Annex I

Noise And Vibration Impact Assessment

Crawfords Freightlines Ammonium Nitrate Storage Facility – Lot 12 Old Maitland Road, Sandgate (NSW)

Noise and Vibration Impact Assessment

For Crawfords Freightlines Pty Ltd

July 2012

0143175RP01_FINAL

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Crawfords Freightlines Ammonium Nitrate Storage Facility – Lot 12 Old Sandgate Road, Sandgate

Noise and Vibration Impact Assessment

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FINAL REPORT

Crawfords Freightlines Pty Ltd

Crawfords Freightlines - Ammonium Nitrate Storage Facility - Lot 12 Old Maitland Road, Sandgate (NSW)

Noise and Vibration Impact Assessment

July 2012

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EXECUTIVE SUMMARY

Environmental Resources Management Australia Pty Ltd (ERM) on behalf of Crawfords Freightlines Pty Ltd (Crawfords) has completed a detailed acoustic assessment of environmental noise and vibration associated with the ammonium nitrate storage facility site located at Lot 12 Old Maitland Road, Sandgate in New South Wales (NSW).

The scope of this assessment included operational noise and vibration, construction noise and vibration, and operational road traffic noise. The methodology, findings and recommendations for the proposed and existing operations under assessment are presented here and include areas of interest in the vicinity of the ammonium nitrate storage facility site. Specifically, the assessment considered potential acoustic impacts generated by uses at storage Shed A, Shed B, Shed C, Shed D and the outdoor compound; each situated within the broader site area.

The assessment was completed to reflect the intent and requirements of the applicable local, state and Australian standards, acoustic documents and relevant noise guidelines endorsed by NSW regulators. Where necessary, ERM has made in-principle acoustic recommendations for noise and vibration control mitigation and/or management measures for Crawfords to consider and implement on site where feasible and reasonable.

SUMMARY OF FINDINGS

The findings of the operational noise impact assessment indicate that calculated noise levels are at or below the daytime (7am to 6pm) Project-Specific Noise Levels (PSNL) at all locations, any marginal exceedances are not considered significant. Impacts during the daytime period are not anticipated. Calculated noise levels may exceed the more stringent evening (6pm to 10pm) and morning shoulder period (6am to 7am) PSNL by up to 4 dB(A) during both calm and adverse meteorological conditions. A comparison of estimated maximum noise levels to the adopted sleep disturbance criterion indicates that maximum noise level events are unlikely to exceed the criterion at all residential receptors. Sleep disturbance (and awakenings) impacts potentially associated with maximum noise level events during the morning shoulder period are unlikely to occur.

The findings of the construction noise impact assessment indicate that calculated noise levels are below the 'Highly Noise Affected Management Level' at all locations. During potential worst-case works, calculated noise levels are above the 'Noise Affected Management Level' at a limited number of locations. Any calculated exceedances of the 'Noise Affected Management Level' during works are marginal and are not significant.

The findings of the road traffic noise impact assessment indicate that calcualted noise levels associated with site vehicle movements (product distribution) are significantly below the relevant project-specific road traffic noise level criteria. Impacts are not anticipated.

Vibration levels associated with the site are expected to be significantly below the relevant structural damage safe limits and human annoyance guideline values for both construction and operational phases of the project. Based on this, the potential risk of vibration impacts is limited and the magnitude of any impacts will be insignificant.

RECOMMENDATIONS

Operational Noise

Based on the elevated noise levels described above ERM has prepared a consolidated set of noise control mitigation and/or management measures that are to be considered and implemented by Crawfords where feasible and reasonable (refer Section 7). These recommendations are limited to the evening and morning shoulder periods and are summarised below.

- *heavy vehicle drivers should be instructed to quietly enter and exit the site and should be instructed to limit extended periods of engine idling. Where engine idling is unavoidable, ERM recommends that Crawfords utilise on site structures (eg buildings or shipping containers etc.) to obstruct noise sources from the nearest sensitive receptor location, where practical;*

- *the use of plant motion alarms should be limited. Plant and equipment usage on site should be optimised during these periods to maximise forward motion, which will reduce motion alarms that typically sound in reverse. Where this is not achievable ERM recommends that Crawfords investigate visible alarms (i.e. flashing lights instead of audible alarms) or install "squashed duck" type alarms which are less intrusive than standard alarms. Such alarms should still be satisfactory to achieve occupational health and safety requirements; and*

- *the use of large forklifts should be limited. Furthermore, where large forklift usage is required, the operators should be instructed to quietly operate the equipment following normal good operational practices.*

Based on these recommended management measures ERM has re-calculated operational noise levels at the most affected noise sensitive receptor considered in this assessment for each of the worst-case scenarios. The results of this additional (mitigated) modelling are presented below.

Mitigated Operational Noise Levels Scenario

Scenario	*Calculated Noise Level (mitigated)*	*Evening PSNL*	*Morning Shoulder PSNL*	*Evening Compliance*	*Morning Shoulder Compliance*
Rail	*39.9*	*40*	*39*	*-0.1*	***0.9***
Trucks	*39.6*	*40*	*39*	*-0.4*	***0.6***
Rail and Trucks Combined	*40.0*	*40*	*39*	*0.0*	***1.0***
Trucks and Conveyor Use	*39.6*	*40*	*39*	*-0.4*	***0.6***

1. all values are dB(A) re: 2 x 10^{-5} Pa.

The results presented above indicate that operational noise levels may be reduced to be below the evening PSNL and within 1 dB(A) of the most stringent morning shoulder period PSNL (a reduction of approximately 3 dB(A)) following the successful implementation of the recommended good practice noise management measures described above.

At this location an estimated overall L90 value between 6am and 7am was calculated to be 42.5 dB(A) and an additional shoulder period criteria to evaluate potential impacts between 6am and 7am determined as: site noise level contribution $L_{Aeq,}$ 15 minute ≤ 47.5 dB(A).

Based on this, the mitigated operational noise levels presented comply with the INP requirements during all periods and negligible (low) impacts are anticipated during evening and morning shoulder period operations. Furthermore, noise levels potentially affecting the broader community will be reduced.

Operational Noise Monitoring

The results presented above indicate that the site is expected to generally comply with the requirements presented in the relevant regulatory guidelines; however this assumption is based on the successful implementation of the recommended good practice noise management measures described in this report.

Accordingly, ERM recommends that within 3 months of the recommencement of operations, operator attended noise measurements should be undertaken by a qualified and suitably experienced acoustician to verify actual site noise level contributions at a representative number of the closest and/or potentially most affected noise sensitive receptors near the site. Further detail regarding this task is provided in Section 7.

Construction Noise

Based on the noise levels presented above ERM makes the following in-principle recommendations for noise management measures during construction works:

- *apply all feasible and reasonable work practices to meet the criteria; and*
- *inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.*

ERM notes that at this stage the actual requirement for construction works and specific details regarding plant and equipment that may be used for this purpose is unknown. As such it is not practical to provide specific noise control and/or mitigation measures for Crawfords consideration. Should these works be required Crawfords should consider the in-principle recommendations presented above and investigate appropriate measures where practical. Suggested normal good practice construction noise management measures have been provided in Section 7.

Road Traffic Noise

The potential risk of road traffic noise impacts is limited and the magnitude of any impacts will be insignificant. ERM does not recommend any additional road traffic noise control mitigation and/or management measures to those already considered or implemented on site.

Operational and Construction Vibration

The potential risk of vibration impacts is limited and the magnitude of any impacts will be insignificant. ERM does not recommend any additional vibration control mitigation and/or management measures to those already considered or implemented on site.

RESIDUAL IMPACTS

Following the successful implementation of the recommended noise control mitigation and/or management measures described above, and operational noise monitoring undertaken to evaluate the effect of these measures The potential risk of noise impacts will be limited and the magnitude of any impacts will become insignificant.

1 INTRODUCTION

This document has been prepared by Environmental Resources Management Australia Pty Ltd (ERM) on behalf of Crawfords Freightlines Pty Ltd (Crawfords) to assess environmental noise and vibration associated with the ammonium nitrate storage facility site located at Lot 12 Old Maitland Road, Sandgate in New South Wales (NSW).

This noise and vibration impact assessment (the assessment) presents the methodology, findings and recommendations for the existing and proposed operations under assessment and includes areas of interest in the vicinity of the ammonium nitrate storage facility site. Specifically, this report considers potential acoustic impacts generated by uses at storage Shed A, Shed B, Shed C, Shed D and the outdoor compound.

The scope of this assessment includes operational noise and vibration, construction noise and vibration, and operational road traffic noise impact. Where necessary, ERM has made in-principle acoustic recommendations for noise and vibration control mitigation and/or management measures for Crawfords to consider and implement on site where feasible and reasonable.

1.1 PROJECT OVERVIEW

Crawfords operate a storage and distribution depot at Lot 12 Old Maitland Road, Sandgate, where they store and distribute bagged ammonium nitrate on behalf of a range of customers. The site is located on industrial premises owned by Sierra Sun and Crawfords currently lease Shed C and Shed D, and all outdoor storage areas. The only other tenant at the site is 'Scafflink Australia' who occupy a small fenced off area (and associated offices) in the eastern corner of the site. Crawfords are negotiating to take over the lease of Shed A and Shed B, which were previously occupied by 'Impact Fertilisers' who stored and distributed bulk fertiliser.

1.2 SITE DESCRIPTION

The site is located on Old Maitland Road, Sandgate (NSW) approximately 9.8 kilometres (km) north-west of the Newcastle Central Business District and 6.7 km west-north-west of industrial operations on Kooragang Island. The depot is situated within a small light industrial area.

The site is bound by the main Northern Railway (Newcastle-Maitland (Hunter) railway line) to the west and south, where rail container deliveries are made; the Newcastle Inner City Bypass (Shortland to Sandgate) which is under construction to the south; Sandgate Cemetery and the Pacific Highway to the east and Old Maitland Road to the north; the Hunter River is situated approximately 820 metres (m) to the east between Sandgate and Kooragang Island.

1.2.1 Surrounding Land Uses

Land uses and activities directly surrounding the site are generally limited to minor industrial and commercial uses, and residential areas.

To the west of the Northern Railway line (beyond the Hunter Wetlands area) is a residential area with receptors located on Blanch Street, the rear of their properties are approximately 800 metres distant from the site. Directly adjacent and west of the site is the Newcastle Golf Range and Practice Centre; to the south of the site is a residential area with receptors located on Astra Street.

Sandgate Cemetery and mixed industrial and residential areas are located to the south east of the site however these are not directly considered in this assessment. Further to the east of the site is the Pacific Highway which has strip of residential receptors and a commercial development situated directly on the highway. These locations, although in relatively near proximity to the site; experience significant existing road traffic noise from the highway.

To the north of the site are other industrial premises situated within the same industrial area as the Crawfords site and the St Joseph's Home (residential aged care) and St Joseph's Village (independent living), which are on the northern side of Old Maitland Road.

1.2.2 Site Layout and Locality

The Crawfords ammonium nitrate storage facility site, surrounding area and other items relevant to this assessment are visually represented in *Figure 1* and *Figure 2* below.

Figure 3 presents the sensitive receptor locations, noise logging location and attended measurement locations referred and relevant to the acoustic assessment components of this report.

Client:	Crawfords Freightlines Pty Ltd		
Drawing No:	0143175h_N_C001_R0.cdr		
Date:	28/06/2012	Drawing size:	A4
Drawn by:	JD	Reviewed by:	NL

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Figure 1 - Site Locality Plan

Crawfords Freightlines Pty Ltd - Acoustic Assessment

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Client:	Crawfords Freightlines Pty Ltd		
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Figure 2 - Site Layout Plan

Crawfords Freightlines Pty Ltd -
Acoustic Assessment

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Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

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Client:	Crawfords Freightlines Pty Ltd		
Drawing No:	0143175h_N_C003_R0.cdr		
Date:	10/07/2012	Drawing size:	A4
Drawn by:	JD	Reviewed by:	NL

Figure 3 - Acoustic Assessment Map

Crawfords Freightlines Pty Ltd - Acoustic Assessment

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1.4 STORAGE, HANDLING AND DISTRIBUTION

Crawfords customers import product from various countries including South America, Scandinavia, Asia and more locally from Orica on Kooragang Island. The imported product is received via Port Botany, Sydney; Port of Newcastle and directly from Orica's batching plant on Kooragang Island. Once the shipment of product is on-route to these locations, Crawfords is notified by their customers regarding storage and distribution logistics and timing. Other storage, handling and distribution factors relevant to this assessment include:

- ***Port Botany, Sydney***: Ammonium nitrate is received in Intermediate Flexible Bags (ICBs) (1-1.25 tonne per ICB; 20 tonne per container) in shipping containers by rail from Port Botany, Sydney.

