predicted noise levels at a one kilometre distance from construction activities range from 49 dB(A) to 53 dB(A). At a three kilometre distance, the range is 39 dB(A) to 44 dB(A).

Table 3-1 Predicted Construction Noise over Distance, dB(A)

Activity	Overall sound power level dB(A)	Distance (m)						
		50	100	250	500	1000	2000	3000
Civil Works[1]	119	77	71	63	57	51	45	41
Track Works	121	79	73	65	59	53	47	44
Quarries and Borrow Pits	117	75	69	61	55	49	43	39

1 Excludes pile driving impact noise

Predicted construction noise levels at the identified nearest sensitive receptors are provided in Table 3-2. Minimum predicted noise levels at these locations are in the order of 38 dB(A). Maximum predicted noise levels are in the order of 49 dB(A), excluding impact piling activities. Impact piling is predicted to generate higher noise levels in the order of 61 dB(A), however is largely confined to civil works associated with river crossings.

Table 3-2 Predicted Construction Noise for the Nearest Sensitive Receptors, dB(A)

Receptor	Distance from investigation corridor (m)	Civil works (excluding impact piling)	Track Works	Impact Piling
1	2,450	43	45	57
2	3,300	40	43	55
3	3,000	41	44	55
4	3,000	41	44	55
5	4,200	38	41	53

Receptor	Distance from investigation corridor (m)	Civil works (excluding impact piling)	Track Works	Impact Piling
6	2,000	45	47	59
7	1,600	46	49	61
8	3,000	41	44	55
9	1,900	45	48	59

* Predictions assume that the construction equipment is operating at the nearest part of the Project (Rail).

The daytime background noise level in the vicinity of the nearest sensitive receptors is typical of a rural setting and measured to be in the order of 31 dB(A). The ambient daytime noise level is in the order of 48 dB(A).

The adopted WHO criteria for night-time sleep disturbance of 55 dB(A) L_{max} external to the dwelling is predicted to be met at all receptors, with the exception being impact piling during night time hours . Therefore, as discussed in Section 3.4.2 it is recommended that the use of impact piling is restricted to day-time hours only.

Given the intermittent, mobile and short-term nature of construction noise, the estimates are considered conservative. Essentially, they represent the maximum possible distances over which an acoustic impact may occur during quiet ambient conditions. If such impacts were to occur, they would likely be intermittent and infrequent. Furthermore, the construction of the rail track is transient in nature, exposing individual receptors for short periods of time (usually in the order of days or weeks). Noise impacts would reduce as the rail construction progresses along the route away from receptors.

Based on the above findings, it is not anticipated that construction of the rail corridor will cause adverse noise impacts at identified receptors. Based on the above findings, while it is not anticipated that construction of the rail corridor will cause adverse noise impacts at identified receptors, measures to minimise the generation of construction noise will be applied and are provided in Section 3.2.2.

3.2.2 Management Measures

While construction noise levels are unlikely to cause adverse impacts, it is considered that implementation of management measures will further facilitate minimisation of the generation of noise and associated potential for impacts arising from the construction of the Project (Rail). In particular, noise controls should be implemented during high noise generating activities, such as pile driving, or when construction activities are required to be undertaken outside of the standard daytime working hours.

The following reasonable and practical measures will be considered (having due regard for operational health and safety constraints) in developing ways to minimise the potential of unreasonable noise during the construction of the Project (Rail):

- Locate mobile plant (e.g. compressors, generators), concrete batching plants and construction camps as far as practicable away from the nearest potential sensitive receptors
- Construction activities generating noise above ambient levels in the vicinity of the nearest noise sensitive places (within 2 km of the Project (Rail)) should, wherever possible and practicable, be confined to general work hours of 6:30 am – 6.30 pm Monday to Saturday.

- Where it is necessary for such activities to be carried out outside standard day-time working hours, potentially impacted receptors will be notified in advance of the activities (at least 1 week before). The notification will include:
  - The schedule of construction and maintenance activities (the proposed times)
  - The reasons for construction and maintenance activities being carried out outside standard day-time working hours
  - Likely timeframes of construction and maintenance activities (the proposed dates)
  - Access routes for workers and equipment
  - Nature of construction and maintenance activities
- Due to the potential for sleep disturbance, it is recommended that, impact pile driving should only be undertaken during the “standard day-time working hours” listed above
- Direct principal noise sources (e.g. exhausts) away from noise-sensitive places as far as possible
- Fitting of equipment with effective and properly maintained noise suppression equipment consistent with the requirements of the activity, where possible
- Ensure equipment utilised is maintained and operated as per manufacturers’ specifications
- Minimise the use of warning devices to within operational health and safety constraints
- Co-ordination of loading/unloading of material activities to be within standard day-time working hours wherever practicably possible
- Encourage construction operators to have equipment that includes noise performance as a selection criterion at the time of purchase
- Refine construction noise and vibration predictions (as necessary) once a construction methodology for detailed design has been determined and implement and manage further controls through development of a Construction Noise Management Plan.

3.3 Vibration from Pile Driving and Equipment Use

3.3.1 Potential Vibration Impact

While blasting normally generates the highest levels of ground vibration, construction activities and equipment such as pile driving can also lead to high vibration levels resulting in infrastructure damage. Assessment of potential vibration impacts is needed to minimise potential adverse impacts on the surrounding sensitive receptors. Ground vibration caused by blasting is covered in Section 3.3.

The predicted ground vibrations at various distances for typical construction equipment are shown in Table 3-3, based on the reference data provided in Table 1-11.

Table 3-3 Predicted Construction Equipment Vibration Levels

Plant Item[3]	Human Perception Preferred Criteria *(Maximum Criteria)*		Predicted Ground Vibration Levels (mm/s PPV)				
	Day	Night	10 m	30 m	50 m	100 m	300 m
Pile Driving (Impulsive)	8.6 *(17.0)*	2.8 *(5.6)*	21.0	4.0	1.9	0.7	0.1
15t Roller	0.28 *(0.56)*	0.2 *(0.4)*	7.5	1.4	0.7	0.2	<0.1
Dozer	0.28 *(0.56)*	0.2 *(0.4)*	3.3	0.6	0.3	0.1	<0.1
7t compactor	0.28 *(0.56)*	0.2 *(0.4)*	6.0	1.2	0.5	0.2	<0.1
Rock Breaking	0.28 *(0.56)*	0.2 *(0.4)*	7	1.3	0.6	0.2	<0.1
Backhoe	0.28 *(0.56)*	0.2 *(0.4)*	1	0.2	0.1	<0.1	<0.1

Table 3-3 indicates vibration levels of 0.1 mm/s or less at a distance of approximately 300 m. This is well below the adopted vibration criteria for all nominated plant items, including pile driving. The nearest identified sensitive receptor to the Project (Rail) is located 1.6 km from the rail corridor. Therefore, it is unlikely that ground vibration as a result of construction activities and equipment (excluding blasting) will adversely impact potentially sensitive receptors.

Furthermore, vibration levels produced by construction activities within the rail corridor are expected to be well below the most stringent structural damage criteria of 3 mm/s at receptors located at distances greater than 50 m.

3.3.2 Management Measures

While construction vibration levels are unlikely to cause adverse impacts, it is considered that implementation of the following management measures will further facilitate minimisation of potential impacts arising from the construction of the Project (Rail):

- Undertake pre-construction building and infrastructure surveys on properties potentially susceptible to vibration damage from construction of the railway
- Monitor vibration levels during construction to prevent sustained vibration levels causing unacceptable loading

[3] NSW RMS Environment Noise Management Manual 2001.

3.4 Vibration from Blasting

3.4.1 Potential Impact

The need for blasting is not yet determined and is dependent on further geotechnical investigations. It is however, not considered likely at this stage for the Project (Rail). In the event that blasting is required for excavations of sections of the Project (Rail) the most likely effect is airblast overpressure. Methods to reduce the impact of airblast overpressure are detailed in Section 3.4.2.

Potential adverse impacts to sensitive receptors may include:

- Disturbance of native fauna and livestock
- Damage to property and infrastructure as a result of vibration

Blast impacts (airblast overpressure and ground vibration) have been predicted at sensitive receptors, based on a MIC of 50 kg and are shown in Table 3-4.

Table 3-4 Predicted Blast Impacts

Receptor	Distance from Project (Rail) (m)	Estimated Airblast Overpressure, dB(Linear)*		Estimated Ground Vibration, PPV (mm/s)*	
		k_a = 10	k_a = 100	K_g = 800	K_g = 1600
1	2,450	92.1	112.1	0.1	0.1
2	3,300	88.4	108.4	0.0	0.1
3	3,000	89.6	109.6	0.0	0.1
4	3,000	89.6	109.6	0.0	0.1
5	4,200	85.3	105.3	0.0	0.1
6	2,000	94.7	114.7	0.1	0.2
7	1,600	97.5	117.5	0.1	0.3
8	3,000	89.6	109.6	0.0	0.1
9	1,900	95.3	115.3	0.1	0.2
Adopted criteria		115 dB(L)		5 mm/s PPV	

*Based on MIC 50 kg.

Predictions indicate that with a MIC of 50 kg and average ground conditions, the ground vibration criterion is met at all receptors. Predicted airblast overpressure levels have the potential to exceed the recommended blasting criteria by 2.5 dB(L) at the nearest sensitive receptor under adverse conditions (k_a = 100). This exceedence would occur if blasting was to take place at the closest location to these sensitive receptors.

While blasting is considered unlikely to cause adverse impacts to potentially sensitive receptors, potential blasting mitigation measures are provided in Section 3.4.2.

3.4.2 Management Measures

If required, blasting noise and vibration levels may be reduced by application of the following[4]:

- Reducing the MIC by using delays, reduced hole diameter and/or deck loading
- Changing the burden and spacing by altering the drilling pattern and/or delay layout, or altering the hole inclination
- Exercise strict control over spacing and orienting all blast drill holes
- Use minimum practicable sub-drilling which gives satisfactory toe conditions
- Investigate alternative rock-breaking techniques
- Establish times of blasting to suit local conditions
- Direction of detonator initiation away from near residences
- Once the exact location of blasting is known the distance to any potential receptors should be used for the charge mass estimate. Blast monitoring should be undertaken to assess compliance, determine the site constants and confirm the predictions. The blast design should ensure that the airblast overpressure and ground vibration limits are met at sensitive receptors.
- Undertake blasting only during standard day-time work hours. Adverse meteorological conditions such as temperature inversions and wind direction can significantly increase airblast overpressure levels. Temperature inversions are most common during night and early morning periods, therefore should not affect blasting during the recommended standard hours.
- Undertake airblast overpressure monitoring during the initial blasts to assist with the optimisation of the blast parameters and confirmation of predictions. MIC and stemming height together with other blast parameters should be modified to achieve the airblast criteria.

3.5 Operational Train Movements

3.5.1 Potential Impact

Train movements have the potential to adversely impact on noise sensitive places through:

- Disturbance to sleep, social activities and/or work activities
- Disturbance of native fauna and livestock

Predicted rail noise levels are compliant with the Code of Practice for Railway Noise Management (QR, 2007) at all existing identified sensitive receptors, falling below the 65 LAeq, 24hr dB(A) and 87 Lmax dB(A) criteria. Predicted noise levels at sensitive receptors are expected to range between 40 – 51 L_{Aeq}, 24hr dB(A) and 51 – 62 L_{Amax} dB(A). At the closest sensitive receptor, modelling indicates that operational rail noise levels, would be 14 dB(A) and 25 dB(A) below the acceptable L_{Aeq}, 24hr and L_{Amax} noise criteria, respectively.

Table 3-5 shows predicted rail noise levels at identified noise sensitive receptors. Noise modelling contours are provided in **Error! Reference source not found.** for the proposed 100 Mtpa development scenario.

[4] It must be acknowledged that the design of the blast is undertaken by the appointed blast contractor and that the management measures are assumed only for the purpose of this assessment, and in the absence of more specific information.

Table 3-5 Comparison of Predicted Noise Levels at Identified Sensitive Receptors

Potential Sensitive Receptor	$L_{Aeq,24hr}$ dB(A)		L_{max} dB(A)	
	Noise Criteria*	Predicted Noise Level	Noise Criteria*	Predicted Noise Level
1		48		59
2		45		56
3		45		56
4		45		56
5	65	40	87	51
6		49		61
7		51		62
8		43		54
9		48		61

* Code of Practice for Railway Noise Management (QR, 2007)

Given the nearest sensitive receive is 1.6 km from the Project (Rail), it is unlikely there would be adverse impact regarding operational vibration. Furthermore, recent vibration testing of coal trains in the Hunter Valley has indicated that there is low probability of adverse impact upon the human comfort or structures when located more than 40 m from the rail line (Vipac, 2009). The vibration monitoring was completed on the Australian Rail Track Corporation (ARTC) rail network, where both Pacific National and QR National trains operate.

Additional rail vibration assessments have been conducted on the ARTC network in the Hunter Valley (Hunter8 Alliance, 2010). Measurements of pass-by vibration levels of trains similar to what would be used for the Project (Rail) resulted in similar findings, with negligible vibration levels at distances greater than approximately 50 m from the rail line. These reports are considered to be relevant and represent typical rail vibration levels from the Project (Rail). Therefore, operational rail related vibration is expected to be negligible at all identified receptors.

3.5.2 Management Measures

While predicted noise levels are compliant with the adopted QR National criteria, it is considered that the following management measures (in line with the Code of Practice for Railway Noise Management (QR, 2007)) will further facilitate minimisation of potential impact arising from the operation of the Project (Rail):

- Appropriate use of horns and warning devices will be included within driver training
- Maintenance activities and potential noise from maintenance facilities will be managed through operational controls developed specifically for the sites (e.g. maintenance yard, bad order sidings) and documented in a Noise Management Plan. Measures may include, for example, regular maintenance of equipment to facilitate operation within acceptable sound and vibration limits; limiting the dropping of containers and materials from heights; improved training and induction with regard to

noise and vibration; reduce unnecessary revving and idling or engines; direct noise sources away from potential noise receptors; and locate mobile plant away from potential noise receptors as far as is practicable.

- Refine further noise modelling as the Project (Rail) design progresses and develop additional controls as appropriate. Although control measures would not be expected to be required, such measures may include installation of noise barriers and construction of embankments to deflect noise.

3.6 Noise Impacts on Native Fauna and Livestock

Current research indicates that there are no government policies or widely accepted guidelines with regard to noise criteria for animals. However, information is provided in technical literature which is discussed below.

3.6.1 Native Fauna

Previous extensive clearing of vegetation in the Project (Rail) area for agricultural purposes has reduced the amount of available habitat, and as a result, has minimised the potential for impact by the Project's (Rail) operational noise on local wildlife.

The effect of noise on wildlife can be similar to the effects observed in humans. Noise can adversely affect wildlife by interfering with communication, masking the sounds of predators and prey, cause "stress" or avoidance reactions and (in the extreme) result in temporary or permanent hearing damage. Experiments have also shown that exposure to noise impulses throughout the night-time sleep period resulted in poorer daytime task performance by animals (see Fletcher and Busnel, 1978).

The learning ability of many animal species is discussed by Busnel (1971). The animal's initial reaction to a new noise source is fright and avoidance but if other sensory systems are not stimulated (for instance optical or smell), the animal learns quite quickly to ignore the noise source, particularly when it exists in the presence of man.