- the maximum shipment received at Port Botany is 400 tonne which is the maximum berth-limit at the Port;

- the container-wagons are delivered to the rail-siding at the site, lifted off by container-forklift and emptied immediately so that empty containers can be returned as quickly as possible;

- standard unloading time is one working day;

- ***Port of Newcastle***: Ammonium nitrate is received in ICBs (1-1.25 tonne per bag) through the Port of Newcastle as a break-bulk shipment (i.e. bags transported in hold of ship with no pallets and no shipping containers).

- the maximum shipment is 3,000 tonne which is the maximum berth-limit at the Port;

- unloading is generally completed in 5 x 8-hour shifts using single and double trailers;

- Orica, Kooragang Island: Ammonium nitrate is received at Crawfords in ICBs (1-1.25 tonne per bag) on single and double flatbed trailers on timber pallets; and

- once the product is received on site it is to be stored in three locations being Shed A, Shed B, Shed C and in shipping containers in the outdoor compound to the south of Shed B.

Ammonium nitrate is normally distributed from the site in flexible bags on flat-top trucks direct to Hunter Valley and other NSW mining areas. Single trailer vehicles carry up to 20 flexible bags (approximately 25 tonne) while B-double vehicles (2 trailers) carry up to 30 flexible bags (approximately 37.5 tonne). The number of trucks per day varies depending on when a shipment of product is received, approximately three to four vehicles per day is typical.

The product is also distributed in bulk where the flexible bags are emptied into a hopper and transferred by a diesel powered conveyor and an electric screw conveyor (auger) into bulk carriers or transport trailers. Approximately five bulk trailers per day are distributed in this manner with B-double vehicles carrying approximately 35 tonne in total and single trailer vehicles carrying approximately 23 tonne. This processing is conducted outdoors, generally in the outdoor compound adjacent to Shed C. Shipping containers are distributed by road or rail from the Port of Newcastle or Sydney.

Based on current requirements, the quantity of ammonium nitrate stored at the site will remain relatively constant, though other storage and distribution activities at the site may vary over time depending on contracts and client requirements. They are likely to be similar to activities already undertaken within the site area.

1.4.1 Hours of Operation

The existing and proposed hours of operation for the site are as below:

- Monday to Friday, 06:00am to 10:00pm; and
- Saturdays and Sundays, 06:00am to 10:00pm if required.

2 ASSESSMENT METHODOLOGY

2.1 OVERVIEW

The site will be reintroducing a number of potential noise and vibration sources and there are a number of receptors near or adjoining the site area that may be classified as sensitive to noise and vibration. The broad objectives of assessment are to:

- quantify potential environmental noise and vibration levels associated with operational, construction and road traffic aspects of the site;
- qualify the magnitude of any noise and vibration impacts; and
- where necessary, provide recommendations to reduce any noise and/or vibration impacts identified as part of the assessment.

All works are being undertaken to reflect the intent and requirements of the applicable local, state and Australian standards, acoustic documents and relevant noise guidelines endorsed by NSW regulators.

2.1.1 *Acoustic Glossary*

A glossary of relevant acoustical concepts and terminology is presented in *Annex A*.

2.1.2 *Scope of Works*

To meet the assessment objectives the following scope of works were completed:

- review and become familiar with the relevant local standards and guidelines, applicable to the project and the assessment;
- review any existing project data and/or information relevant to the assessment, including review of project site plans and proposed operational, construction and road traffic scenarios;
- identify the closest and/or potentially most affected sensitive receiver locations. These locations have been adopted as the project-specific assessment locations (potentially sensitive receptors);
- quantify ambient and background noise levels via measurement at representative potentially sensitive receptors and develop the project-specific noise criteria at these locations;
- develop the project-specific vibration criteria at the potentially sensitive receptors;

- develop a project-specific noise model (refer 'Noise Modelling') to accurately quantify operational and construction noise level contributions including fixed and mobile noise sources associated with the site;

- complete spread-sheet calculations to quantify road traffic noise level contributions for site vehicles on public roads, and operational and construction vibration levels;

- compare the resultant noise and vibration levels to the project-specific criteria and determine the impact at the closest and/or potentially most affected sensitive receptor locations in the vicinity of the site; and

- recommend relevant noise and/or vibration control mitigation and/or management measures (and monitoring actions), to be considered by Crawfords for implementation at the site, if required.

2.2 *POLICY SETTING*

In NSW, noise pollution is regulated through the *Protection of the Environment Operations Act 1997* (POEO Act) as the key piece of environment protection legislation. Noise pollution is defined under the POEO Act as:

'*the emission of offensive noise, which means noise that by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances, is harmful (or is likely to be harmful) to or interferes unreasonably (or is likely to interfere unreasonably) with the comfort or repose of a person outside the premises from which the noise is emitted*'.

Under the POEO Act, the 'POEO (Noise Control) Regulation 2008' addresses common noisy activities that occur in residential situations; it limits the time of day that noisy articles (such as lawn mowers, stereos and leaf blowers) are permitted to be heard in neighbouring residences, however it does not specify noise limits and an applicable assessment approach for the assessment of new or existing developments

In this case various noise and vibration assessment guidelines endorsed by NSW regulators provide a guideline framework and methodology for deriving acceptable levels and standard methods for assessing and measuring impacts with due regard to the POEO Act, refer below.

2.2.1 Relevant Documents, Standards and Guidelines

This report has been prepared with due regard to and in general accordance with the following documents, standards and guidelines:

- NSW Environment Protection Authority – NSW *Environmental Noise Management – Industrial Noise Policy* (INP), January 2000 and relevant application notes;
- NSW Department of Environment and Climate Change – NSW *Interim Construction Noise Guideline* (ICNG), July 2009;
- NSW Department of Environment, Climate Change and Water – NSW *Road Noise Policy* (the road noise policy), March 2011;
- NSW Department of Environment, Climate Change and Water – NSW *Noise Guide for Local Government* (the noise guide), October 2010;
- Roads and Traffic Authority – *Environmental Noise Management Manual* (ENMM), December 2001;
- Standards Australia AS1055–1997™ (AS1055) – *Description and Measurement of Environmental Noise*, Parts 1, 2 and 3;
- Standards Australia AS IEC 61672.1–2004™ (AS61672) – *Electro Acoustics - Sound Level Meters Specifications Monitoring*;
- Standards Australia AS 2436–2010™ (AS2436) – *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites*; and
- International Organisation for Standardisation (ISO) 9613-2:1996 (ISO9613:2) - *Acoustics – Attenuation of Sound During Propagation Outdoors - Part 2: General Method of Calculation*;
- NSW Department of Environment and Conservation – NSW *Environmental Noise Management – Assessing Vibration: a Technical Guideline* (the vibration guideline), February 2006;
- German Institute for Standardisation – DIN 4150 (1999-02) Part 3 (DIN4150-3) – *Structural Vibration - Effects of Vibration on Structures*; and
- '*Crawford Freightlines Pty Ltd - Hazard Analysis (Revision 2)*' prepared by Health & Safety Essential Pty Ltd, dated 22 May 2012 (May 2012 hazard analysis).

A detailed description of the INP assessment methodology is provided here as *Annex C*. A summary of the ICNG and road noise policy assessment approach is presented as *Annex D* and the applicable vibration assessment methodology is presented as *Annex E*.

2.3 SENSITIVE RECEPTOR LOCATIONS

Based on a review of aerial photos, observations made on site and information provided by Crawfords the sensitive receptor locations shown in *Table 2.1* were identified.

It should be noted that the locations presented *Table 2.1* do not include all sensitive receptors in the vicinity of the site. These locations have been selected by ERM based on the review of data available at the time of the assessment. These locations have been selected as they are considered to be representative of the closest and/or potentially most affected receptor locations near the site, where operational, construction and road traffic noise and vibration levels may be assessed.

Noise and vibration levels for receivers at greater distances to the site and associated emission sources than those directly assessed are expected to be lower; predicted noise levels around each location under assessment are expected to be broadly similar.

Guidance Note

Based on ERM observations during the operator attended measurements the acoustic environment at and surrounding the site varies. Generally, the receptor locations in the vicinity of the site are best described as either urban or suburban as defined in the INP and presented below:

Suburban—an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry. This area often has the following characteristics:

- decreasing noise levels in the evening period (1800–2200); and/or
- evening ambient noise levels defined by the natural environment and infrequent human activity.

This area may be located in either a rural, rural-residential or residential zone, as defined on a Local Environmental Plan (LEP) or other planning instrument.

Urban—an area with an acoustical environment that:

- is dominated by 'urban hum' or industrial source noise;
- has through traffic with characteristically heavy and continuous traffic flows during peak periods;
- is near commercial districts or industrial districts; and/or
- has any combination of the above, where 'urban hum' means the aggregate sound of many unidentifiable, mostly traffic-related sound sources.

This area may be located in either a rural, rural-residential or residential zone as defined on an LEP or other planning instrument, and also includes mixed land use zones such as mixed commercial and residential uses.

The sensitive receptor locations (nine in total) will be adopted to assess both noise and vibration impacts; they are described in *Table 2.1* and visually presented in *Figure 3* (see *Section 1*).

Table 2.1 Sensitive Receptor Locations

ID	Description	GPS Coordinates (56H)		Direction from site	Distance from Site (m)	Elevation (m)
		Easting	Northing			
R1	Residential receptor located on Blanch Street[1]	377728	6362297	South-west	907	2.4
R2	Newcastle Golf Practice Centre	378565	6362177	South-west	213	4.6
R3	Residential receptor located on Astra Street[1]	378807	6362092	South	574	5.8
R4	Residential receptor located on Wallsend Road	379159	6362222	South	726	7.7
R5	Residential receptor located on Wallsend Road	378906	6362965	South-east	842	10.3
R6	Residential receptor located on the eastern side of the Pacific Highway[1]	378970	6363002	East	523	12.2
R7	Residential receptor located on the western side of the Pacific Highway	378622	6363491	East	448	13.5
R8	St Joseph's aged care and independent living	378411	6362560	North	431	4.5
R9	Industrial receptor located within the same industrial area and south of Old Maitland Road	378498	6363182	North	749	5.5

1. continuous unattended environmental noise logging was conducted at this location, refer *Section 3* for details.

2.4 ASSESSMENT SCENARIOS

This section presents the assessment scenarios adopted to predict noise and vibration levels at each of the sensitive receptor locations presented above.

Where applicable the adopted source term data is provided for each emission source considered as part of the assessment and included in the project-specific noise model (refer *Section 2.5*).

2.4.1 *Operational Assessment Scenarios*

Based on the information provided by Crawfords and available at the time of the assessment, a set of operational assessment scenarios have been developed which are described in detail in *Table 2.2*.

Each scenario has been assumed to potentially occur during all hours of proposed and existing operations (refer *Section 1*). In accordance with the INP the assessment periods are defined as follows:

- *Daytime*: 7am to 6pm - Monday to Saturday; or 8am to 6pm on Sundays and Public Holidays;
- *Evening*: 6pm to 10pm; and
- *Night time*: all remaining periods.

Accordingly, normal operational noise is assessed during the daytime and evening periods, and the night time/daytime morning shoulder period for works undertaken between 6am and 7am. Maximum noise level events are also considered as part of this assessment for works occurring during the morning shoulder period.

Table 2.2 Operational Assessment Scenarios

ID	Description	Noise Emission Centre (m)	Source Type	Adopted Sound Power Level (Lw)[1] [2]	Rail Scenario	Trucks Scenario	Rail and Trucks Combined	Trucks (and Conveyor Use)
LFL	36T Forklift	1.5	Point	99	2	2	2	2
MFL	25T Forklift	1.5	Point	96	1	1	1	1
SFL	5T Forklift	1.5	Point	94	8	8	8	8
LtVH	Light Vehicle	1.5	Point	74	2	2	2	2
AC1	Air Conditioning Split System	2	Point	72	5	5	5	5
AC2	Air Conditioning Condenser	2	Point	68	1	1	1	1
MA	Motion Alarm	1.75	Point	113	1	1	1	1
TR	Train Engine (1 Loco) Idling	2	Point	103	1	0	1	0
TR_tp	Train Transfer or Load Point	1	Point	97	1	0	1	0
HyVHs	Flat Top Truck	2	Point	100	0	1	1	1
HyVHl	Bulk Truck	2	Point	102	0	1	1	1
CNV_tp	Conveyor Transfer or Load Point	1	Point	97	0	0	0	2
FL_m	All Forklifts	1	Moving[3]	108	1	1	1	1
TR_m	Train Engine (1 Loco)	2	Moving[3]	102	1	0	1	0
LtVH_m	Light Vehicle	0.75	Moving[3]	80	1	1	1	1
HyVH_m	Flat Top and Bulk Truck Combined	1.75	Moving[3]	104	0	1	0	1
CNV	Conveyor	Various	Line	93 (80 dB/m)	0	0	0	1

1. dB re: 20µPa;
2. estimated source terms or obtained from the ERM noise database for similar plant; and
3. moving sources are representative of multiple items of plant and equipment in operation concurrently.

2.4.2 Construction Assessment Scenarios

At this time there is limited information available regarding potential construction works at the site, this is primarily due to the fact that civil works (which may include construction) have not yet been determined necessary.

Accordingly, these two construction assessment scenarios have been conservatively developed by ERM and are considered representative of potential civil works that may be undertaken at the site. These representative and potential worst-case scenarios are presented in *Table 2.3*.

Table 2.3 Construction Assessment Scenarios

Plant and Equipment	Noise Emission Centre (m)	Source Type	Adopted Sound Power Level (Lw)[1 2]	Representative Scenario	Worst-Case Scenario
Metal on Metal Contact	1.5	Point	116	2	2
Ute	1.5	Point	74	2	2
Ute	1.5	Moving	80	2	2
Excavator	1.75	Point	113	0	1
Crane	2	Point	109	0	1
Hand Tools	1	Point	112	4	4
Concrete Pump/mixer truck	1	Point	107	0	1
Concrete Mixer Truck	1.75	Moving	109	0	1

1. LAeq, 15minute, dB re: 20µPa; and
2. source terms obtained from the ERM noise database.

2.4.3 *Road Traffic Assessment Scenarios*

In considering potential road traffic noise level impacts, ERM has adopted the known average heavy vehicle movements presented in the May 2012 hazard analysis, which stated that the number of truck movements per day varies but three to four per day is typical.

It should be noted that in accordance with the road noise policy, daytime is defined as the hours between 7am and 10pm and night time is 10pm to 7am. It is likely that heavy vehicle movements associated with the site will occur during both periods.

For the purposes of CoRTN calculations ('Calculation of Road Traffic Noise', the globally accepted United Kingdom algorithm for the calculation of road traffic noise levels); a flow of eight vehicles per period has been adopted. This is representative of eight trucks entering and then exiting the site during the given assessment period. Where one hour assessment parameters are required (local roads) an average flow of four vehicles has been adopted; representative of four trucks entering and then exiting the site.

2.5 *NOISE MODELLING*

To quantify operational and construction noise level contributions at the closest and/or potentially most affected noise sensitive receiver locations in the vicinity of the site, ERM has completed a comprehensive noise modelling assessment for the site. Brüel & Kjær's Predictor 7810 (Version 8.01) noise modelling software package was utilised to calculate noise levels using the ISO 9613.2 industrial noise propagation algorithms (international method for general purpose, 1/3 octaves).

The Predictor software package allows topographic[1] details to be combined with ground regions, water, grass, significant building structures etc. and project-specific assessment locations, to create a detailed and accurate representation of the site and surrounding area. Noise emission sources deemed representative of typical conditions under each scenario (refer *Table 2.2* and *Table 2.3* above) can be placed at locations within the site area.

The noise model allowed quantification of noise levels from multiple sources (fixed, moving and line), based on sound pressures or sound power levels emitted from the key plant components. The model computed the noise propagation in the project area of influence and quantified the A-weighted decibels, dB(A) noise level from site.

[1] © Commonwealth of Australia (Geoscience Australia) 2011

2.6 *PREDICTING VIBRATION*

As is apparent in the relevant standards and guidelines for evaluating the effect of vibration on humans or structures, there is no defined calculative process that may be followed to precisely predict vibration levels at a given assessment location.

Unlike noise which travels through air, the transmission of vibration is highly dependent on substratum conditions between the source/s and receiver. Also dissimilar to noise travelling through air, vibration levels diminish quickly over distance, thus an adverse impact from vibration on the broader community is not typically expected.

To comprehensively assess the operational and construction aspects of the site, a conservative vibration impact assessment has been undertaken based on measured vibration levels for comparable sources from the ERM database.

To calculate vibration dose values in accordance with the vibration guideline; approximate values based on the proposed works have been predicted, again based on measured vibration levels in the ERM data base. This methodology will provide guidance as to the potential impacts (which are not anticipated) from activities which may generate vibration.

3 EXISTING ENVIRONMENT

A key element in assessing environmental noise impacts is to quantify the existing ambient and background noise environment at or near to the closest and/or potentially most affected noise sensitive receiver locations. As such, continuous unattended environmental noise logging was conducted to quantify the existing noise environment and to establish the INP Assessment Background Level (ABL), Rating Background Level (RBL) parameters, and the existing road traffic noise level with regard to the requirements specified in the road noise policy. The ABL and RBL parameters are applicable to both the operational and construction noise impact assessments.

3.1 MEASUREMENT EQUIPMENT

The measurement instrumentation used in this assessment complied in general accordance with the requirements of AS61672 with current NATA calibration certificates, with certification at intervals not exceeding two years at the time of use. The equipment used for this assessment was as follows:

- 2 x ARL 215 Environmental Noise Loggers;
- 1 x ARL Ngara Environmental Noise Logger;
- 1 x Brüel & Kjaer 2250 Type 1 Sound Level Meter; and
- 1 x Brüel & Kjaer Type 4230 Sound Level Calibrator.

Acoustic measurements were completed in general accordance with AS1055.1. The Brüel & Kjaer sound level calibrator was used to calibrate the noise loggers prior to and after measurement, with no significant difference in calibration noted. All data analysis was performed by a member of the Australian Acoustical Society, at the grade of 'Associate Member' or higher.

3.2 AMBIENT AND BACKGROUND NOISE LEVELS

3.2.1 Unattended Noise Logging

Continuous unattended environmental noise logging was conducted at three locations and over two monitoring periods, where required. These unattended monitoring locations were:

- 24 Astra Street, Sandgate;
- 49 Blanch Street, Shortland; and
- 211 Maitland Road, Sandgate.

During the first monitoring period, significant rainfall (and wind speeds at the microphone above 5m/s) affected the data set, and noise loggers where redeployed to ensure a robust baseline data-set was captured. The first round of monitoring (Period One) was completed between Tuesday, 29 May 2012 and Tuesday, 12 June 2012 and the second round of monitoring (Period Two) was completed between Wednesday, 13 June 2012 and Friday, 22 June 2012.

During environmental noise logging, data was recorded at 15 minute intervals over the measurement period, with parameters (considered to be representative of the existing noise environment) calculated including L_{eq}, L_1, L_{10}, L_{90}, L_{max} and L_{min} values. The daily and overall ABL and RBL assessment values were then calculated from this 15 minute data.

At the conclusion of monitoring, noise logging data was combined with local meteorological data (including wind speed and rainfall) for the sample period. This was completed with due regard to and in accordance with the INP. Weather data was obtained from the closest Bureau of Meteorology (BOM) weather observation station which simultaneously recorded both wind speed and rainfall data at the time of this assessment.

Meteorological data used to analyse environmental noise logging data captured during round one and two of monitoring was obtained from the Williamtown RAAF station (ID: 061078). If wind speeds exceeded the prescribed INP 5m/s wind limit[2], or it rained, the affected noise data was disregarded.

A summary of measured existing ambient and background noise levels is presented in *Table 3.1* to *Table 3.5*. Daily charts, which visually represent the measured noise levels in 15 minute sample periods over the duration of the monitoring, are included as *Annex B*.

[2] This limit applies at the monitoring devices microphone and meteorological data is as provided by the BOM Williamtown RAAF observation station. Based on this, data recorded during periods of wind up to 7.8m/s have been excepted

Table 3.1 49 Blanch Street, Shortland (Period One)

	Measured Existing Noise Levels[1 4 5]					
Date	**ABL Day[2]**	**ABL Evening[2]**	**ABL Night[2]**	**Leq Day[3]**	**Leq Evening[3]**	**Leq Night[3]**
Wednesday, 30 May 2012	-	35.1	34.2	-	41.4	41.4
Thursday, 31 May 2012	34.3	35.6	36.4	51.8	42.0	43.9
Friday, 1 June 2012	-	38.3	34.8	-	43.9	41.7
Saturday, 2 June 2012	32.2	-	-	52.1	-	-
Sunday, 3 June 2012	-	-	-	-	-	-
Monday, 4 June 2012	35.3	-	-	47.7	-	-
Tuesday, 5 June 2012	-	-	-	-	-	-
Wednesday, 6 June 2012	-	-	-	-	-	-
Thursday, 7 June 2012	-	38.7	36.6	-	42.6	42.7
Friday, 8 June 2012	31.8	38.3	36.6	46.5	45.1	44.2
Saturday, 9 June 2012	31.0	37.3	36.0	44.1	42.8	42.4
Sunday, 10 June 2012	32.3	34.2	-	44.5	39.2	-
Monday, 11 June 2012	-	-	-	-	-	-
Tuesday, 12 June 2012	-	-	-	-	-	-
Summary Values	**32.3**	**37.3**	**36.2**	**49.0**	**42.8**	**42.8**

1. dB(A) re 2 x 10^{-5} Pa;
2. LA90 values (ABL) represent the level exceeded for 90 per cent of the interval period and is referred to as the average minimum or background noise level;
3. the LAeq index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period;
4. '-' indicates periods with too few valid samples due to weather or logger operation;
5. in accordance with the INP the assessment periods are defined as follows: Daytime is the period from 7am to 6pm - Monday to Saturday; or 8am to 6pm on Sundays and Public Holidays, Evening is the period from 6pm to 10pm and Night time is all remaining periods.

Table 3.2 49 Blanch Street, Shortland (Period Two)

	Measured Existing Noise Levels					
Date	ABL Day	ABL Evening	ABL Night	Leq Day	Leq Evening	Leq Night
Wednesday, 13 June 2012	-	41.5	39.0	-	43.3	42.7
Thursday, 14 June 2012	35.1	42.7	34.8	47.8	47.8	42.6
Friday, 15 June 2012	35.2	41.5	35.3	48.2	47.6	45.4
Saturday, 16 June 2012	37.7	-	-	49.3	-	-
Sunday, 17 June 2012	-	32.3	30.9	0.0	51.9	39.7
Monday, 18 June 2012	31.9	31.8	30.7	44.4	46.9	39.6
Tuesday, 19 June 2012	-	33.1	32.0	0.0	49.4	40.5
Wednesday, 20 June 2012	34.4	37.0	33.4	46.9	43.1	42.5
Thursday, 21 June 2012	35.8	41.5	34.3	49.4	46.7	45.0
Friday, 22 June 2012	-	-	-	-	-	-
Summary Values	**35.2**	**39.3**	**33.8**	**48.0**	**47.9**	**42.7**

1. refer notes presented in Table 3.1.