Migratory birds have the potential to be influenced by noise from the Project (Rail). Studies of birds (Larkin, 1996) have shown that they will habituate to loud noises that are not biologically meaningful for them. For example if the noise is associated with possible harm such as thunder on a cloudy day, birds will avoid it, but routine noises such as traffic will not disturb them. Examples are provided of sea-birds that voluntarily co-exist with relatively loud noise environments, such as around airports, and birds roosting on light-posts above busy motorways.

Attempts at using noise to deliberately scare birds away from an area, for example to protect farming crops, have been shown to grow less effective over time as birds habituate to the noise. Larkin suggests that keeping the noise as consistent as possible both in the sound produced and the frequency with which it occurs may also help mitigate its effects on birds.

Poole (1982) and Algers *et al* (1978) shows that birds tend to adapt to steady state noise levels, even of a relatively high level (in the order of 70 dB(A)). Given the predicted noise levels from the Project (Rail) are expected to be much less than this level, noise impacts on birds surrounding the Project (Rail) are considered acceptable.

3.6.2 Livestock

The noise goals provided in this report are based on human response and annoyance factors and, as such, are not applicable to livestock or other non-human receptors. However, it is recognised that sudden noise has the potential to startle or upset domestic livestock and pets. Heggies Pty Ltd conducted a literature review as part of their assessment of blasting noise impacts on livestock for the proposed Caval Ridge Coal Mine Project (Heggies 2009). Heggies cites results from a study on the response of farm animals to sonic booms, which indicated that reactions of sheep, horses and cattle to sonic booms (125 dB to 136 dB) were considered slight to mild.

The study indicated that analysis of data from 42 herds did not show any evidence that flyovers or proximity to the ends of the active runways had an effect on the milk production of the herds. Animal installations were selected for observations on animal behaviour under sonic boom conditions. Numbers of animals observed in this study were about 10,000 commercial feedlot beef cattle, 100 horses, 150 sheep and 320 lactating dairy cattle. Booms during the test period were scheduled at varying intervals during the morning hours Monday to Friday of each week.

Results of the study showed that the reactions of the sheep and horses to sonic booms were slight. Dairy cattle were little affected by sonic booms (125 dB to 136 dB). Only 19 of 104 booms produced even a mild reaction, as evidenced by a temporary cessation of eating, rising of heads, or slight startle effects in a few of those being milked. Milk production was not affected during the test period, as evidenced by total and individual milk yield.

Heggies conclude that apart from the possibility of noise from blasting startling birds and therefore over time possibly changing where they nest, no adverse impacts on animals are predicted for this project. Given that there is no conclusive information available to confirm that should birds be startled they will change where they nest, noise impacts on animal life surrounding the Project (Rail) are considered acceptable.

4. Conclusion

4.1 Operational Noise and Vibration

This assessment indicates that rail noise levels from the proposed corridor are expected to meet the 65dB(A) $L_{Aeq,24hrs}$ and 87dB(A) L_{max} noise targets at all identified sensitive receptors.

Similarly, operational vibration targets will readily be met at all identified receptors.

4.2 Construction Noise and Vibration

Calculations indicate that the highest sound pressure levels will be generated in proximity to construction activities such as impact piling. Given the separation distance between construction work and the nearest sensitive receptors it is unlikely that any adverse noise impacts will occur during construction works.

Mitigation measures to minimise construction noise are outlined in Section 3. It is recommended that these are considered and implemented if high noise generating activities such as impact piling are conducted outside standard day-time working hours.

Vibration levels produced by rail corridor construction activities are expected to be well below the most stringent structural damage criteria of 3 mm/s at all identified receptors.

4.3 Blasting

Given the distance to the nearest sensitive receptors, noise and vibration impacts from blasting are unlikely to occur under the majority of scenarios. Under worst-case conditions it has been predicted that a marginal exceedance of the airblast overpressure criteria may occur at the nearest sensitive receptor when blasting is conducted at the closest point of the Project (Rail) to the receptor. Blasting mitigation measures have been recommended to assist in reducing the magnitude of the noise and vibration levels as well as the perception of vibration at sensitive locations. It is recommended that blast monitoring be considered to assess compliance and confirm the predictions. All residential receptors will be informed when blasting is to be undertaken.

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Wiss, J., 1981, Construction Vibrations: State of the ArtHeggies (2009), Caval Ridge Coal Mine Project Environmental Impact Assessment*,* report to BHP Billiton Mitsubishi Alliance

Appendix A

Terms of Reference Cross-reference

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Terms of Reference Requirement / Section Number	Section of this Report
3.7 Noise and Vibration	
3.7.1 Description of environmental values	
Describe the existing noise and vibration environment that may be affected by the project in the context of environmental values as defined by the *Environmental Protection (Noise) Policy 2008* (EPP Noise). DERM's *Noise Measurement Manual* should be considered and references should be made to the EPA's *Guideline: Noise and Vibration from Blasting*.	Sections 1.3 and 2
Identify sensitive noise receptors adjacent to all project components and estimate typical background noise and vibration levels based on surveys at representative sites. Include proposed accommodation camps as sensitive noise receptors.	Section 2
Discuss the potential sensitivity of such receptors and nominate performance indicators and standards.	Sections 1.3, 2.1. and 3
The locations of any noise sensitive receptors, as listed in Schedule 1 of EPP Noise, should be identified on a map at a suitable scale.	Section 2.1 Figure 1-2
Where a railway is also proposed to be constructed and operated, conduct an assessment of the acoustic impacts of the rail in the context of: ◗ the QR Code of Practice for Railway Noise Management for external design level noise criteria ◗ meeting indoor design level noise criteria to achieve average maximum sound level between 10:00 pm and 6:00 am of 45 decibels (dB)	Section 3 Section 1.3

Terms of Reference Requirement / Section Number	Section of this Report
3.7 Noise and Vibration	
3.7.2 Potential impacts and mitigation measures	
Describe the impacts of noise and vibration generated during the construction and operational phases of the project. Noise and vibration impact analysis should include: ◗ the levels of noise and vibration generated, including noise contours, assessed against current typical background levels, using modelling where appropriate ◗ impact of noise, including low frequency noise (noise with components below 200 Hz) and vibration at all potentially sensitive receptors compared with the performance indicators and standards nominated above ◗ impact on terrestrial and aquatic fauna ◗ proposals to minimise or eliminate these effects, including details of any screening, lining, enclosing or bunding of facilities, or timing schedules for construction and operations that would minimise environmental harm and environmental nuisance from noise and vibration	Sections 3.2, 3.3, 3.5 and 3.6 Figure 1-2
Any impact on human health at sensitive receptors (including accommodation camps) must be appropriately mitigated to achieve a satisfactory internal noise level for the preservation of health and well-being identified within the *Environmental Protection (Noise) Policy 2008*.	Sections 3.2, 3.3, 3.5 and 3.6 Figure 1-2
Provide management options at sensitive receptors when noise attenuation at the source does not adequately reduce noise generation.	

Appendix B

Noise Monitoring Data

Location A

Location B

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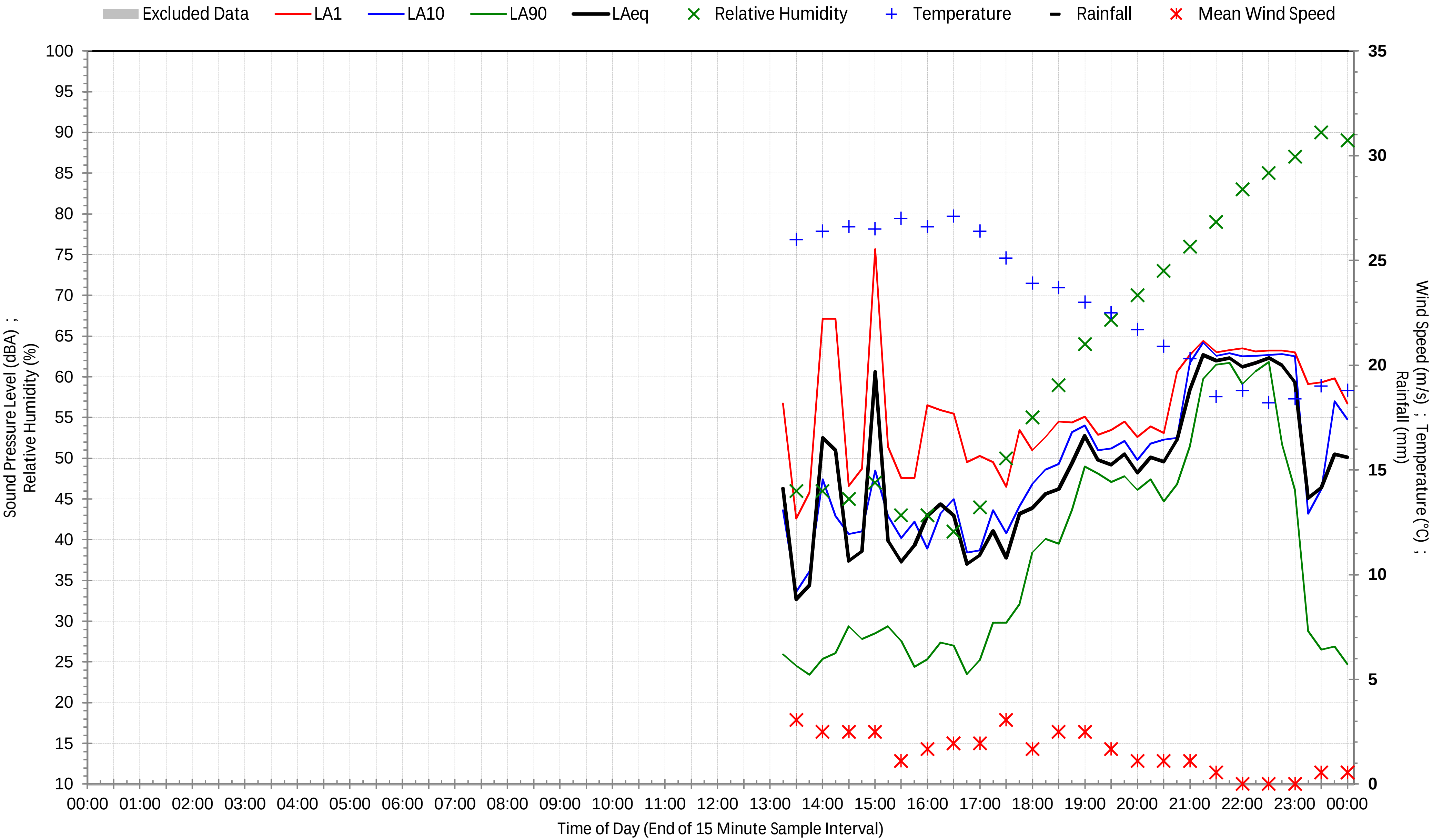
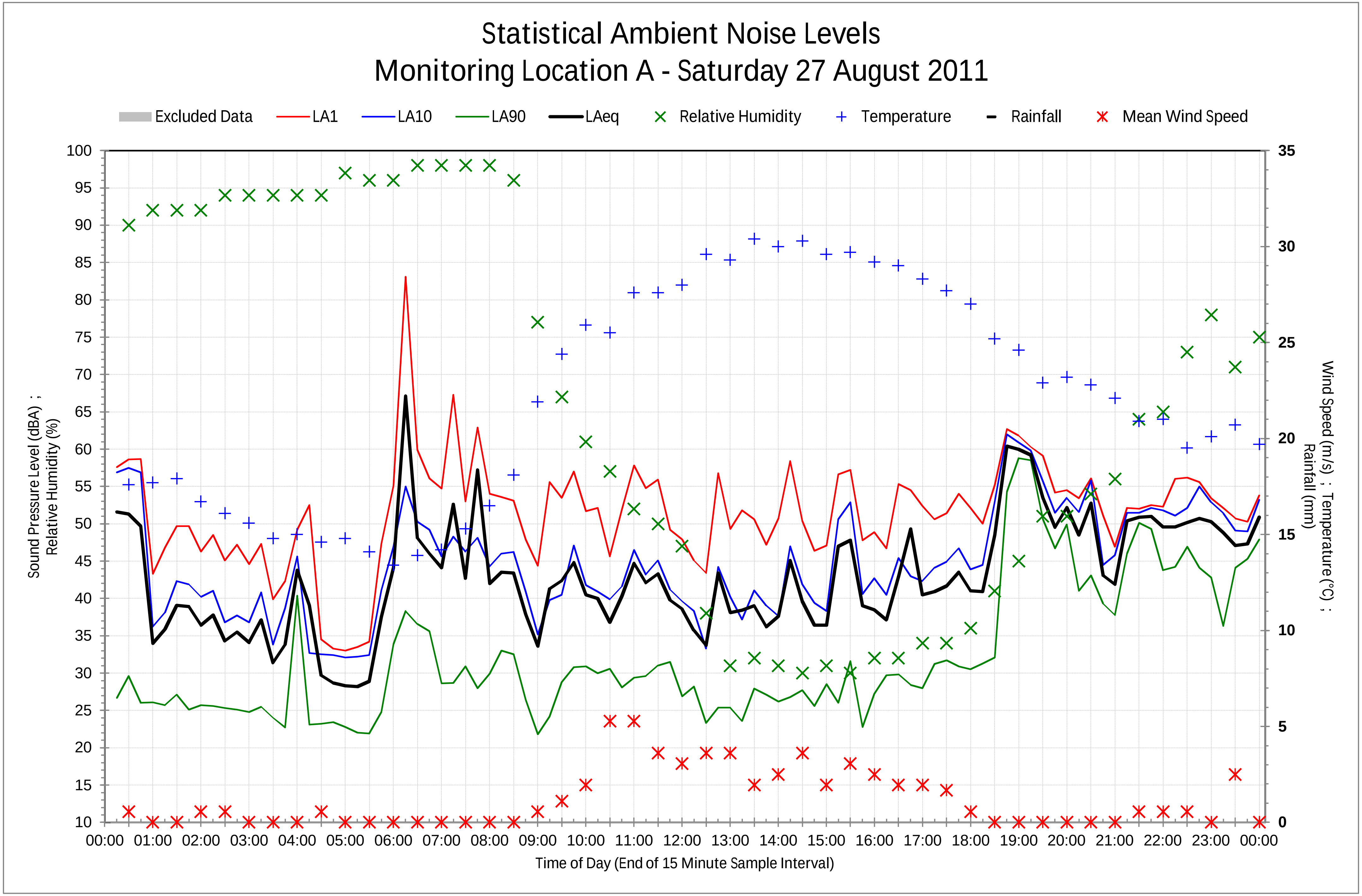
Statistical Ambient Noise Levels
Monitoring Location A - Friday 26 August 2011




Statistical Ambient Noise Levels
Monitoring Location A - Saturday 27 August 2011
Excluded Data
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Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
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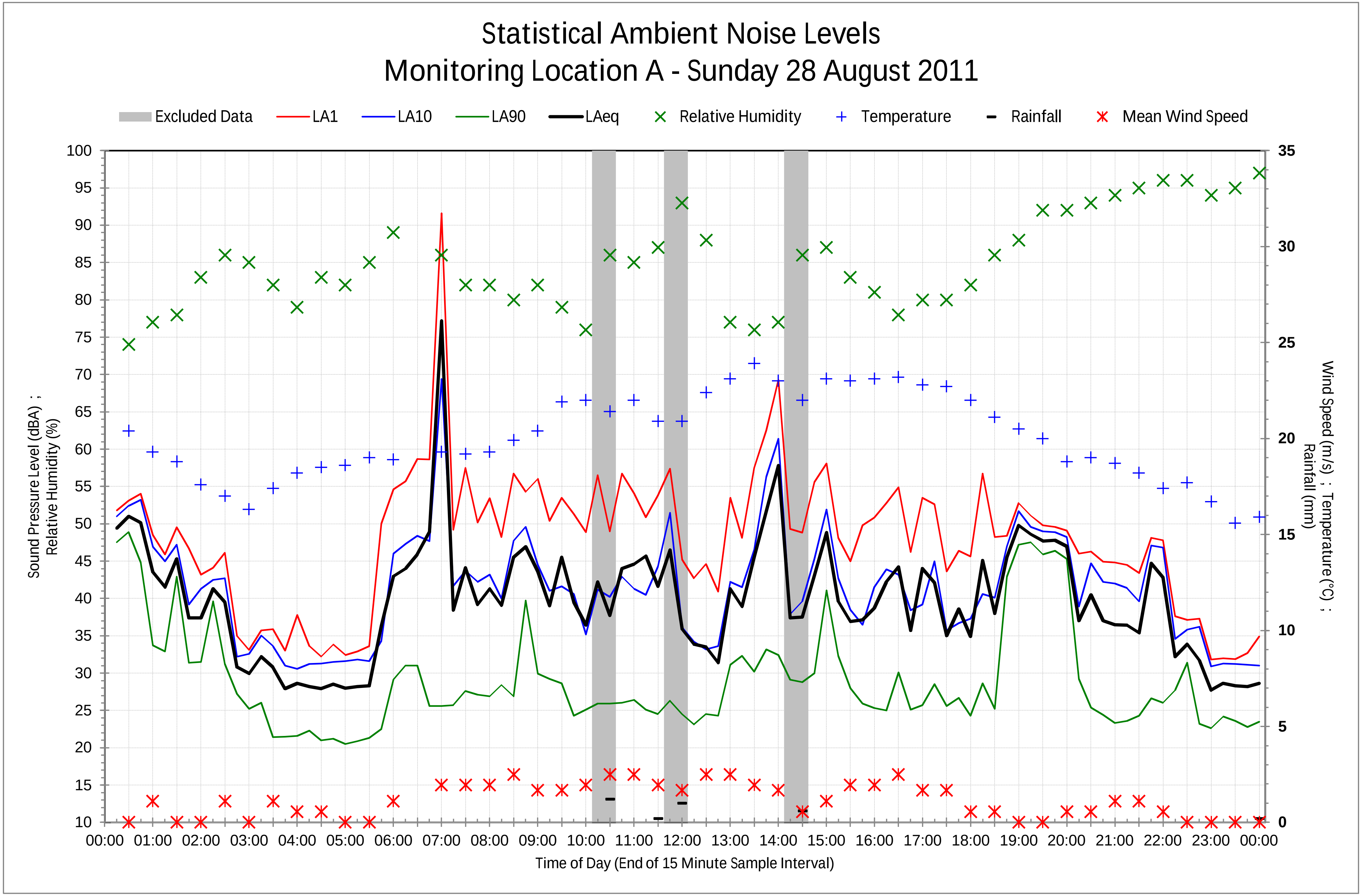
Time of Day (End of 15 Minute Sample Interval)



Statistical Ambient Noise Levels
Monitoring Location A - Sunday 28 August 2011
Excluded Data
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LA10
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Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
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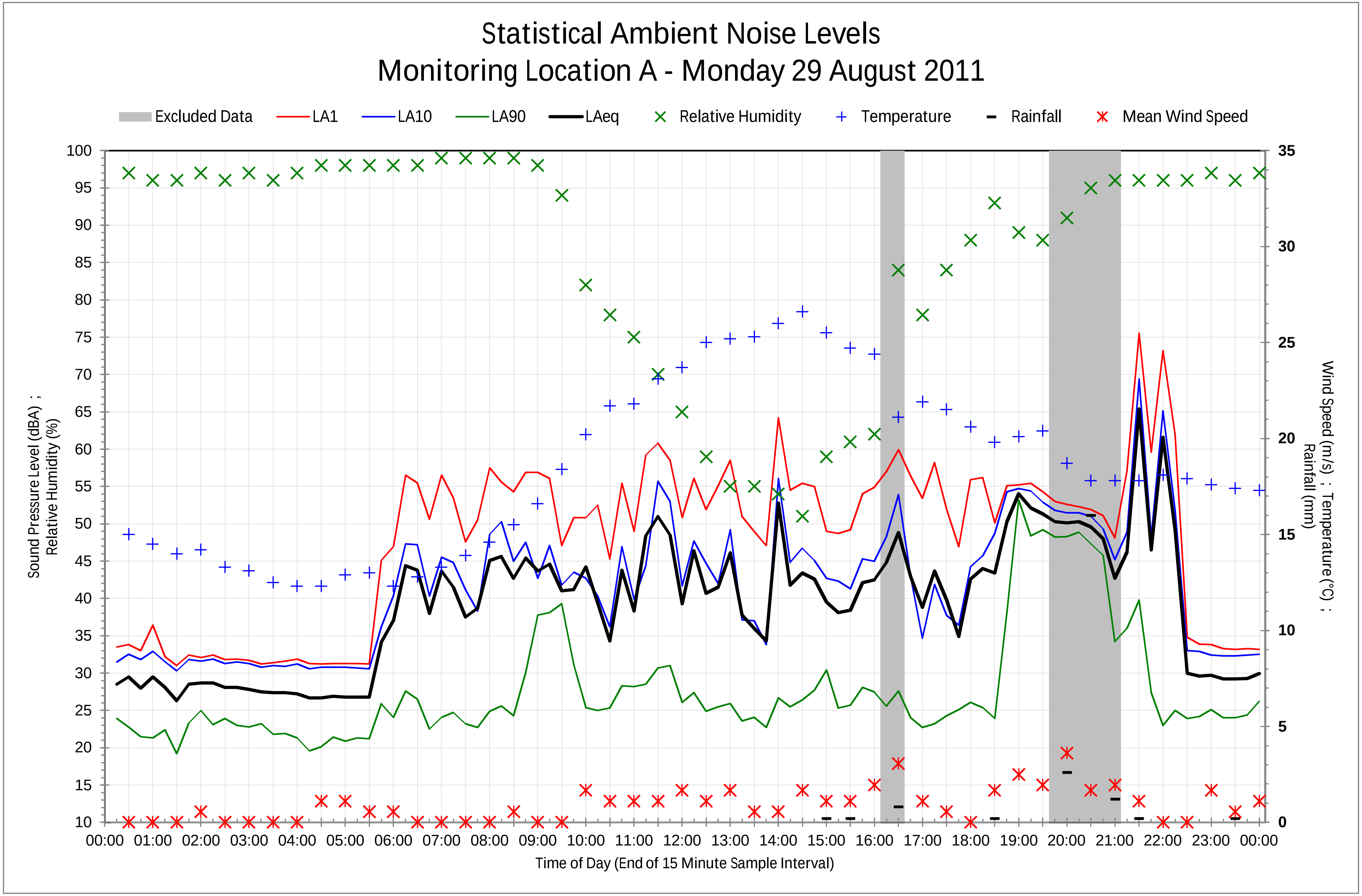
Time of Day (End of 15 Minute Sample Interval)



Statistical Ambient Noise Levels
Monitoring Location A - Monday 29 August 2011
Excluded Data
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Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)
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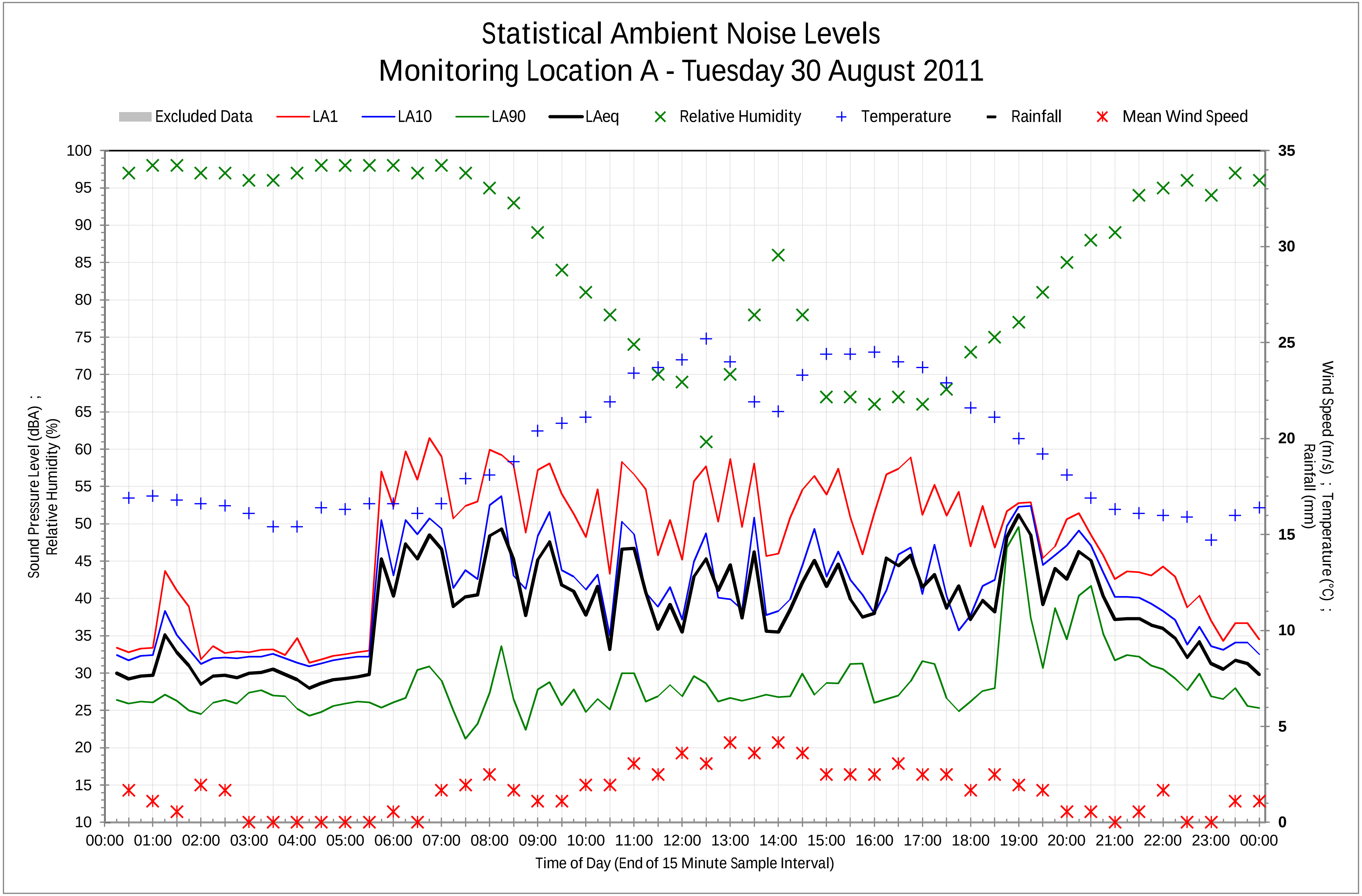
Statistical Ambient Noise Levels
Monitoring Location A - Tuesday 30 August 2011
Excluded Data
LA1
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LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)
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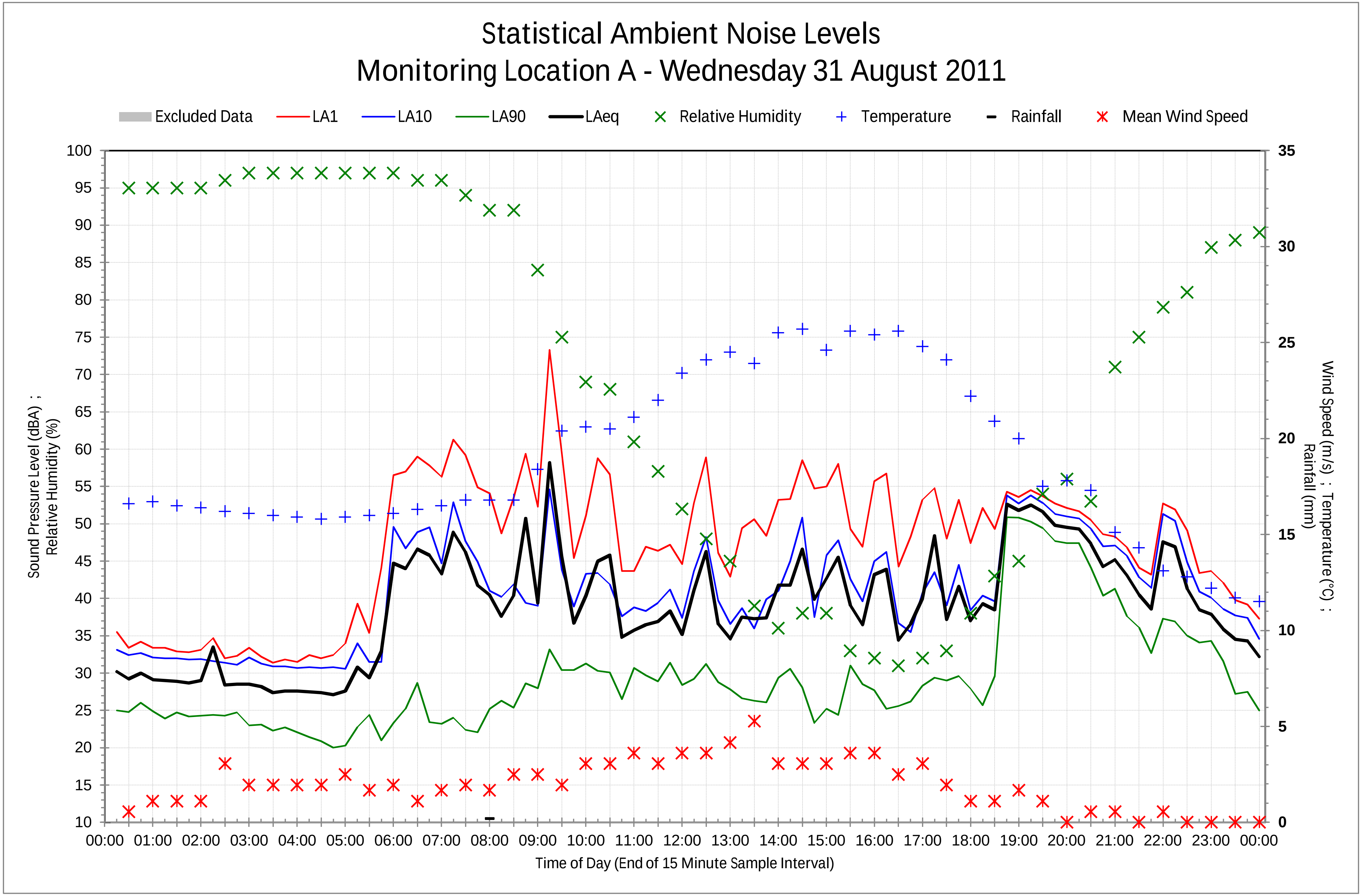
Statistical Ambient Noise Levels
Monitoring Location A - Wednesday 31 August 2011
Excluded Data
LA1
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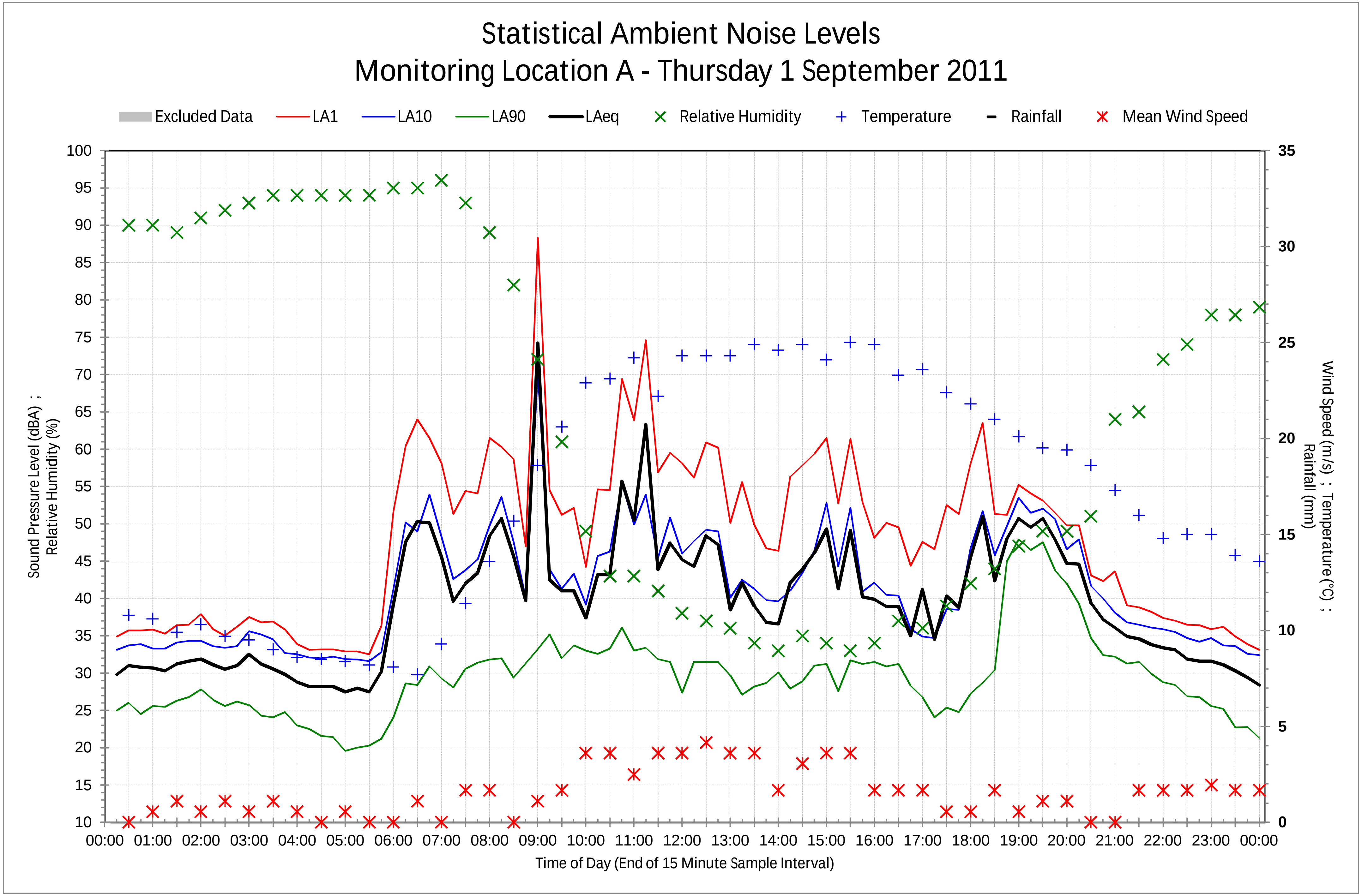
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