Table 3.3 24 Astra Street, Sandgate (Period One)

	Measured Existing Noise Levels					
Date	ABL Day	ABL Evening	ABL Night	Leq Day	Leq Evening	Leq Night
Tuesday, 29 May 2012	-	-	-	-	-	-
Wednesday, 30 May 2012	-	39.0	36.0	-	45.2	43.3
Thursday, 31 May 2012	37.0	37.5	37.0	53.4	46.2	43.7
Friday, 1 June 2012	-	39.0	34.0	-	43.7	43.3
Saturday, 2 June 2012	36.5	-	-	49.3	-	-
Sunday, 3 June 2012	-	-	-	-	-	-
Monday, 4 June 2012	37.5	-	-	54.8	-	-
Tuesday, 5 June 2012	-	-	-	-	-	-
Wednesday, 6 June 2012	-	-	-	-	-	-
Thursday, 7 June 2012	-	-	-	-	-	-
Friday, 8 June 2012	-	-	-	-	-	-
Saturday, 9 June 2012	-	-	-	-	-	-
Sunday, 10 June 2012	-	-	-	-	-	-
Monday, 11 June 2012	-	-	-	-	-	-
Tuesday, 12 June 2012	-	-	-	-	-	-
Summary Values	**37.0**	**39.0**	**36.0**	**53.1**	**45.2**	**43.4**

1. refer notes presented in Table 3.1.

Table 3.4 24 Astra Street, Sandgate (Period Two)

	Measured Existing Noise Levels					
Date	ABL Day	ABL Evening	ABL Night	Leq Day	Leq Evening	Leq Night
Wednesday, 13 June 2012	-	43.0	38.5	-	46.7	45.3
Thursday, 14 June 2012	36.8	44.0	35.5	51.2	48.2	46.2
Friday, 15 June 2012	37.5	45.0	38.0	50.3	50.0	46.6
Saturday, 16 June 2012	39.5	-	-	48.7	-	-
Sunday, 17 June 2012	-	39.0	36.5	-	46.9	44.0
Monday, 18 June 2012	38.0	40.5	37.0	49.8	48.8	46.2
Tuesday, 19 June 2012	-	42.0	37.5	-	48.8	45.7
Wednesday, 20 June 2012	37.5	42.0	39.5	50.2	48.0	49.9
Thursday, 21 June 2012	40.5	46.0	39.0	59.1	49.9	49.1
Friday, 22 June 2012	-	-	-	-	-	-
Summary Values	**37.8**	**42.5**	**37.8**	**53.4**	**48.6**	**47.0**

1. refer notes presented in Table 3.1.

Table 3.5 211 Maitland Road, Sandgate (Period One Only)

	Measured Existing Noise Levels					
Date	ABL Day	ABL Evening	ABL Night	Leq Day	Leq Evening	Leq Night
Tuesday, 29 May 2012	-	-	-	-	-	-
Wednesday, 30 May 2012	-	52.0	42.0	0.0	68.7	68.2
Thursday, 31 May 2012	55.5	51.0	41.0	72.1	68.9	67.4
Friday, 1 June 2012	-	49.0	39.0		69.3	65.4
Saturday, 2 June 2012	53.5	-	-	70.0	-	-
Sunday, 3 June 2012	-	-	-		-	-
Monday, 4 June 2012	59.0	-	-	73.0	-	-
Tuesday, 5 June 2012	-	-	-	-	-	-
Wednesday, 6 June 2012	-	-	-	-	-	-
Thursday, 7 June 2012	-	54.5	43.5	-	69.5	68.3
Friday, 8 June 2012	57.5	53.5	43.5	72.6	69.2	65.7
Saturday, 9 June 2012	54.0	51.5	43.0	71.1	67.7	63.4
Sunday, 10 June 2012	51.0	49.5	-	69.5	67.2	-
Monday, 11 June 2012	-	-	-	-	-	-
Tuesday, 12 June 2012	-	-	-	-	-	-
Summary Values	**54.8**	**51.5**	**42.5**	**71.6**	**68.7**	**66.7**

1. refer notes presented in Table 3.1; and
2. This location was dominated by road traffic noise. As defined in Section 3.5 of the INP, areas where the background noise levels are affected significantly by nearby road traffic with regular daily pattern, three days' worth of valid data is sufficient. Accordingly round two of monitoring was not undertaken at this location.

Summary of Measured Overall Noise Levels

The overall RBL and L_{Aeq} values for each monitoring location are summarised in *Table 3.6*. For the purposes of this impact assessment these overall values (period one and two combined) are applied to determine the appropriate INP, ICNG and road noise policy criteria.

Table 3.6 Overall Ambient and Background Noise Levels

	Measured Overall Noise Levels[1]					
Location	**RBL Day**	**RBL Evening**	**RBL Night**	**Leq Day**	**Leq Evening**	**Leq Night**
49 Blanch Street	33.8	38.3	35.0	48.5	46.1	42.8
24 Astra Street	37.4	40.8	36.9	53.2	47.2	45.6
211 Maitland Road	54.8	51.5	42.5	71.6	68.7	66.7

1. dB(A) re 2 x 10^{-5} Pa;
2. LA90 values (RBL) represent the level exceeded for 90 per cent of the interval period and is referred to as the average minimum or background noise level;
3. the LAeq index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period;
4. in accordance with the INP the assessment periods are defined as follows: Daytime is the period from 7am to 6pm - Monday to Saturday; or 8am to 6pm on Sundays and Public Holidays, Evening is the period from 6pm to 10pm and Night time is all remaining periods.

Guidance Note

The results of long term unattended background noise monitoring has determined that the RBL for the evening and night period are higher than the RBL for the daytime period at 49 Blanch Street and 24 Astra Street. This has most likely arisen due to increased noise from traffic during the evening and night, or due to temperature inversion conditions. Therefore, in determining noise criteria (refer *Section 4*) for this site, ERM will set the noise levels for evening and night time no greater than the intrusive noise level for daytime in accordance with the recommended approach presented in the INP.

3.2.2 Attended Noise Measurements

In order to better understand the existing acoustic environment for the majority of noise sensitive receivers in the vicinity of the site, a series of operator attended environmental noise measurements were completed on Tuesday, 5 June 2012.

Operator attended environmental noise measurements of 15 minutes duration were conducted at a total of three accessible assessment locations and were time synchronised with the unattended noise loggers that were in operation for the same sample period. This synchronisation was coordinated so that an accurate comparison unattended noise levels at other locations could be made, where unattended monitoring was not completed. The resultant level differences between unattended noise logger data and attended noise measurement data have been considered as part of the noise impact assessment at applicable locations. This differential has only been incorporated into the assessment where measured noise levels appear significant.

Results of the attended noise measurements (including comparison to the time synchronised noise logging data) is summarised in *Table 3.7*.

Table 3.7 Attended Noise Measurements

		Unattended[2]		Attended[3]		Differential (A – U)	
Location	**Time**	**LAeq[1]**	**LA90[1]**	**LAeq[1]**	**LA90[1]**	**LAeq[1]**	**LA90[1]**
Front yard of 49 Blanch Street, Shortland (A1)	09:30 AM	48.2	41.4	62.2	54.7	14.0	13.3
Front yard of 24 Astra Street, Sandgate (A2)	10:45 AM	*No Data[4]*		53.8	47.3	*No Data[4]*	
Southern boundary of St Joseph's, Sandgate (A3)	11:30 AM	72.5	61.5	51.3	44.5	-21.2	-17.0

1. dB re: 2 x 10^{-5} Pa;
2. nearest representative continuous unattended environmental noise logging location;
3. operator attended environmental noise measurement data; and
4. due to the unattended monitoring device failure on this day, no comparison can be made. This is not considered significant.

Discussion

These results indicate that noise levels at the front yard of 49 Blanch Street are elevated when compared to noise levels in the rear yard (which faces the site). This is typical of a residential area, where the front of the house faces the local street and other residences in the area; in this case the year yard faces the wetlands area with no significant existing noise emission sources audible at the location. It should be noted, that at this location no adjustment to the overall ambient and background noise levels has been made, as the unattended monitoring location is representative of the most affected boundary at the assessment location.

At 24 Astra Street, although no comparison of unattended and attended data sets measured can be made due to the unattended device failure on this day, the measured ambient and background noise levels are broadly similar and slightly elevated when compared to those measured at 49 Blanch Street. This is consistent with the overall values measured as part of unattended logging and assists to validate the higher noise criteria at this (and surrounding) assessment location/s.

At the southern boundary of St Joseph's ambient and background noise levels were measured to be approximately 17 dB(A) to 21 dB(A) below the levels measured at 211 Maitland Road. These differential values have been applied to the unattended data captured at 211 Maitland Street to estimate representative ambient and background noise levels at St Joseph's, and to determine appropriate INP, ICNG and road noise policy criteria at this assessment location.

3.2.3 Meteorological Conditions

Meteorological conditions, especially prevailing winds and temperature inversions have the potential to increase noise levels (and impacts) at the closest and/or potentially most affected noise sensitive receiver locations in the vicinity of the site.

The May 2012 hazard analysis presented prevailing meteorological conditions which were measured at the Williamtown RAAF weather observation station and used as part of the air quality assessment; parameters relevant to this acoustic assessment are reproduced below.

Table 3.8 Existing Meteorological Conditions

	Temperature Inversion Category					
Parameter	**B3 (A and B)**	**D3 (C and D, wind speeds <4m/s)**	**D6 (C and D, wind speeds 4 to 10 m/s)**	**D12 (C and D, wind speeds >4m/s)**	**E3 (E only)**	**F2 (F only)**
Ambient temperature (minimum) [1]	6	2	3	8	3	2
Ambient temperature (maximum) [1]	34	32	36	33	31	28
Ambient temperature (average) [1]	**20.8**	**16.1**	**18.2**	**16.9**	**16**	**13.2**
Wind speed (minimum) [2]	0.6	0.6	4.2	10.7	2.2	0.6
Wind speed (maximum) [2]	4.7	3.6	9.7	16.4	4.7	2.5

Parameter		Temperature Inversion Category						
		B3 (A and B)	D3 (C and D, wind speeds <4m/s)	D6 (C and D, wind speeds 4 to 10 m/s)	D12 (C and D, wind speeds >4m/s)	E3 (E only)	F2 (F only)	
	m/s	**2.9**	**2.7**	**6.3**	**11.7**	**3.6**	**1.9**	
Wind speed (average)	N %	1.23	2.66	0.42	0.00	1.32	3.14	**8.77**
	NE %	0.9	3.15	3.08	0.00	3.34	31.7	**13.64**
	E %	0.42	2.08	3.89	0.01	1.04	1.08	**8.52**
	SE %	0.57	1.29	7.53	0.17	0.89	0.55	**11.00**
	S %	0.43	1.55	7.04	0.32	0.4	0.61	**10.35**
	SW %	0.55	2.23	3.43	0.13	0.53	0.66	**7.53**
	W %	1.43	4.73	10.21	1.11	2.31	1.97	**21.76**
	NW %	2.30	6.06	3.58	0.64	2.25	3.60	**18.43**
	Total %	**7.83**	**23.75**	**39.18**	**2.38**	**12.08**	**14.78**	

1. degrees Celsius (^{0} C); and
2. Meters per Second (m/s).

The data reproduced above indicates that in accordance with the INP, prevailing winds are not a feature of the area. However, Class-D temperature inversions may occur more than 30% of the time and are conservatively considered a potential feature of the area.

These known (BOM measured) values are appropriate to quantify existing prevailing weather conditions in the area and to determine representative adverse noise modelling scenarios (Class-D temperature inversion) which have been modelled in addition to calm conditions. The default INP parameters for meteorological conditions have therefore been excluded from this assessment. The average ambient temperatures presented above have been adopted also for each meteorological scenario.

3.3 AMBIENT VIBRATION LEVELS

Ambient vibration levels do not form part of the assessment approach. However, considering that there is limited existing major industry in near proximity of each of the sensitive receptor locations, it is assumed that existing vibration levels are likely to be less than the human threshold for the perception of vibration which is typically considered to be 0.2mm/s.

4 PROJECT-SPECIFIC CRITERIA

4.1 NOISE IMPACT ASSESSMENT

This section summarises the project-specific noise criteria that have been determined with due regard to and in accordance with the relevant documents, standards and guidelines.