Statistical Ambient Noise Levels
Monitoring Location A - Thursday 1 September 2011
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Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)
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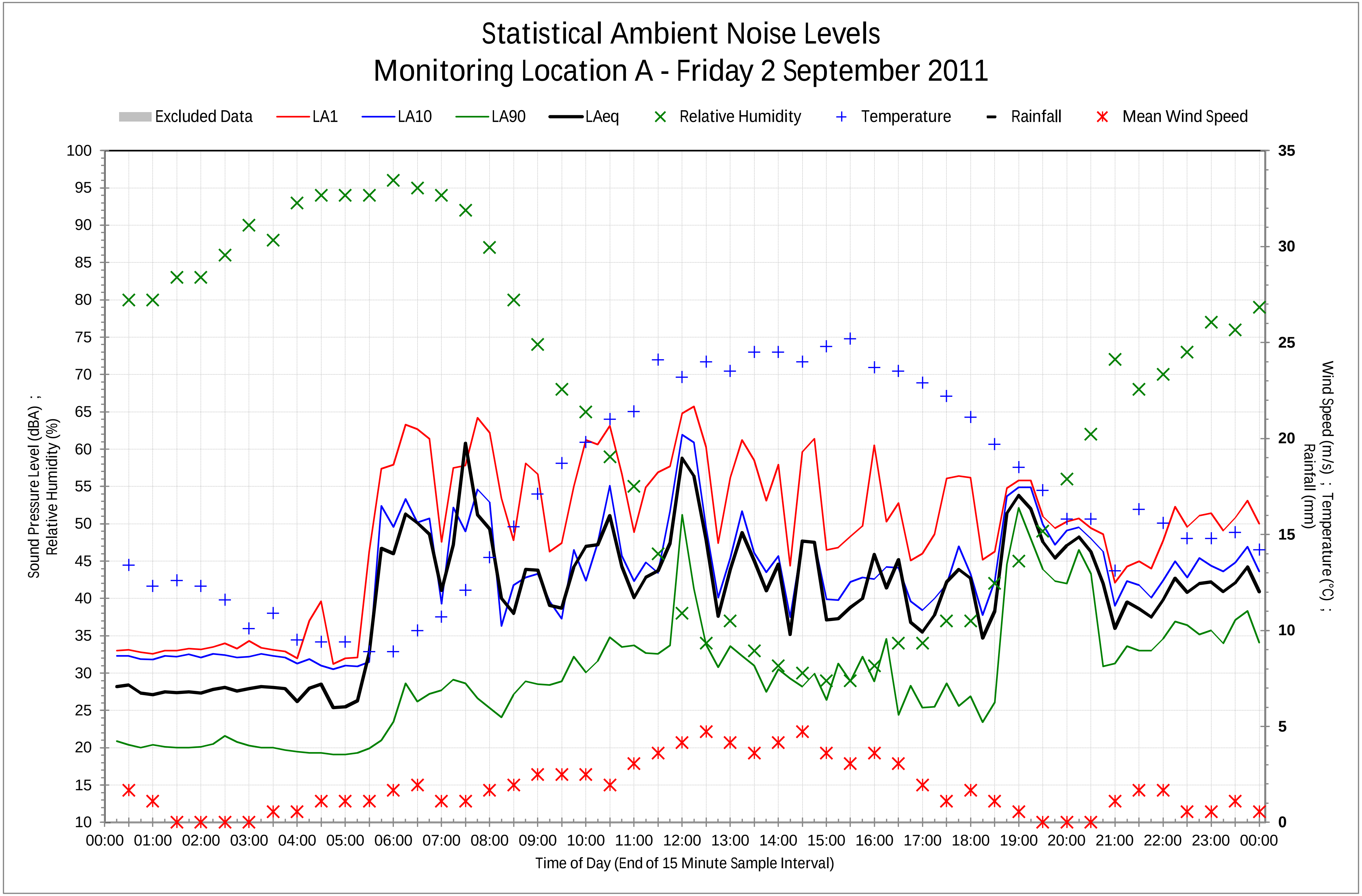
Statistical Ambient Noise Levels
Monitoring Location A - Friday 2 September 2011
Excluded Data
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Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
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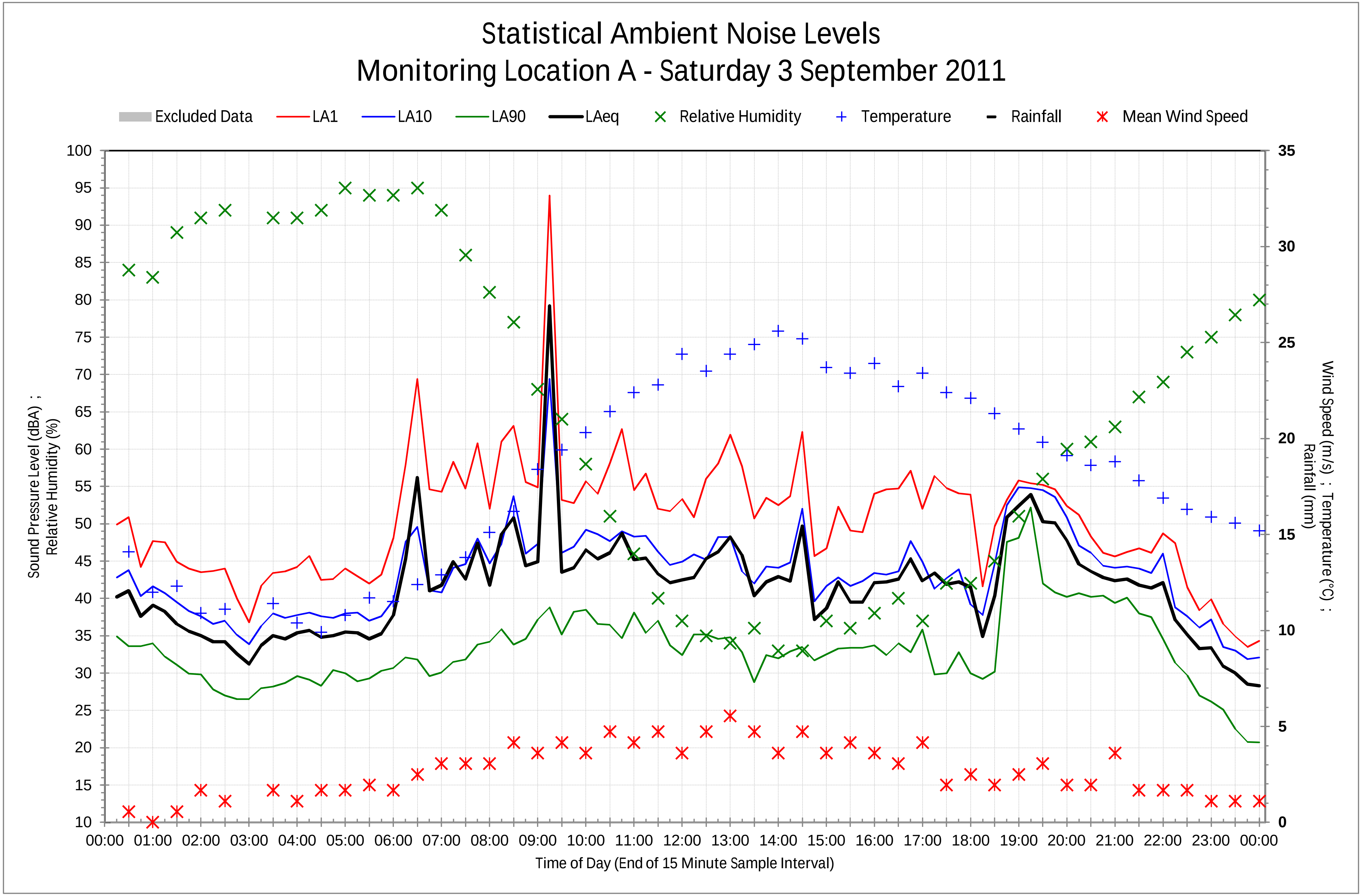
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Monitoring Location A - Saturday 3 September 2011
Excluded Data
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Relative Humidity
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Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
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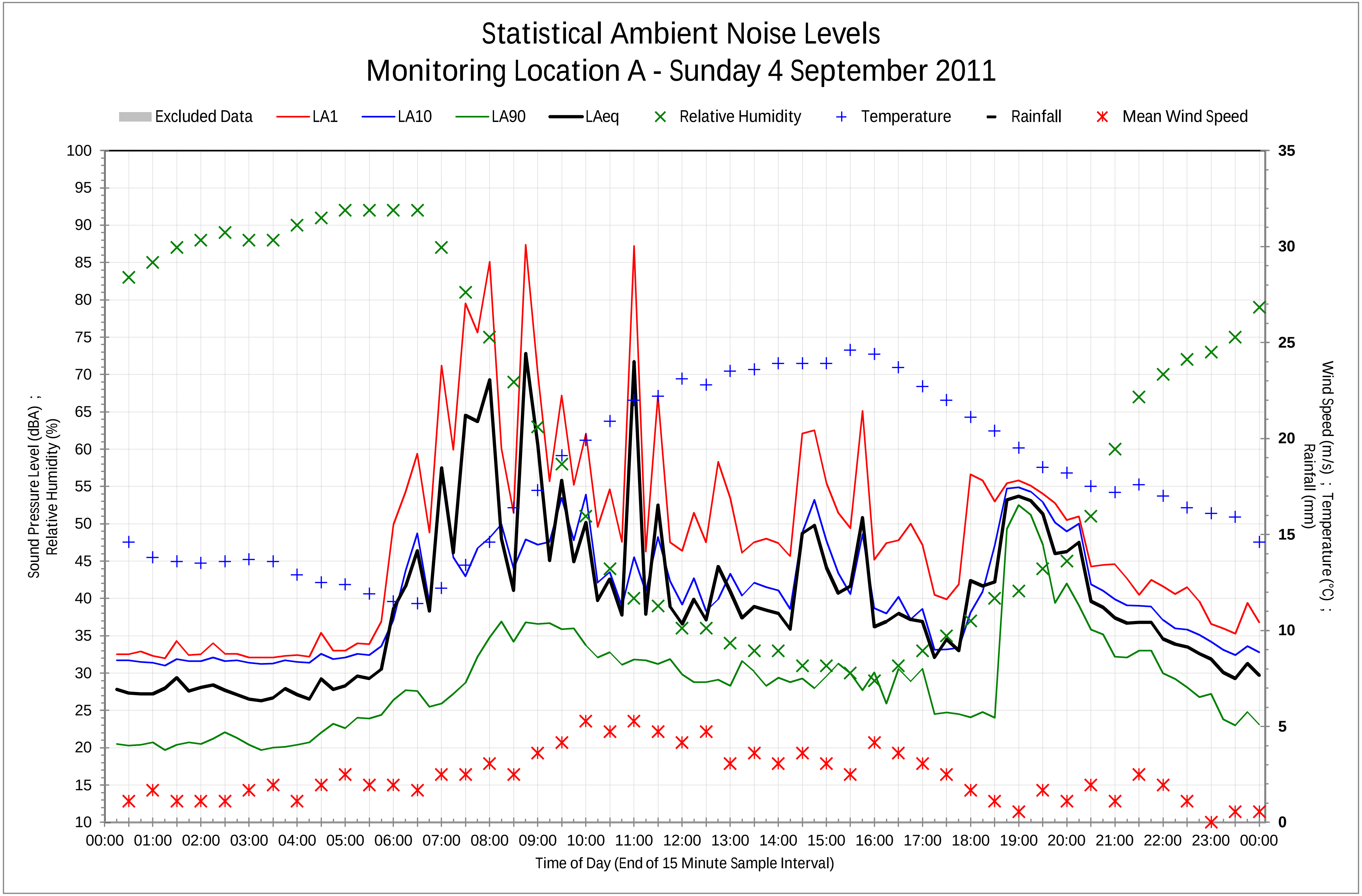