4.1.1 INP Summary

The intrusiveness and amenity criteria determined for each assessment location, as well as the Project-specific Noise Level (PSNL) are presented in *Table 4.1*.

Table 4.1 Project-Specific Noise Levels

		Intrusiveness[1]			Amenity[1]			PSNL[1]			
ID	**Description**	**D**	**E**	**N**	**D**	**E**	**N**	**D**	**E**	**N**	**S[3]**
R1	Residential receptor located on Blanch Street	39	43	40	55	44	40	**39**	**39**	**39**	**39**
R2	Newcastle Golf Practice Centre		*n/a*[2]		55	55	55	**55**	**55**	**55**	**55**
R3	Residential receptor located on Astra Street	42	46	42	60	50	45	**42**	**42**	**42**	**42**
R4	Residential receptor located on Wallsend Road	42	46	42	60	50	45	**42**	**42**	**42**	**42**
R5	Residential receptor located on Wallsend Road	42	46	42	60	50	45	**42**	**42**	**42**	**42**
R6	Residential receptor located on the eastern side of the Pacific Highway	60	57	48	60	50	45	**60**	**57**	**48**	**54**
R7	Residential receptor located on the western side of the Pacific Highway	60	57	48	60	50	45	**60**	**57**	**48**	**54**
R8	St Joseph's aged care and independent living	43	40	35	60	48	45	**43**	**40**	**35**	**39**
R9	Industrial receptor located within the same industrial area and south of Old Maitland Road		*n/a*[2]		70	70	70	**70**	**70**	**70**	**70**

1. dB re: 2×10^{-5} Pa;
2. not applicable at active recreational or industrial receptors; and
3. "S" is shoulder period PSNL.

Shoulder Periods

Regarding the shoulder period values presented in *Table 4.1*, ERM has adopted the conservative approach of determining this criteria as the mid-point between the overall daytime and night time RBL values for each monitoring location or applying the most stringent daytime PSNL, where evening and night time RBL values were measured to be above the daytime value. It should be noted that in this area the existing road network generates significant road traffic noise in some cases, especially for receptors located east of the site where Pacific Highway traffic volumes (and associated noise) are significant.

A review of noise logging charts for data recorded at 211 Maitland Road has identified a diurnal cycle where existing background noise levels steadily rise in these early morning hours, on each week day.

The lowest recorded ABL at 211 Maitland Street was captured on Friday, 1 June 2012. On this day the overall L_{90} value between 6am and 7am was measured to be 59.5 dB(A) which is significantly elevated when compared to the overall night time RBL values of 42.5 dB(A). This phenomenon is also a relevant consideration at St Joseph's aged care and independent living who also experience some (though not to the same magnitude as Pacific Highway receptors) level of existing road traffic noise. At this location an estimated overall L_{90} value between 6am and 7am was calculated to be 42.5 dB(A).

Where noise levels comply with the more stringent shoulder period criteria determined as the as the mid-point between the overall daytime and night time RBL values, no further action is required. Where noise level exceedances are predicted ERM will consider the additional shoulder period criteria to evaluate potential impacts between 6am and 7am:

- R6 and R7 (*residential receptors located on the Pacific Highway*) – site noise level contribution $L_{Aeq,\ 15\ minute} \leq 64.5$ dB(A); and
- R8 (St Joseph's aged care and independent living) – Site noise level contribution $L_{Aeq,\ 15\ minute} \leq 47.5$ dB(A).

4.1.2 ICNG Summary

The project-specific Noise Management Levels for construction works undertaken during the recommended standard hours of construction are presented in *Table 4.2* below.

Table 4.2 Noise Management Levels

ID	Description	Noise Affected Management Level	Highly Noise Affected Management Level
R1	Residential receptor located on Blanch Street	44	75
R2	Newcastle Golf Practice Centre	65	*n/a*[2]
R3	Residential receptor located on Astra Street	47	75
R4	Residential receptor located on Wallsend Road	47	75
R5	Residential receptor located on Wallsend Road	47	75
R6	Residential receptor located on the eastern side of the Pacific Highway	65	75
R7	Residential receptor located on the western side of the Pacific Highway	65	75
R8	St Joseph's aged care and independent living	48	75
R9	Industrial receptor located within the same industrial area and south of Old Maitland Road	75	*n/a*[2]

1. dB re: 2 x 10^{-5} Pa;
2. not applicable at active recreational or industrial receptors.

4.1.3 Road Traffic Policy

The project-specific road traffic noise criteria for existing residences affected by additional traffic on existing *freeways/arterial/sub arterial roads* generated by land use developments is $L_{Aeq,\ (15\ hour)}$ 60 dB (external) for the daytime assessment period and $L_{Aeq,\ (9\ hour)}$ 55 dB (external) for the night time assessment period.

The criteria for existing residences affected by additional traffic on existing *local roads* generated by land use developments is $L_{Aeq,\ (1\ hour)}$ 55 dB (external) for the daytime assessment period and $L_{Aeq,\ (1\ hour)}$ 50 dB (external) for the night time assessment period.

4.1.4 Evaluating Impact Significance

To evaluate and qualify the significance or magnitude of any predicted noise level exceedances, the following general hierarchy has been adopted:

- where noise levels are expected to be inaudible at the assessment location, no impacts are anticipated;

- where noise levels are predicted to be below the project-specific noise criteria and up to 2 dB(A) above the criteria at the assessment location, negligible (low) impacts are anticipated;

- where noise levels are predicted to be between 2 dB(A) and 5 dB(A) above the project-specific noise criteria at the assessment location, moderate impacts are anticipated;

- where noise levels are predicted to be more than 5 dB(A) above the project-specific noise criteria at the assessment location, high impacts are anticipated; and

- where noise levels are predicted to be more than 10 dB(A) above the project-specific noise criteria at the assessment location, significant high impacts are anticipated.

4.2 VIBRATION IMPACT ASSESSMENT

The project-specific vibration criteria is summarised in *Table 4.3*, *Table 4.4* and *Table 4.5*. These guideline values are applied at each of the assessment locations where applicable.

Table 4.3 Structural Damage Guideline Values

		Vibration Velocity in mm/s			
		At Foundation at a Frequency of:			Plane of Floor of Uppermost Storey
Line	**Type of Structure**	**Less than 10Hz**	**10Hz to 50Hz**	**50Hz to 100Hz [1]**	**All Frequencies**
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	5 to 20	15

1. at frequencies above 100Hz, the values given in this column may be used as a minimum.

Table 4.4 Guideline Values for Impulsive Vibration

Place	Time	Assessment Criteria: Peak Velocity (mm/s) Preferred	Assessment Criteria: Peak Velocity (mm/s) Maximum
Residences	Daytime	8.60	17.0
	Night-time	2.80	5.60
Offices	Day or Night-time	18.0	36.0

1. rms velocity (mm/s) and vibration velocity value (dB re 10-9 mm/s); and
2. values given for most critical frequency >8Hz assuming sinusoidal motion.

Table 4.5 Guideline Values for Intermittent Vibration

Location	Daytime Preferred Value, $m/s^{1.75}$	Daytime Maximum Value, $m/s^{1.75}$	Night-time Preferred Value, $m/s^{1.75}$	Night-time Maximum Value, $m/s^{1.75}$
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and placed of worship	0.40	0.80	0.40	0.80

1. daytime is 7am to 10pm and Night-time is 10pm to 7am; and
2. these criterions are indicative only, and there may be a need to assess intermittent values against continuous or impulsive criteria for critical areas.

5 NOISE IMPACT ASSESSMENT

5.1 OPERATIONAL NOISE

The results of the operational noise impact assessment including results for all scenarios during both calm and adverse meteorological conditions, and comparison to the PSNL at each assessment location are presented in *Table 5.1* and *Table 5.2*. These results are visually presented as noise contour maps in *Figure 4* to *Figure 11*.

Table 5.1 Operational Noise Levels (Calm) and INP Compliance Assessment

Scenario	Receptor	Calculated Noise Level[1]	Daytime PSNL[1]	Evening PSNL[1]	Morning Shoulder PSNL[1]	Daytime Compliance	Evening Compliance	Morning Shoulder Compliance
Rail	R1	29.9	39	39	39	-9.1	-9.1	-9.1
	R2	48.7	55	55	55	-6.3	-6.3	-6.3
	R3	38.7	42	42	42	-3.3	-3.3	-3.3
	R4	32.0	42	42	42	-10	-10	-10
	R5	32.8	42	42	42	-9.2	-9.2	-9.2
	R6	44.5	60	57	54	-15.5	-12.5	-9.5
	R7	46.2	60	57	54	-13.8	-10.8	-7.8
	R8	41.6	43	40	39	-1.4	**1.6**	**2.6**
	R9	49.6	70	70	70	-20.4	-20.4	-20.4
Trucks	R1	30.3	39	39	39	-8.7	-8.7	-8.7
	R2	47.0	55	55	55	-8.0	-8.0	-8.0
	R3	38.1	42	42	42	-3.9	-3.9	-3.9
	R4	32.7	42	42	42	-9.3	-9.3	-9.3
	R5	33.3	42	42	42	-8.7	-8.7	-8.7
	R6	45.2	60	57	54	-14.8	-11.8	-8.8
	R7	46.9	60	57	54	-13.1	-10.1	-7.1
	R8	42.8	43	40	39	-0.2	**2.8**	**3.8**
	R9	50.5	70	70	70	-19.5	-19.5	-19.5
Rail and Trucks Combined	R1	31.0	39	39	39	-8.0	-8.0	-8.0
	R2	49.0	55	55	55	-6.0	-6.0	-6.0
	R3	39.1	42	42	42	-2.9	-2.9	-2.9
	R4	33.2	42	42	42	-8.8	-8.8	-8.8
	R5	33.7	42	42	42	-8.3	-8.3	-8.3
	R6	45.4	60	57	54	-14.6	-11.6	-8.6
	R7	47.1	60	57	54	-12.9	-9.9	-6.9
	R8	43.0	43	40	39	0.0	**3.0**	**4.0**
	R9	50.6	70	70	70	-19.4	-19.4	-19.4
Trucks (and conveyor use)	R1	30.6	39	39	39	-8.4	-8.4	-8.4
	R2	49.2	55	55	55	-5.8	-5.8	-5.8

Scenario	Receptor	Calculated Noise Level[1]	Daytime PSNL[1]	Evening PSNL[1]	Morning Shoulder PSNL[1]	Daytime Compliance	Evening Compliance	Morning Shoulder Compliance
Trucks (and conveyor use)	R3	40.7	42	42	42	-1.3	-1.3	-1.3
	R4	33.7	42	42	42	-8.3	-8.3	-8.3
	R5	33.7	42	42	42	-8.3	-8.3	-8.3
	R6	45.2	60	57	54	-14.8	-11.8	-8.8
	R7	46.9	60	57	54	-13.1	-10.1	-7.1
	R8	42.8	43	40	39	-0.2	**2.8**	**3.8**
	R9	50.5	70	70	70	-19.5	-19.5	-19.5

1. dB re: 2 x 10^{-5} Pa and Leq, 15 minute or Leq, period where applicable; and
2. exceedances to PSNL in **bold** typeset.

Table 5.2 Operational Noise Levels (Adverse) and INP Compliance Assessment

Scenario	Receptor	Calculated Noise Level[1]	Daytime PSNL[1]	Evening PSNL[1]	Morning Shoulder PSNL[1]	Daytime Compliance	Evening Compliance	Morning Shoulder Compliance
Rail	R1	30.0	39	39	39	-9.0	-9.0	-9.0
	R2	48.7	55	55	55	-6.3	-6.3	-6.3
	R3	38.7	42	42	42	-3.3	-3.3	-3.3
	R4	32.1	42	42	42	-9.9	-9.9	-9.9
	R5	32.9	42	42	42	-9.1	-9.1	-9.1
	R6	44.5	60	57	54	-15.5	-12.5	-9.5
	R7	46.2	60	57	54	-13.8	-10.8	-7.8
	R8	41.7	43	40	39	-1.3	**1.7**	**2.7**
	R9	49.5	70	70	70	-20.5	-20.5	-20.5
Trucks	R1	30.4	39	39	39	-8.6	-8.6	-8.6
	R2	47.0	55	55	55	-8.0	-8.0	-8.0
	R3	38.1	42	42	42	-3.9	-3.9	-3.9
	R4	32.8	42	42	42	-9.2	-9.2	-9.2
	R5	33.4	42	42	42	-8.6	-8.6	-8.6
	R6	45.2	60	57	54	-14.8	-11.8	-8.8

Scenario	Receptor	Calculated Noise Level[1]	Daytime PSNL[1]	Evening PSNL[1]	Morning Shoulder PSNL[1]	Daytime Compliance	Evening Compliance	Morning Shoulder Compliance
Trucks	R7	46.9	60	57	54	-13.1	-10.1	-7.1
	R8	42.9	43	40	39	-0.1	**2.9**	**3.9**
	R9	50.5	70	70	70	-19.5	-19.5	-19.5
Rail and Trucks Combined	R1	31.1	39	39	39	-7.9	-7.9	-7.9
	R2	49.0	55	55	55	-6.0	-6.0	-6.0
	R3	39.2	42	42	42	-2.8	-2.8	-2.8
	R4	33.3	42	42	42	-8.7	-8.7	-8.7
	R5	33.8	42	42	42	-8.2	-8.2	-8.2
	R6	45.4	60	57	54	-14.6	-11.6	-8.6
	R7	47.1	60	57	54	-12.9	-9.9	-6.9
	R8	43.1	43	40	39	**0.1**	**3.1**	**4.1**
	R9	50.6	70	70	70	-19.4	-19.4	-19.4
Trucks (and conveyor use)	R1	30.7	39	39	39	-8.3	-8.3	-8.3
	R2	49.2	55	55	55	-5.8	-5.8	-5.8
	R3	40.8	42	42	42	-1.2	-1.2	-1.2
	R4	33.8	42	42	42	-8.2	-8.2	-8.2
	R5	33.7	42	42	42	-8.3	-8.3	-8.3
	R6	45.2	60	57	54	-14.8	-11.8	-8.8
	R7	46.9	60	57	54	-13.1	-10.1	-7.1
	R8	42.9	43	40	39	-0.1	**2.9**	**3.9**
	R9	50.5	70	70	70	-19.5	-19.5	-19.5

1. dB re: 2 x 10^{-5} Pa and Leq, 15 minute or Leq, period where applicable; and
2. exceedances to PSNL in **bold** typeset.

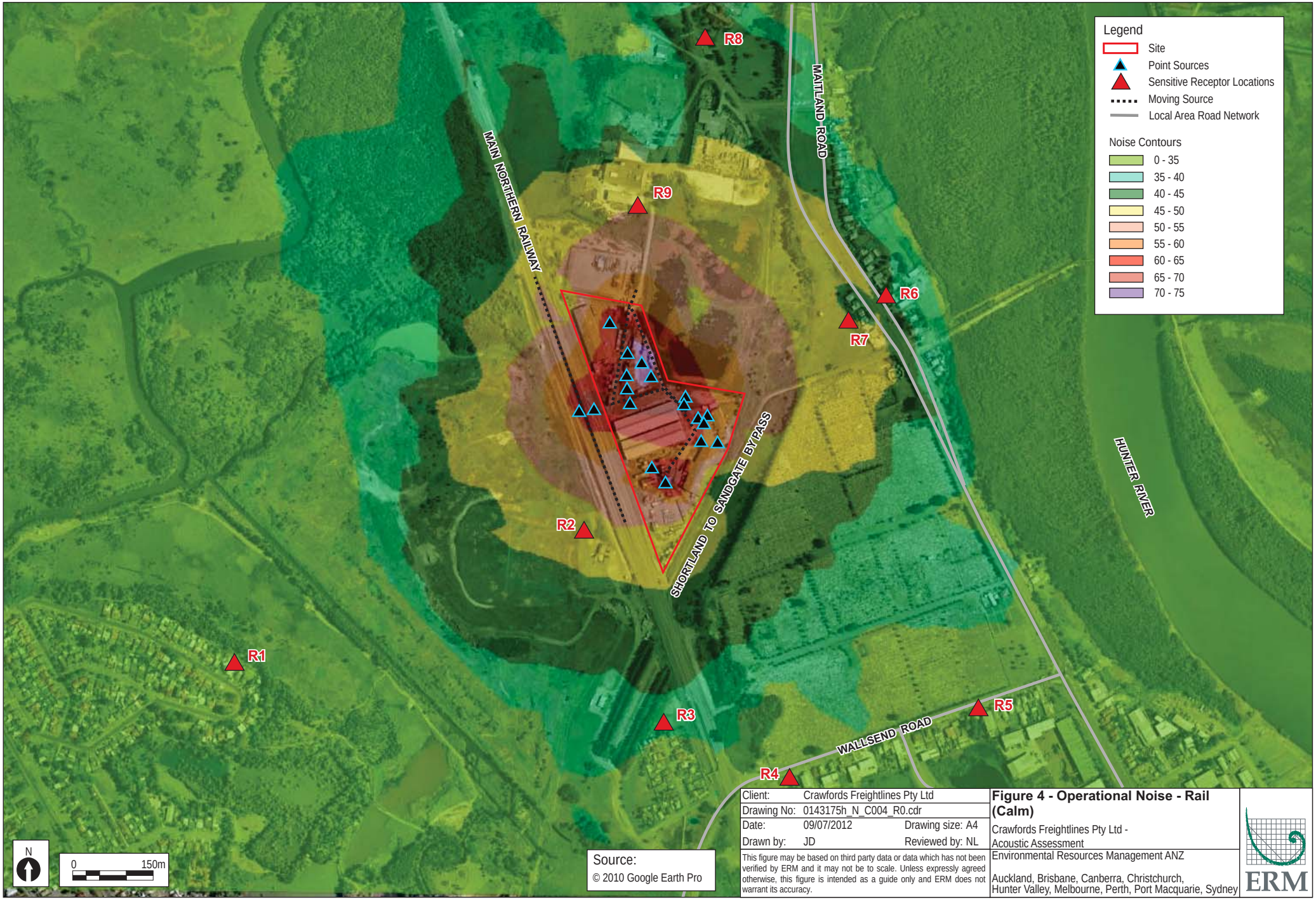

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Figure 4 - Operational Noise - Rail (Calm)

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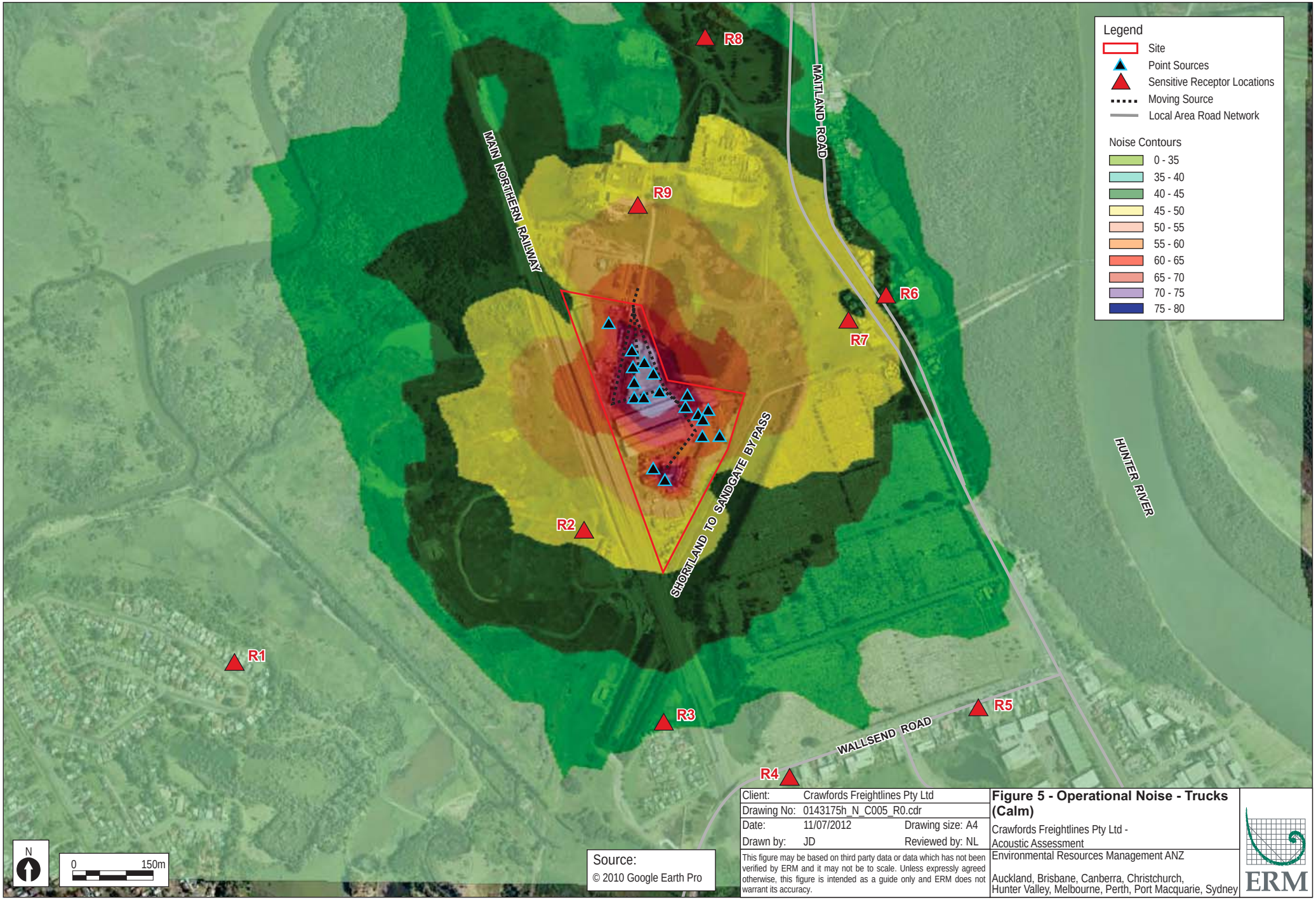

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Figure 5 - Operational Noise - Trucks (Calm)