Statistical Ambient Noise Levels
Monitoring Location A - Sunday 4 September 2011
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Relative Humidity
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Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)
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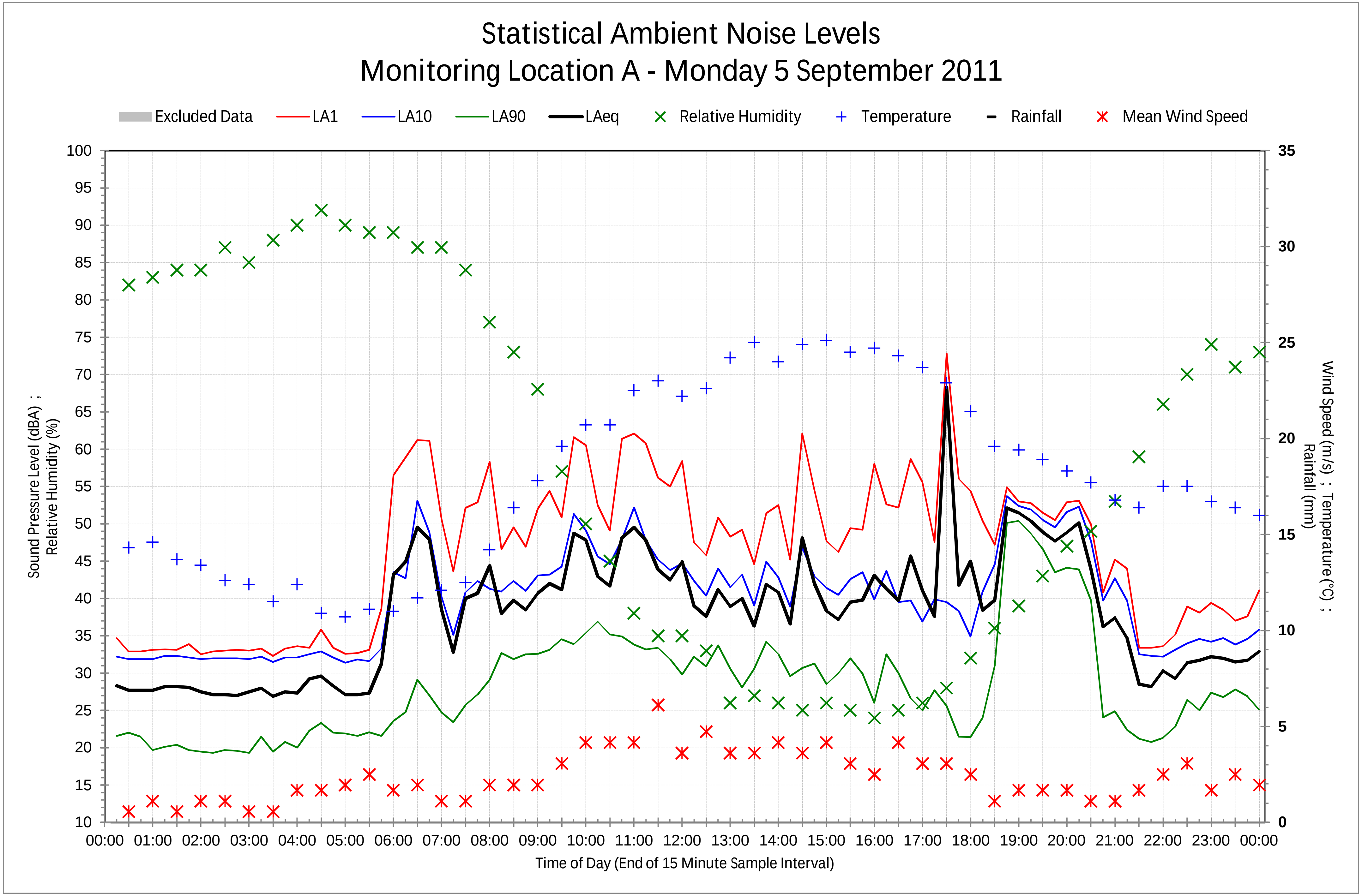

Statistical Ambient Noise Levels
Monitoring Location A - Monday 5 September 2011
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Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)
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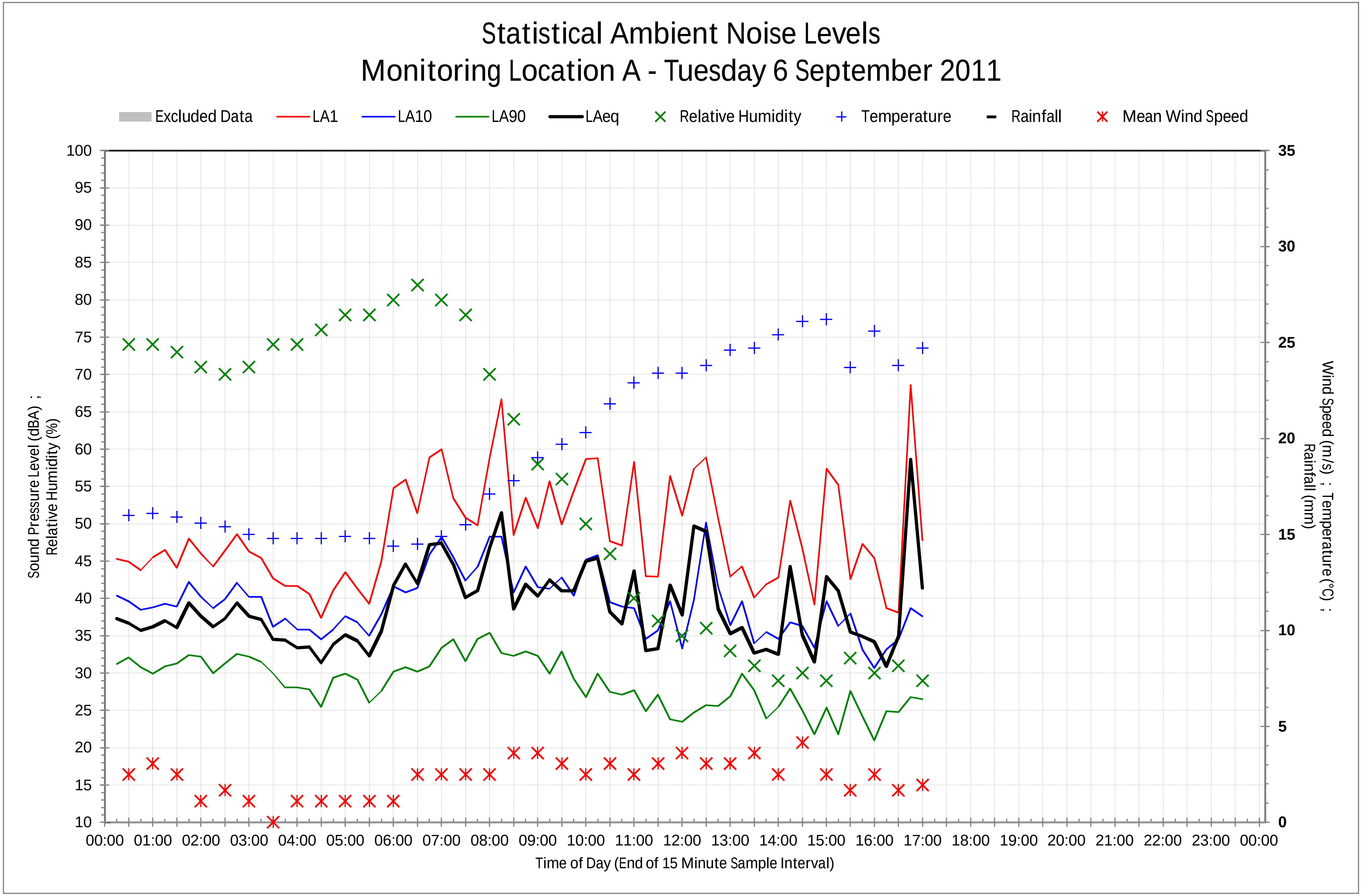

Statistical Ambient Noise Levels
Monitoring Location A - Tuesday 6 September 2011
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Relative Humidity
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Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
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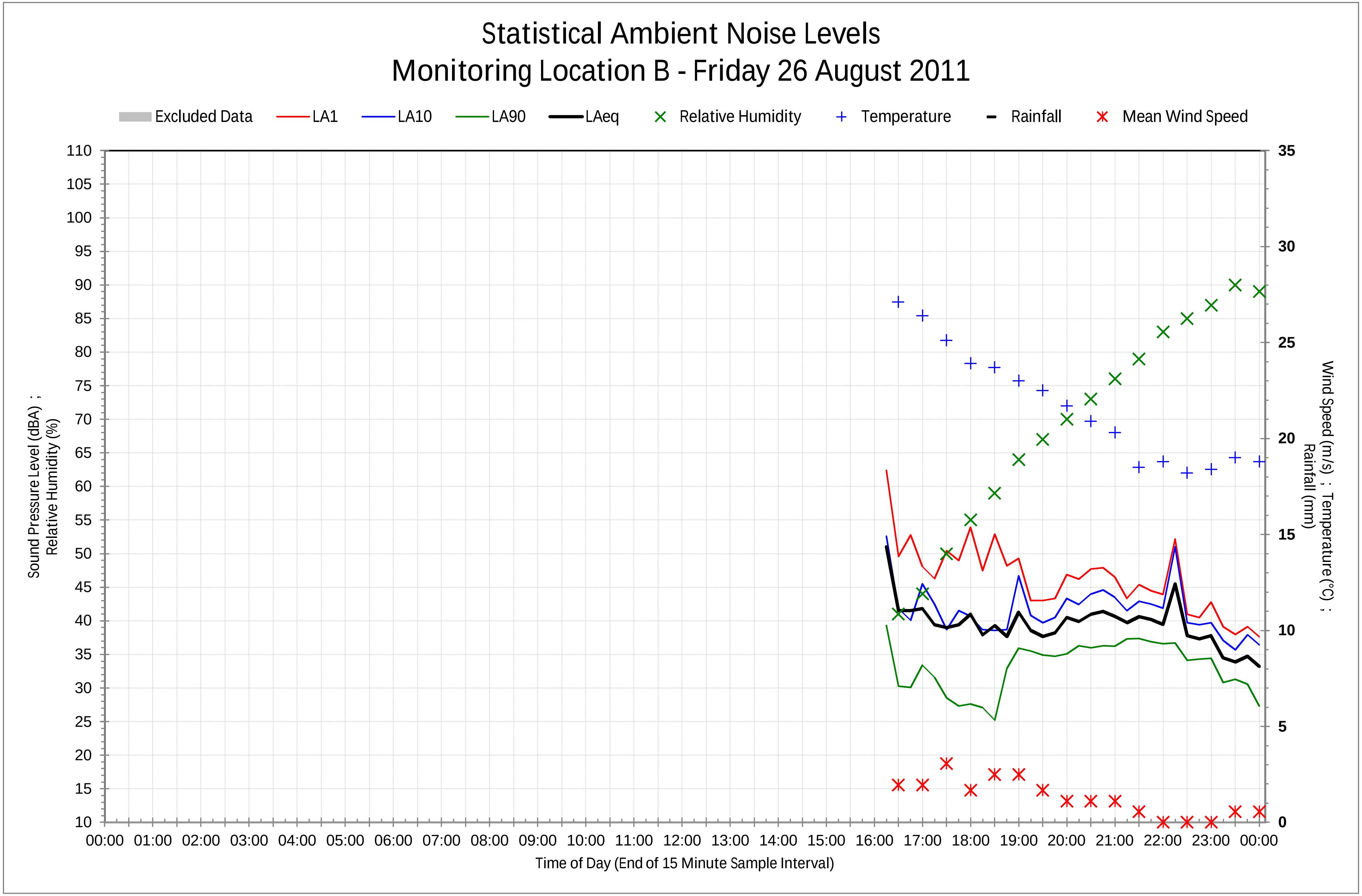
Time of Day (End of 15 Minute Sample Interval)