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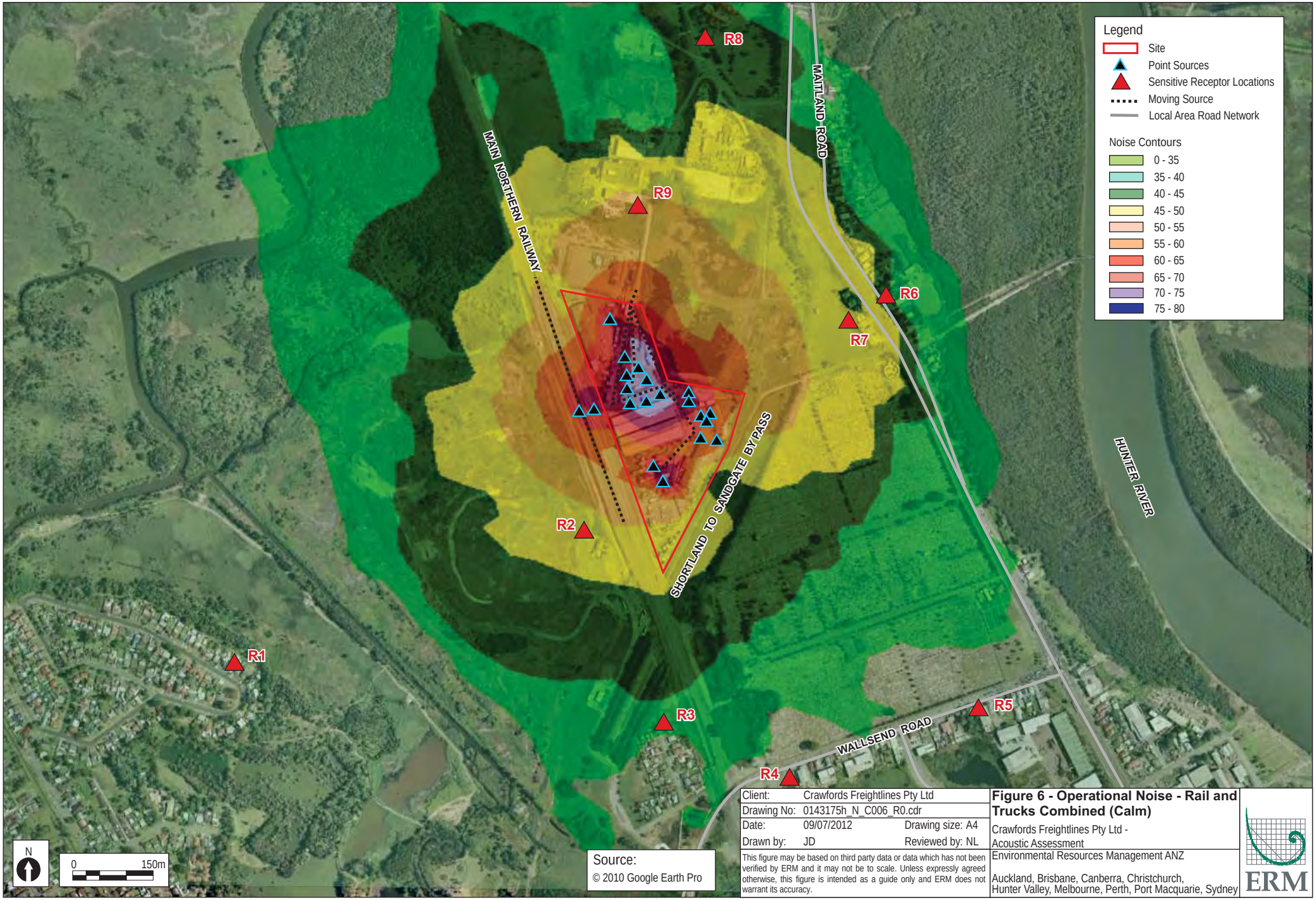

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Figure 6 - Operational Noise - Rail and Trucks Combined (Calm)

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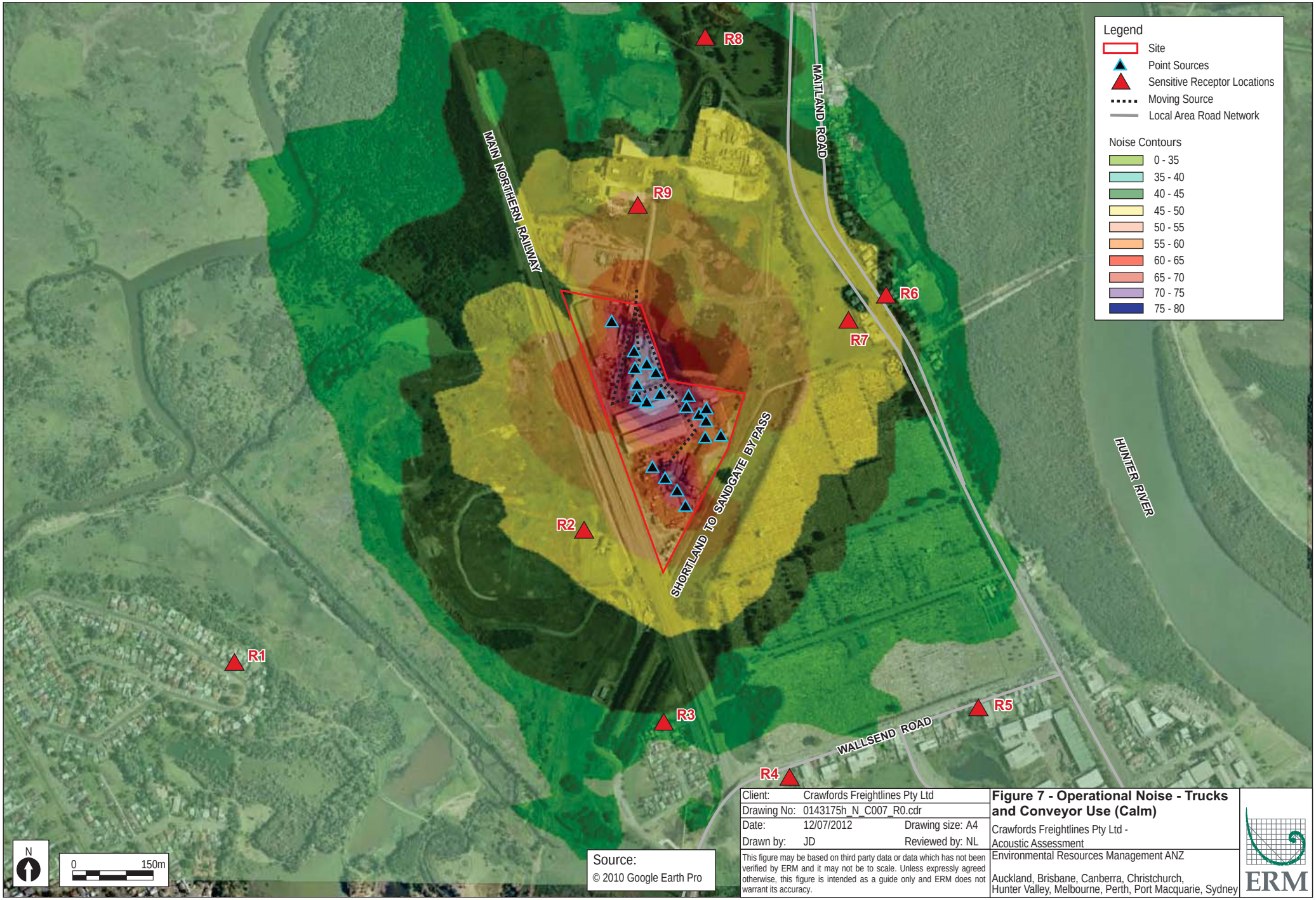

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Figure 7 - Operational Noise - Trucks and Conveyor Use (Calm)

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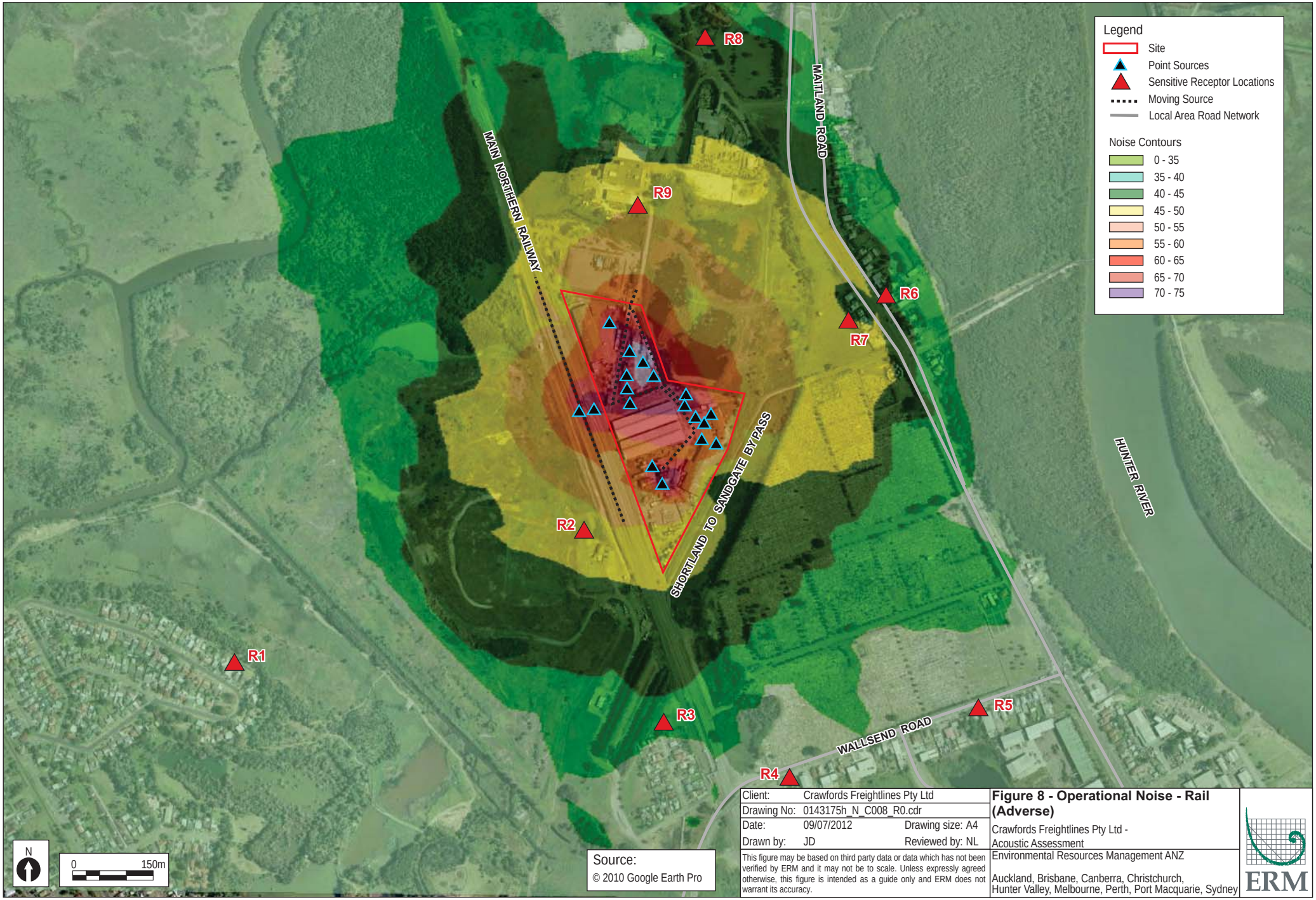

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Figure 8 - Operational Noise - Rail (Adverse)

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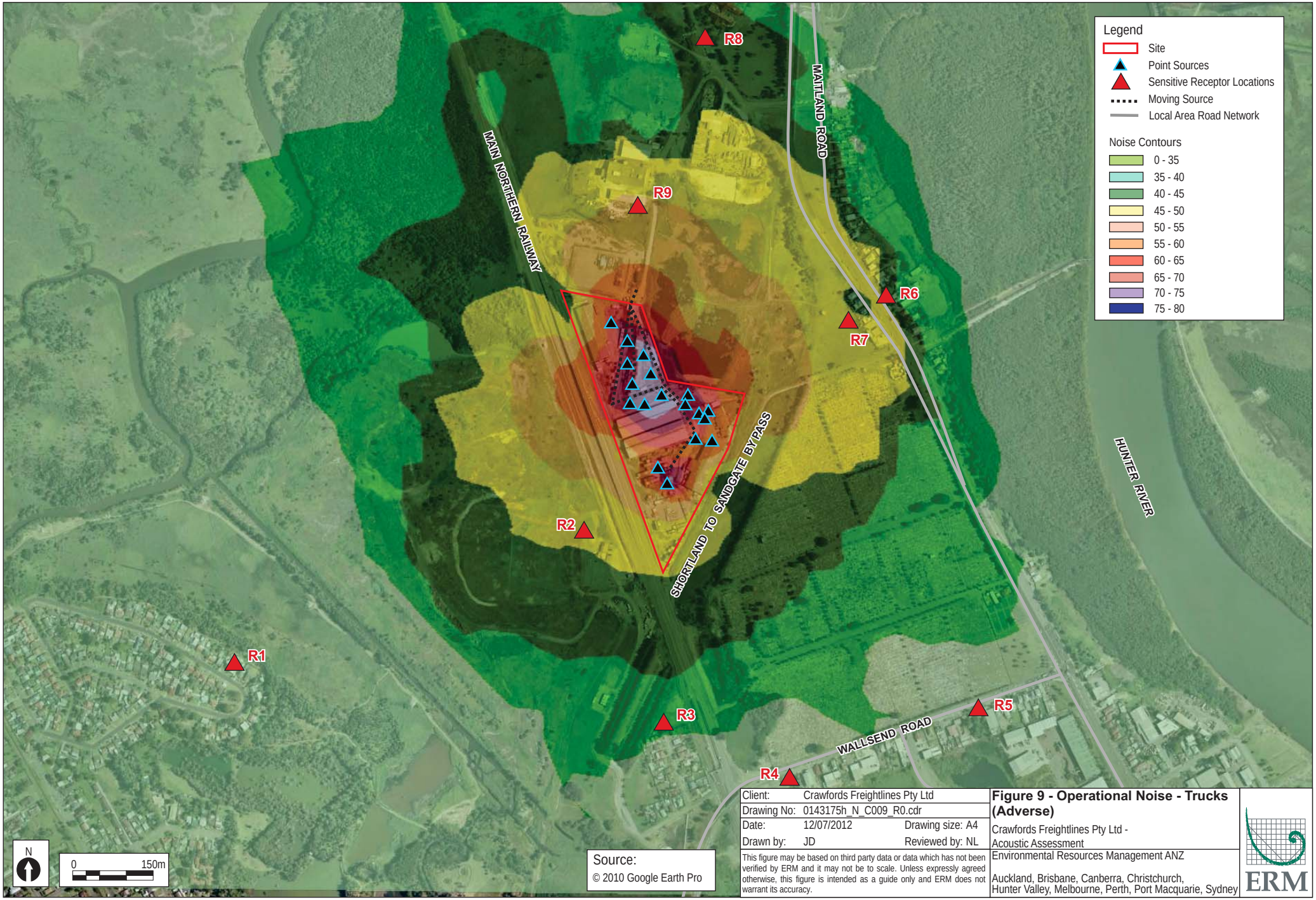