Statistical Ambient Noise Levels
Monitoring Location B - Friday 26 August 2011
Excluded Data
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Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
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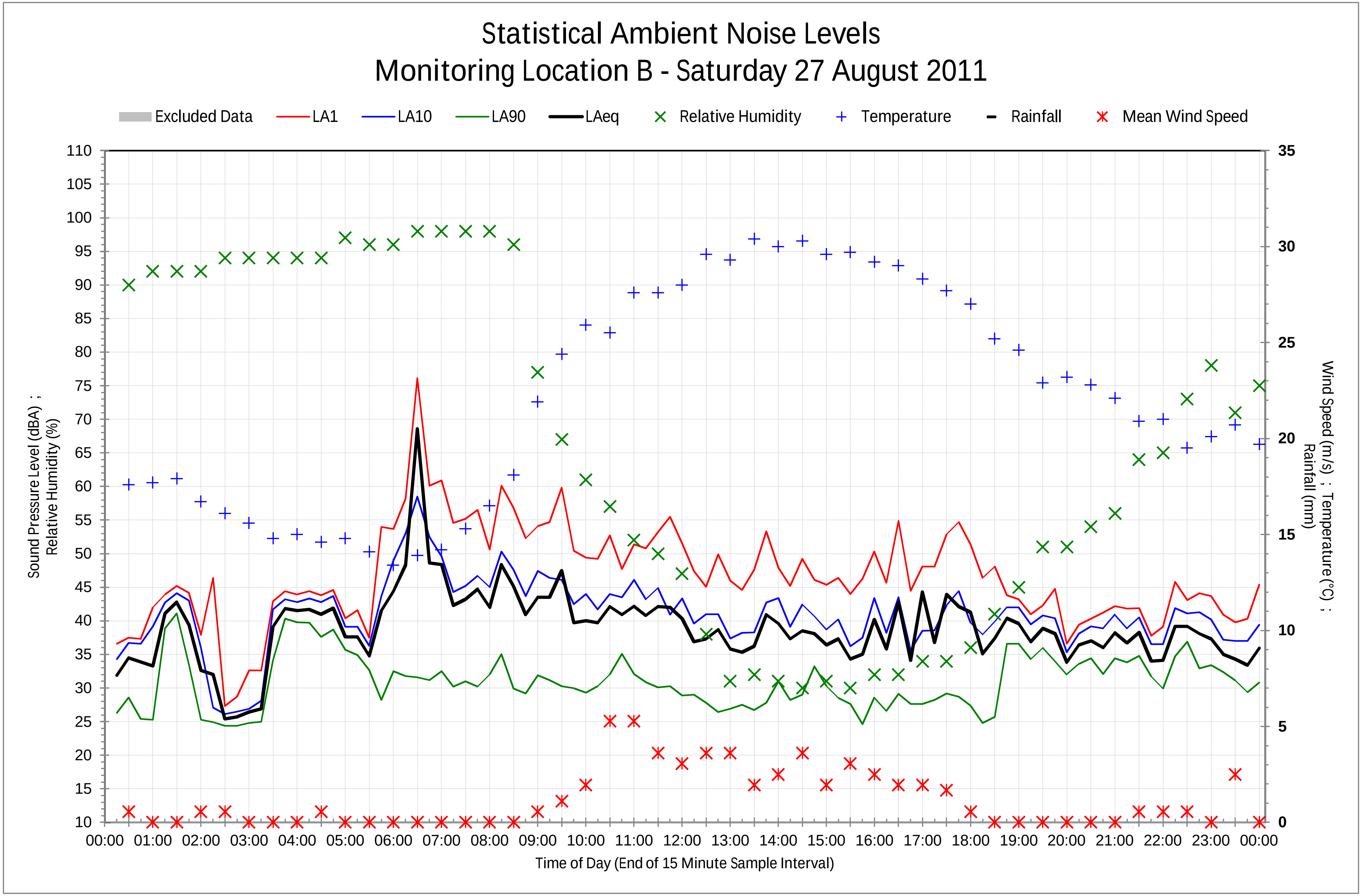
Statistical Ambient Noise Levels
Monitoring Location B - Saturday 27 August 2011
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Relative Humidity
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Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
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Time of Day (End of 15 Minute Sample Interval)
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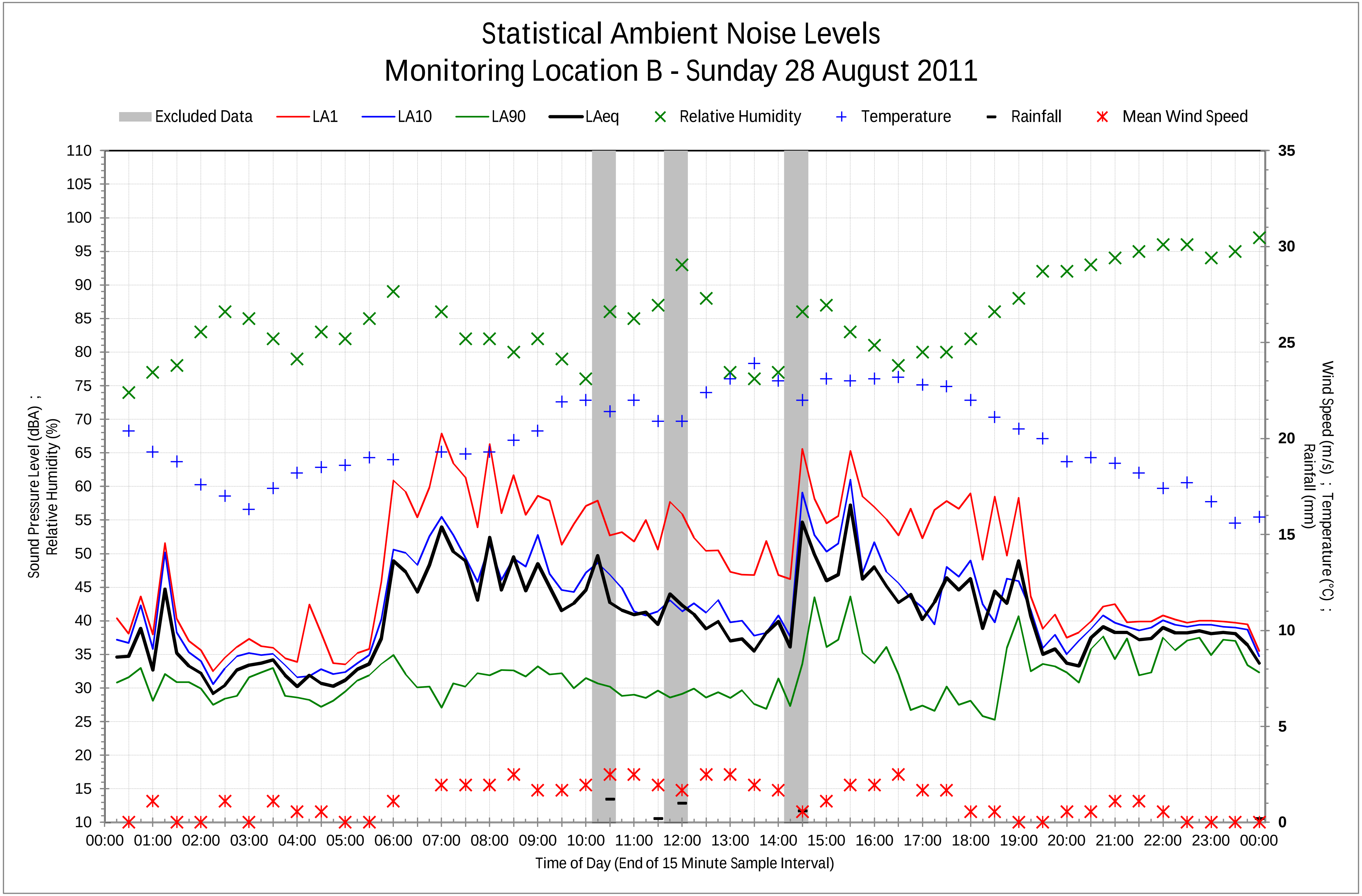

Statistical Ambient Noise Levels
Monitoring Location B - Sunday 28 August 2011
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Sound Pressure Level (dBA) ; Relative Humidity (%)
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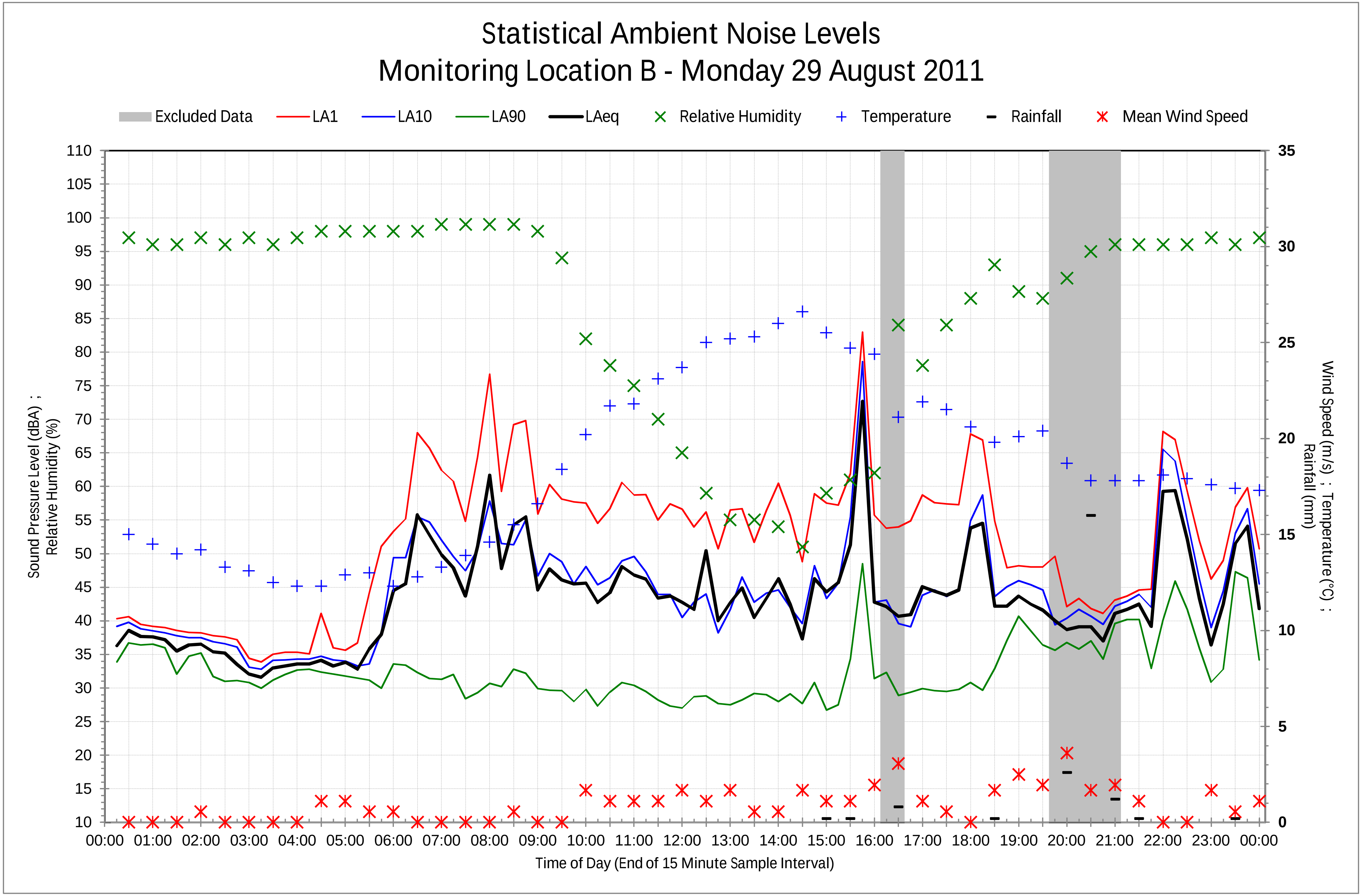
Statistical Ambient Noise Levels
Monitoring Location B - Monday 29 August 2011
Excluded Data
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Relative Humidity
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Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
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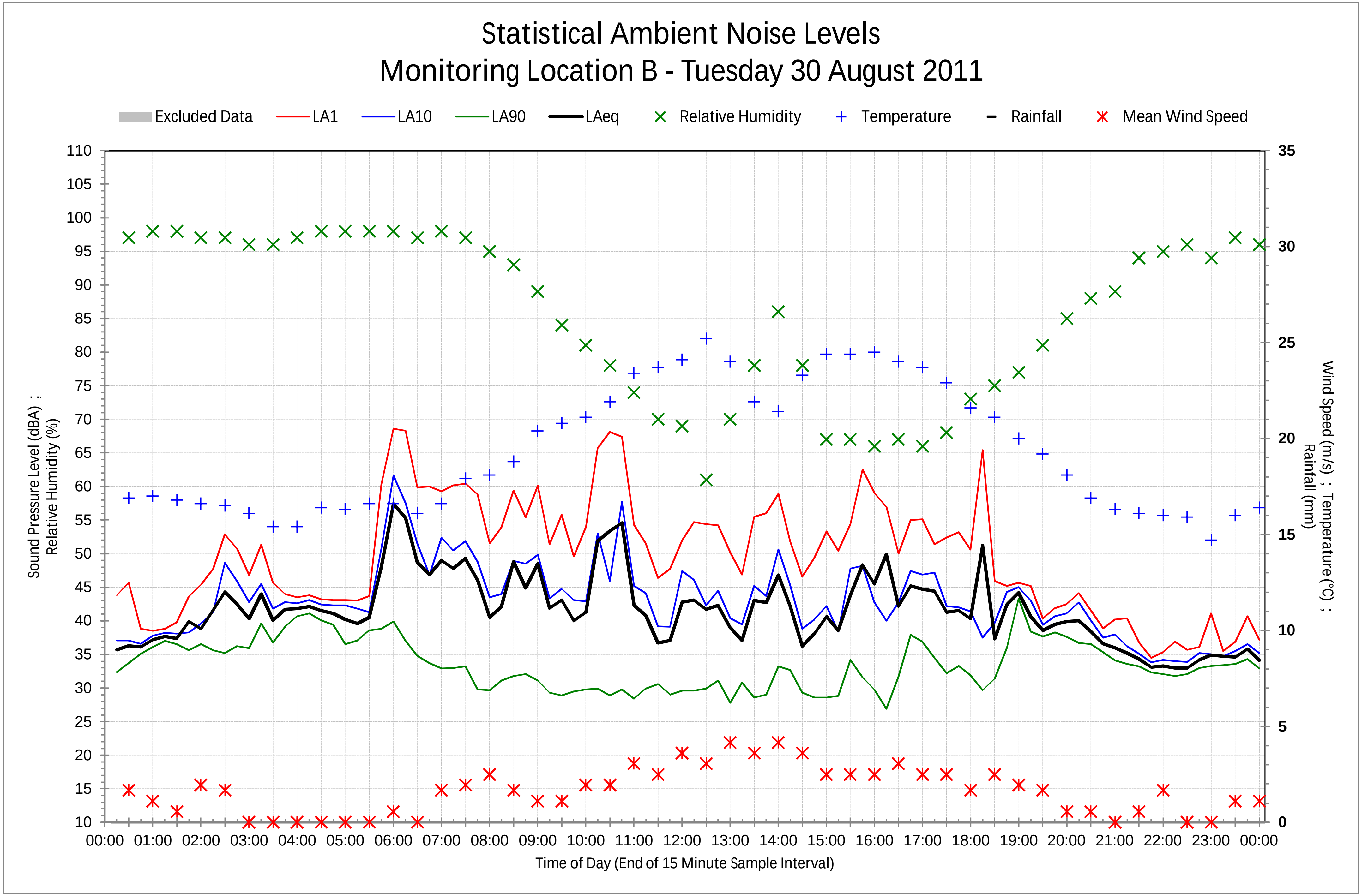

Statistical Ambient Noise Levels
Monitoring Location B - Tuesday 30 August 2011
Excluded Data
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Relative Humidity
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Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)
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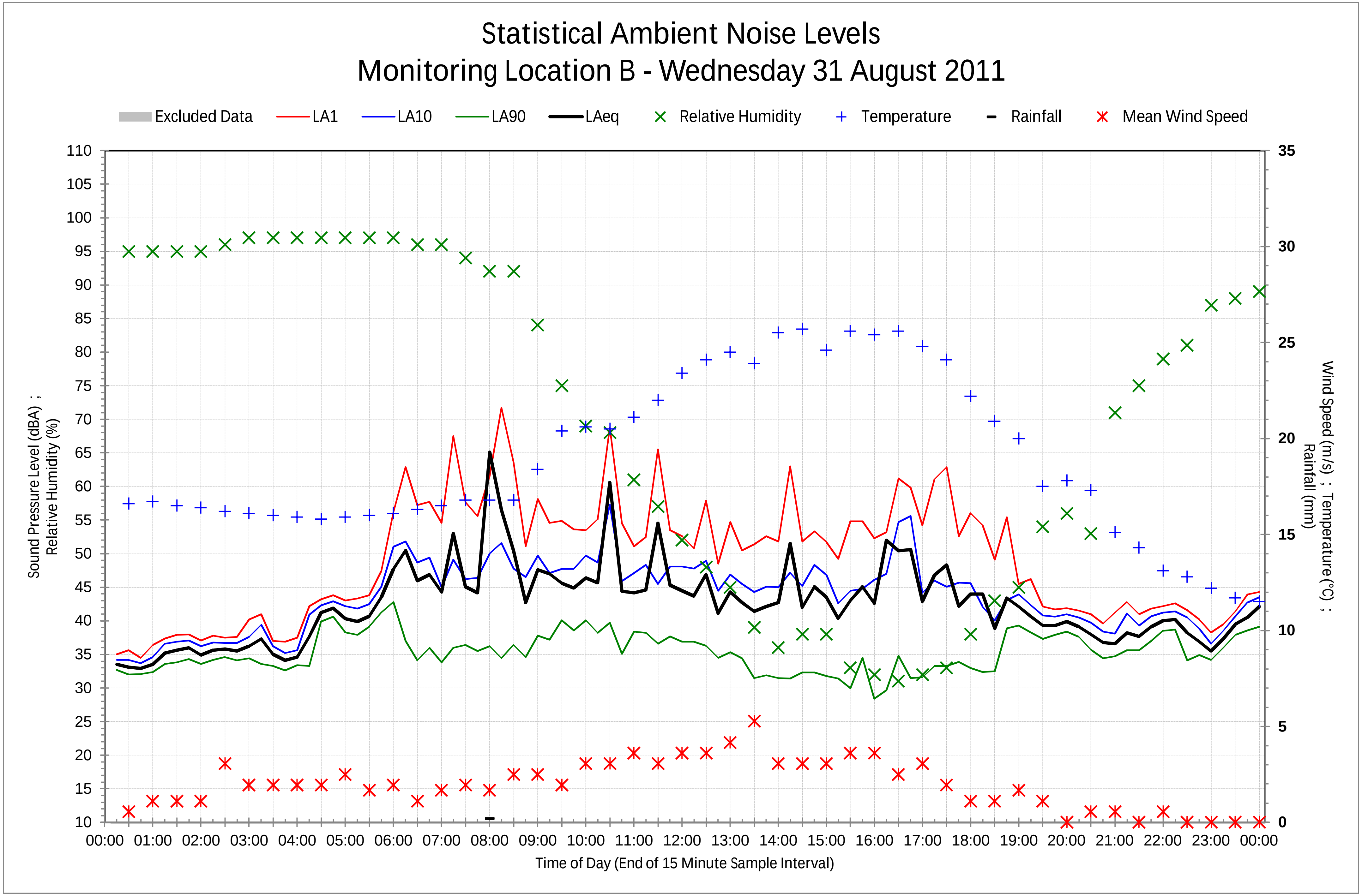

Statistical Ambient Noise Levels
Monitoring Location B - Wednesday 31 August 2011
Excluded Data
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Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
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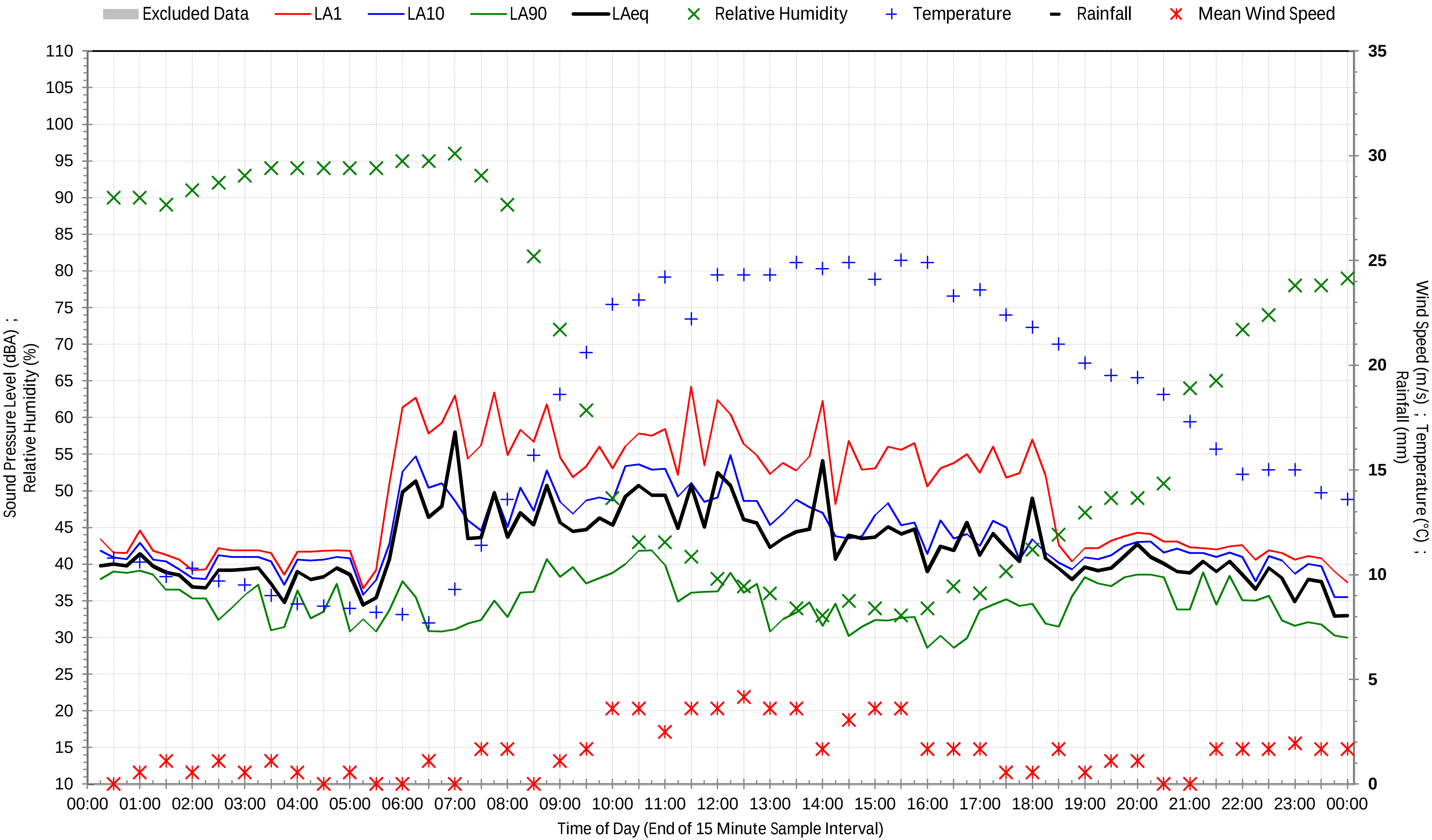
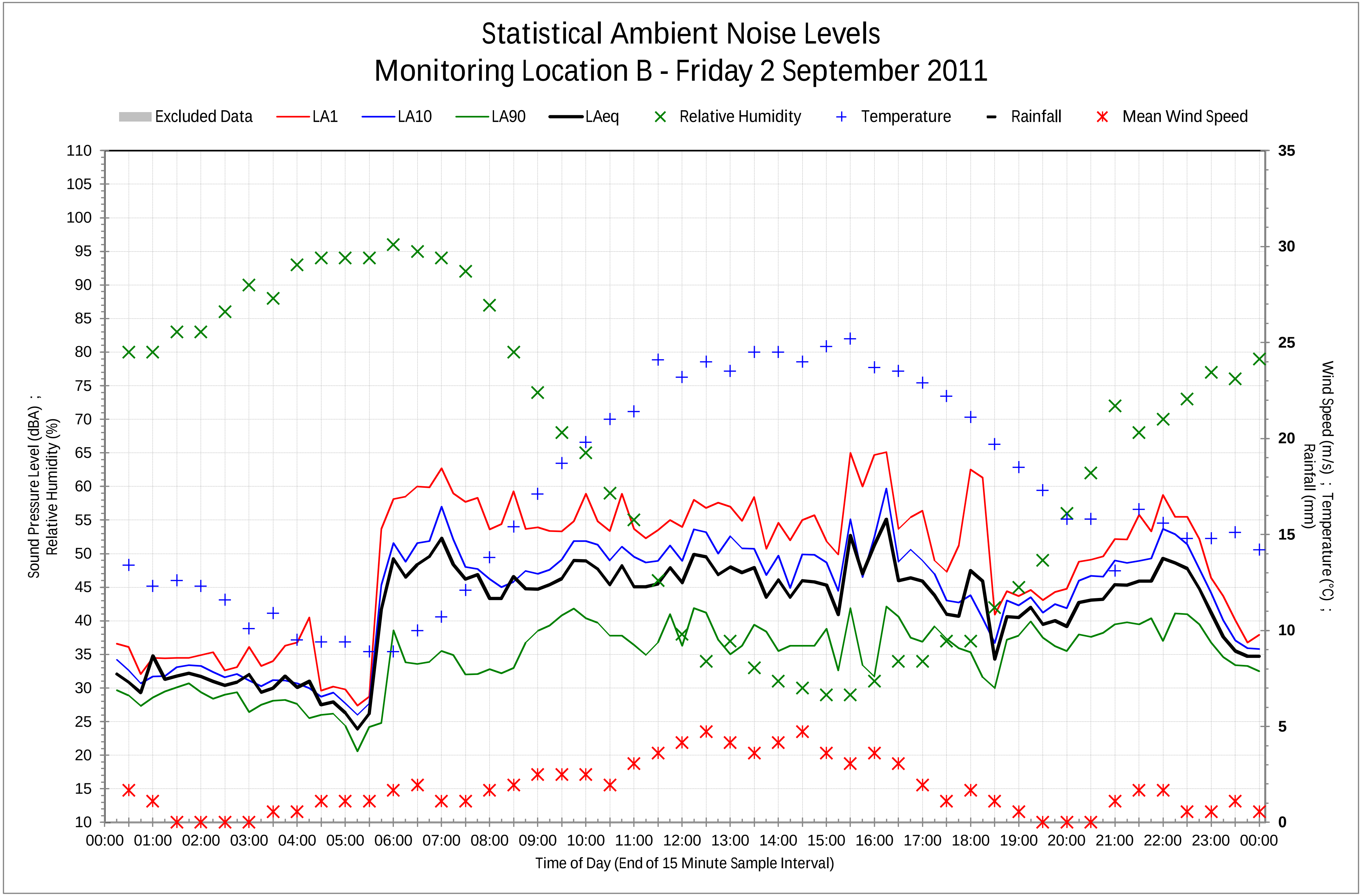
Time of Day (End of 15 Minute Sample Interval)

Statistical Ambient Noise Levels
Monitoring Location B - Thursday 1 September 2011




Statistical Ambient Noise Levels
Monitoring Location B - Friday 2 September 2011
Excluded Data
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Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)
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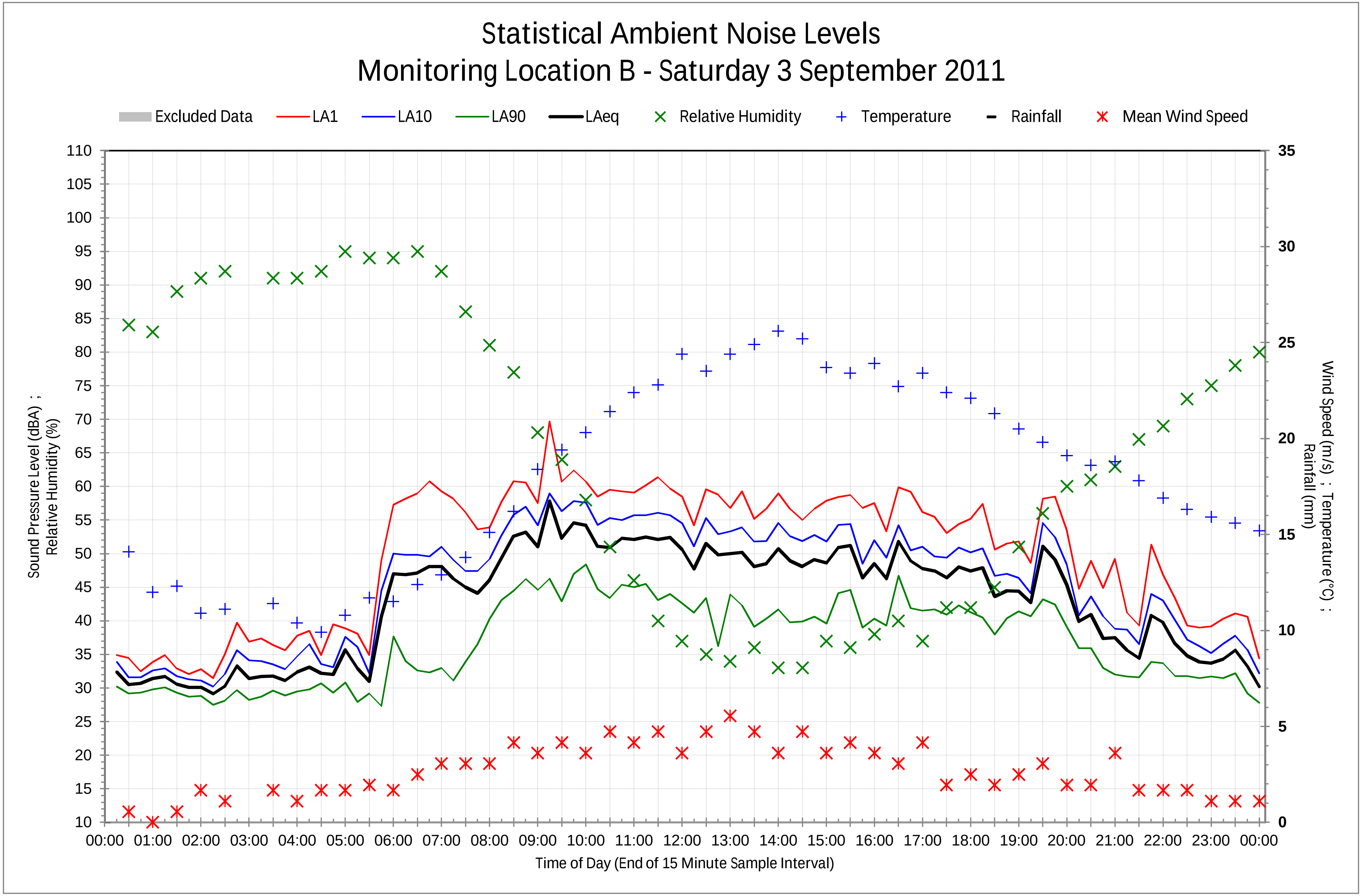
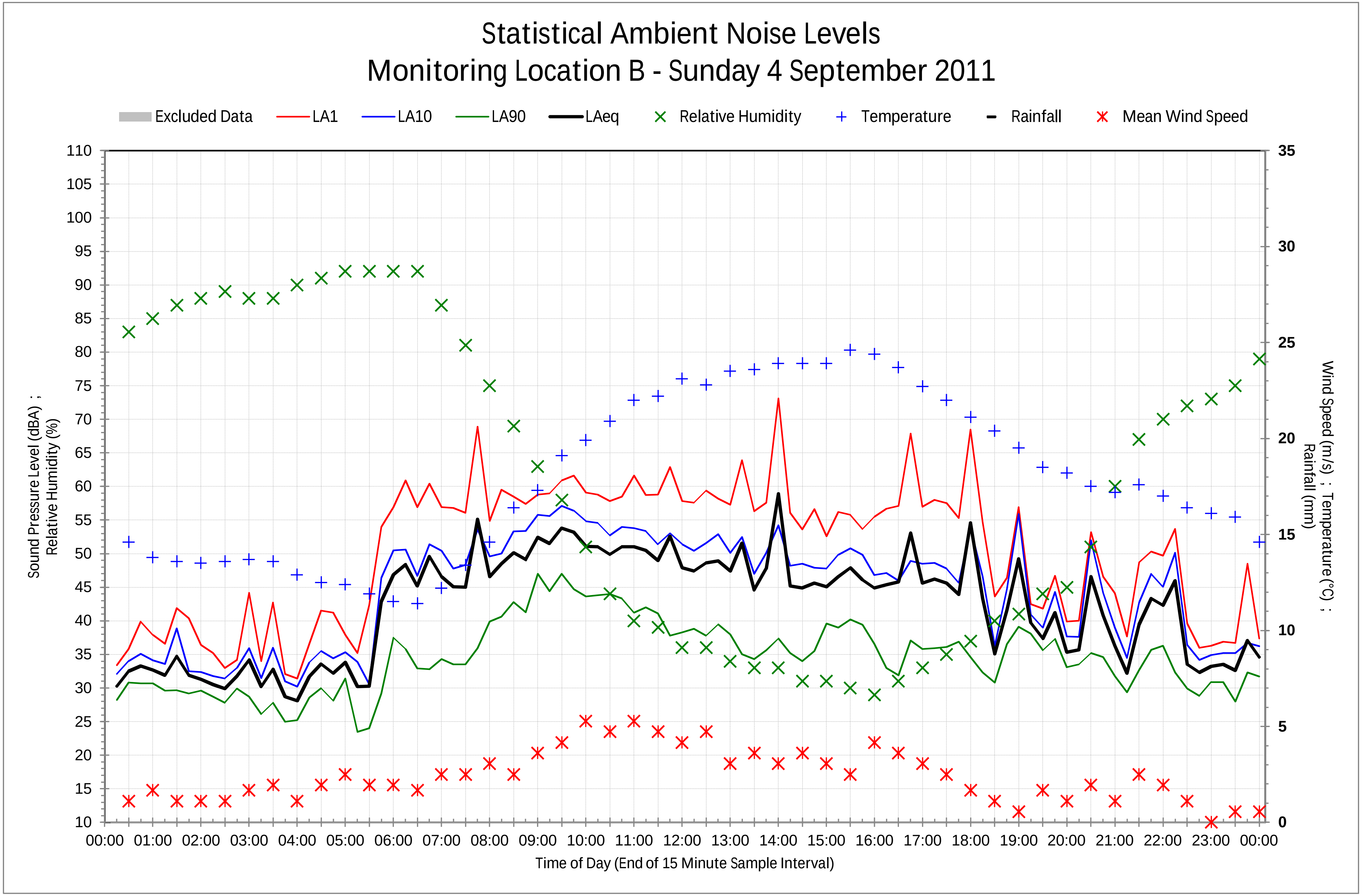
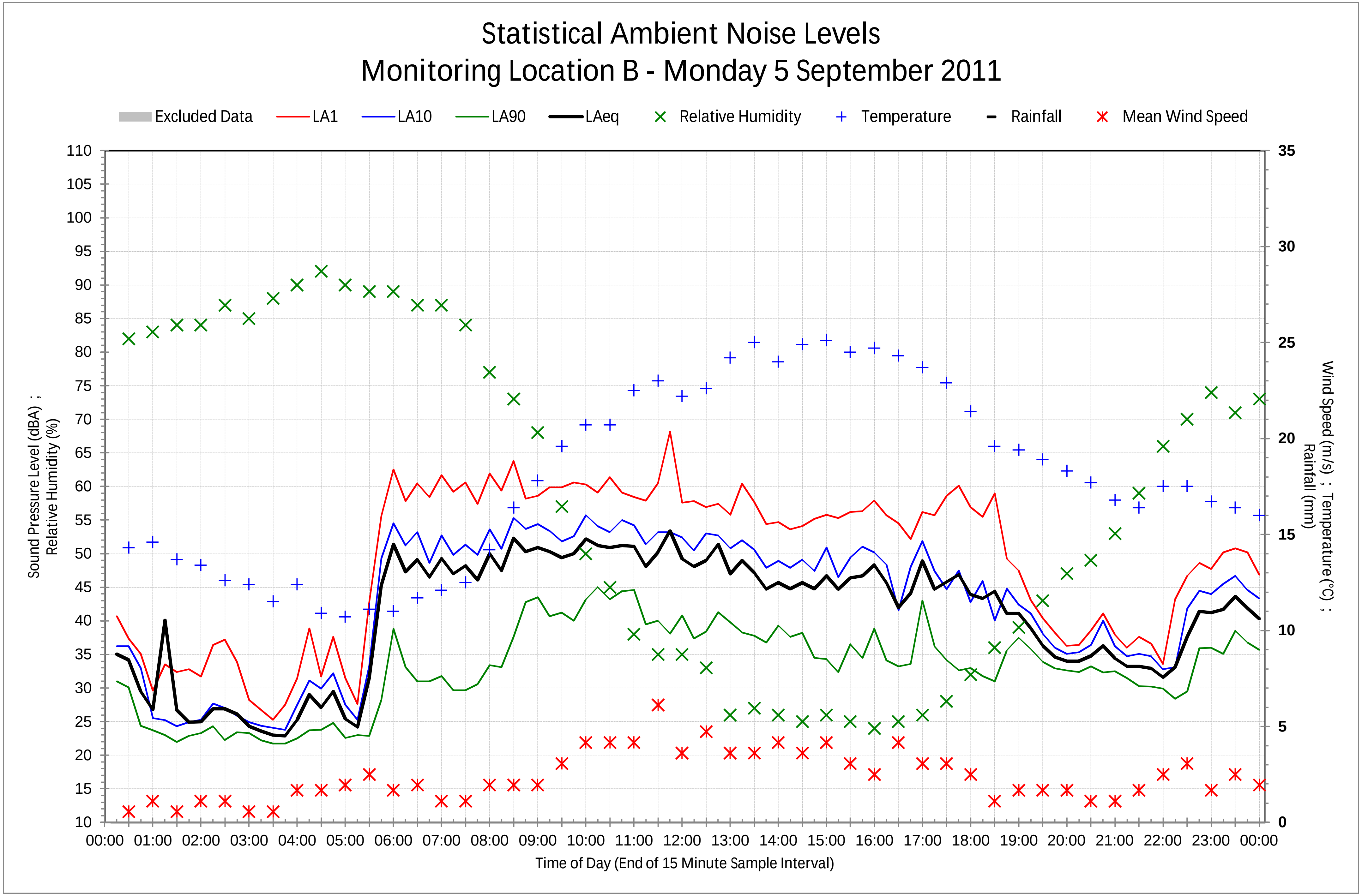

Statistical Ambient Noise Levels
Monitoring Location B - Saturday 3 September 2011
Excluded Data
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
35
30
25
20
15
10
5
0
00:00
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
00:00



Statistical Ambient Noise Levels
Monitoring Location B - Sunday 4 September 2011
Excluded Data
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
35
30
25
20
15
10
5
0
00:00 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00 09:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 00:00
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Monitoring Location B - Monday 5 September 2011
Excluded Data
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
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20
15
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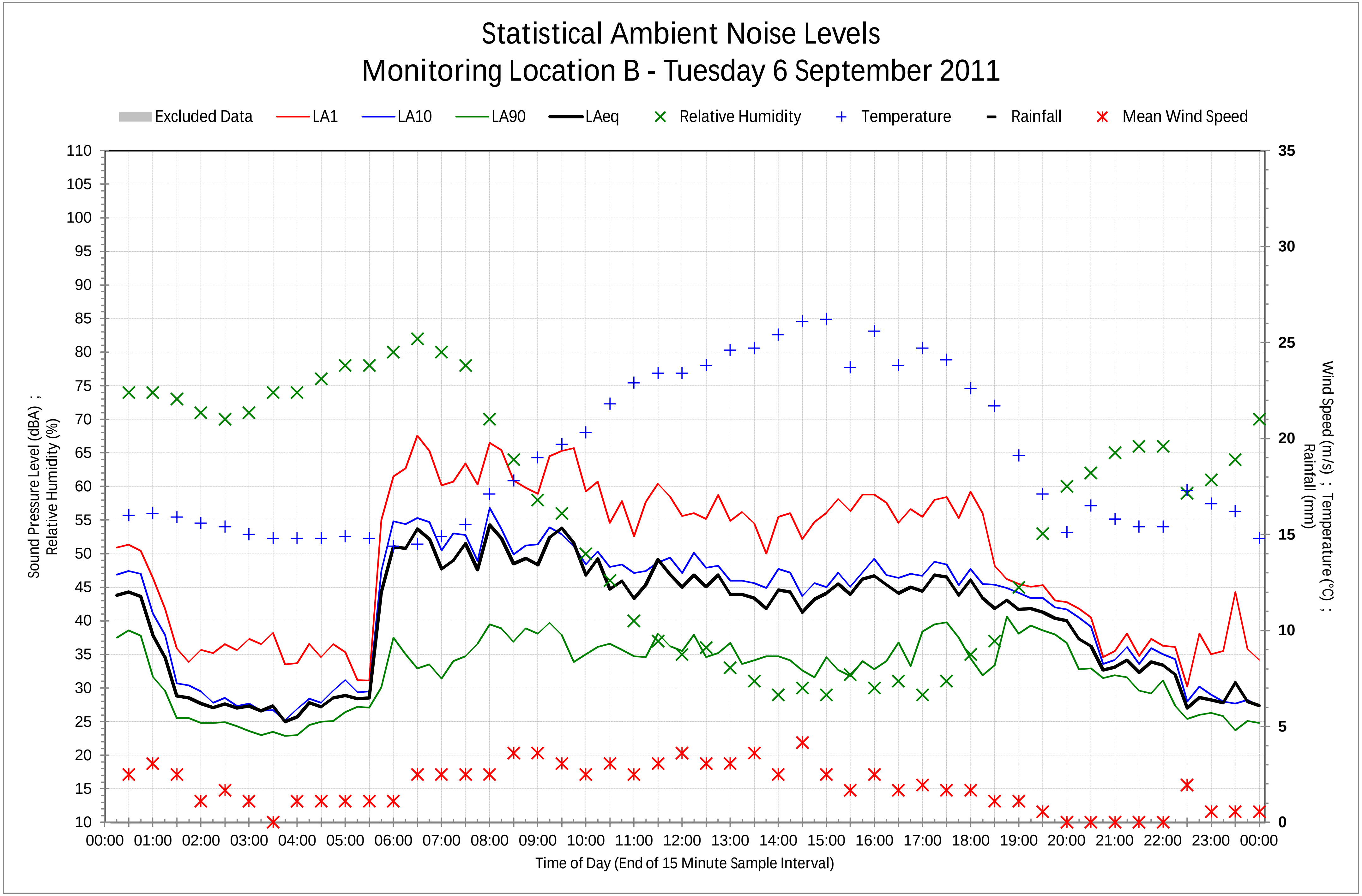

Statistical Ambient Noise Levels
Monitoring Location B - Tuesday 6 September 2011
Excluded Data
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
35
30
25
20
15
10
5
0
00:00
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
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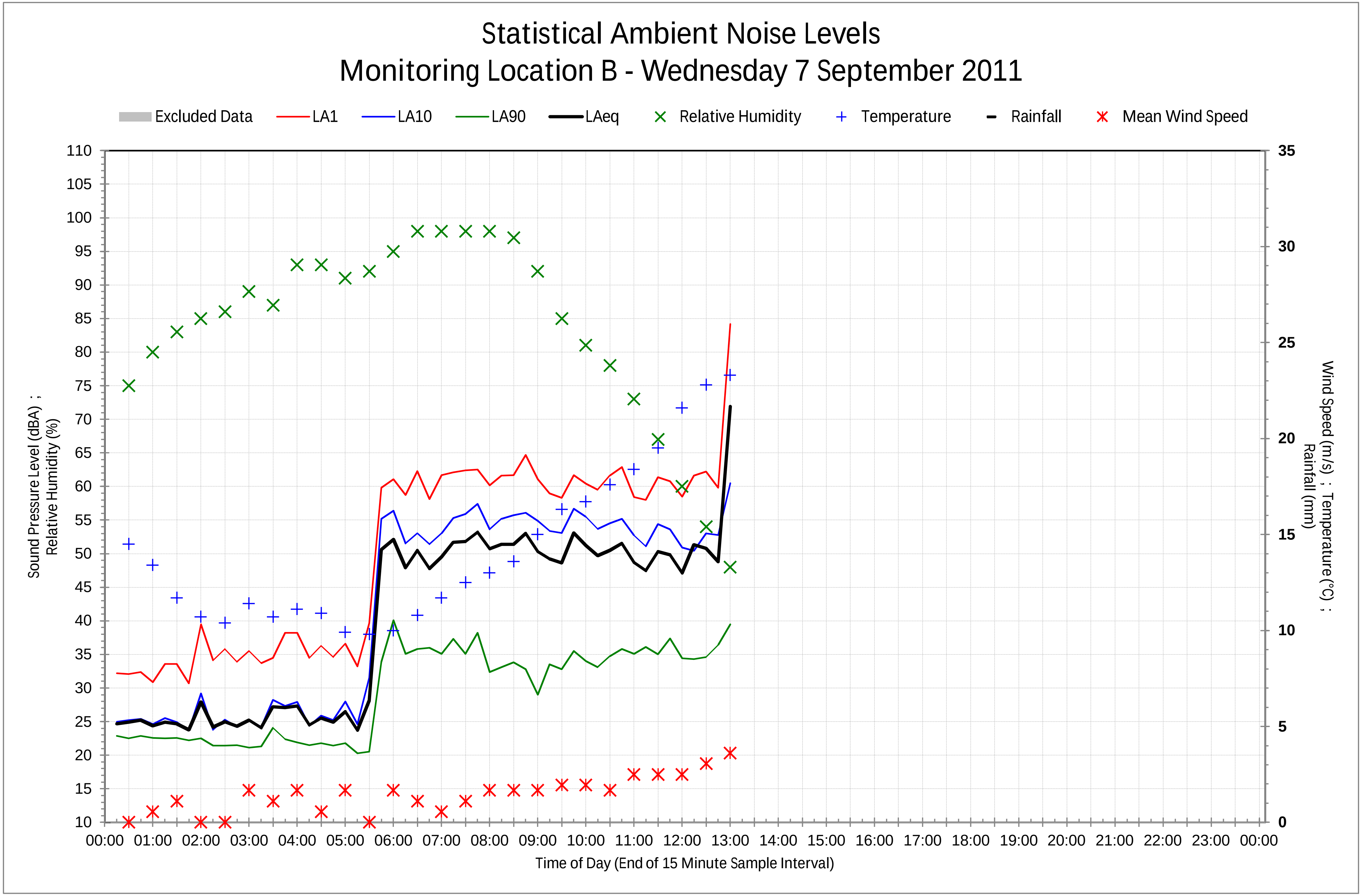
21:00
22:00
23:00
00:00
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Monitoring Location B - Wednesday 7 September 2011
Excluded Data
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)
00:00
01:00
02:00
03:00
04:00
05:00
06:00
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GHD

145 Ann Street Brisbane QLD 4000
GPO Box 668 Brisbane QLD 4001
T: (07) 3316 3000   F: (07) 3316 3333   E: bnemail@ghd.com.au

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	T Gribble	C Evenden G Squires	On file	J Scott	On file	24/01/2012
1	-	G Squires	On file	J Scott	On file	20/02/2012
2	T Gribble	V Chavand G Squires		J Keane		20/09/2012