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Figure 9 - Operational Noise - Trucks (Adverse)

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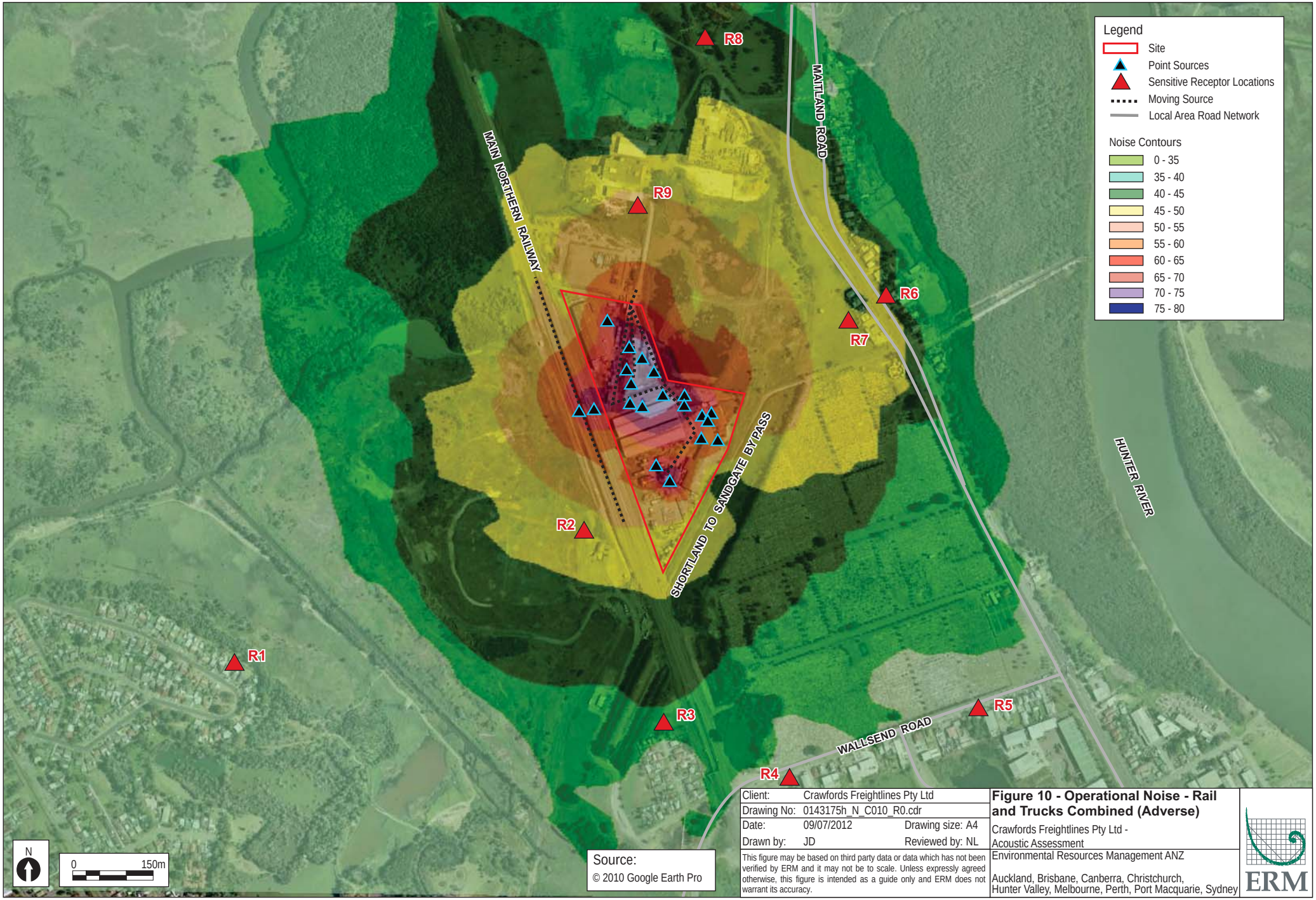

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Figure 10 - Operational Noise - Rail and Trucks Combined (Adverse)

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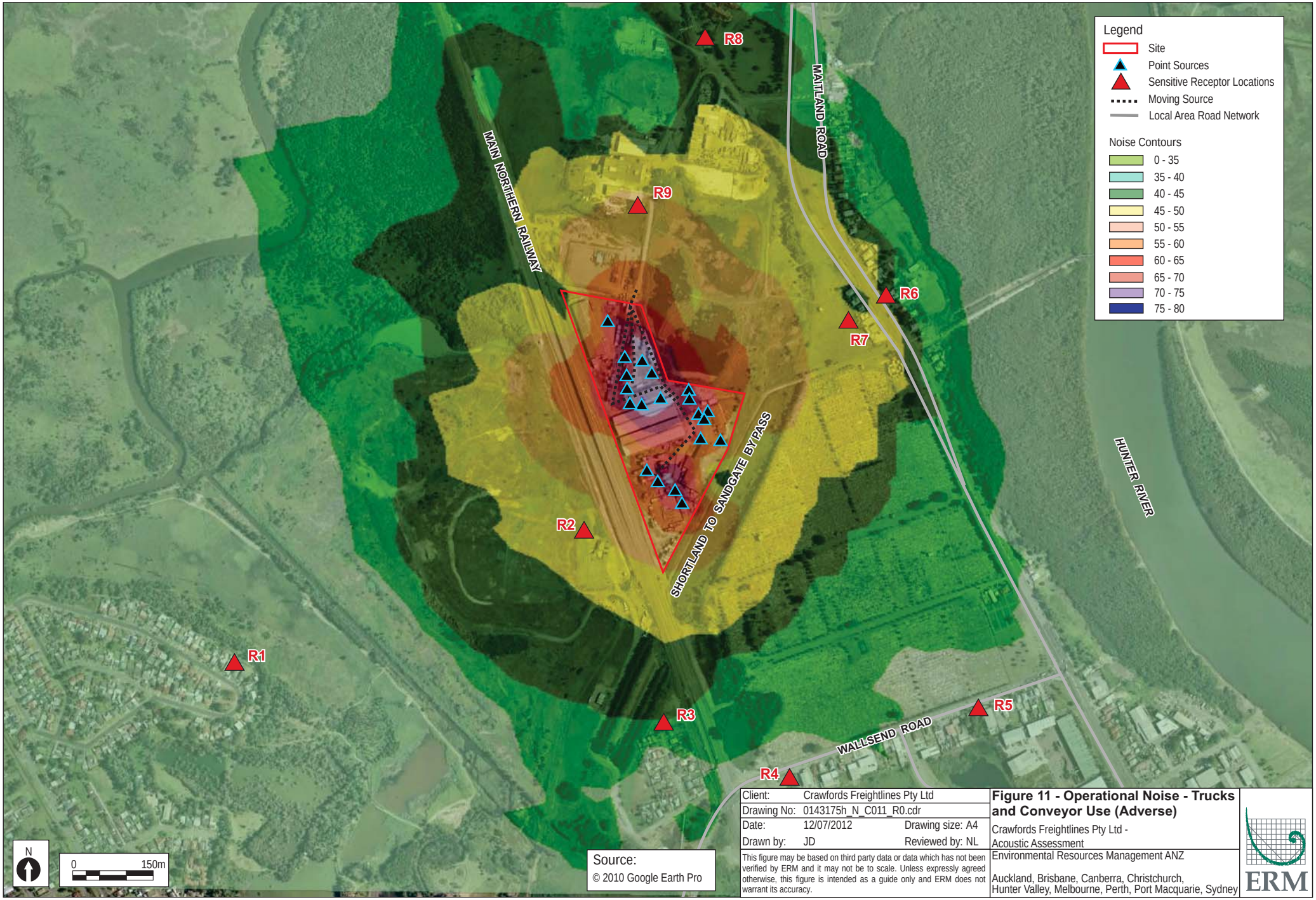

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Figure 11 - Operational Noise - Trucks and Conveyor Use (Adverse)

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5.1.1 Sleep Disturbance

The noise modelling process has conservatively predicted noise levels for comparison to the PSNL. Further, consideration must be given regarding the potential for sleep disturbance (or awakenings) during the morning shoulder period that may be associated with transient, impulsive or maximum noise level events.

The INP does not specifically address sleep disturbance from high noise level events however from various research, NSW regulators accept the following criterion to address maximum noise events:

- $L_{A1\ (1\ minute)}$ not exceeding the $L_{A90\ (15\ minute)}$ by more than 15 dB(A)

This criterion is adopted to mean that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.

ERM has considered all noise logging data collected in the vicinity of the site and determined the lowest overall morning shoulder period RBL (the mid-point between daytime and night time values) to be 39 dB(A). Based on this a representative sleep disturbance criterion of 54 dB(A) $L_{A1\ (1\ minute)}$ may be adopted.

ERM estimates that the predicted values presented in *Table 5.2* may increase by up to 10 dB(A) for $L_{A1\ (1\ minute)}$ values. A comparison of these estimated $L_{A1\ (1\ minute)}$ values to the adopted sleep disturbance criterion of 54 dB(A) at all residential receptors indicates that maximum noise level events may exceed this criterion by up to approximately 3 dB(A).

This is a general and highly conservative approach but indicates that maximum noise level events may generate impacts during the quietest morning shoulder periods, if works are not managed accordingly. This indicates a need to consider additional noise control mitigation and/or management measures; these are addressed in *Section 7*.

5.1.2 Discussion

The findings of the operational noise impact assessment presented in *Table 5.1* and *Table 5.2* may be summarised as below:

- operational noise levels are calculated to be below the daytime PSNL (7am to 6pm) during both calm and adverse meteorological conditions at the majority of receivers. During combined truck and rail operations, noise levels are calculated to marginally (~0.1 dB(A)) exceed the PSNL at R8, although this is not considered significant. Based on this negligible (low) impacts are anticipated during daytime operations;

- operational noise levels are calculated to be below the evening PSNL (6pm to 10pm) during both calm and adverse meteorological conditions at the majority of receivers. Noise levels are calculated to exceed the PSNL by between approximately 1 dB(A) and 3 dB(A) at R8. Based on this negligible (low) to moderate impacts are anticipated during evening operations; and

- operational noise levels are calculated to be below the morning shoulder period PSNL (6am to 7am) during both calm and adverse meteorological conditions at the majority of receivers. Noise levels are calculated to exceed the PSNL by between approximately 2 dB(A) and 4 dB(A) at R8. Based on this negligible (low) to moderate impacts are anticipated during morning shoulder period operations.

It should be noted that any predicted exceedances are limited to one receptor (R8) located close and north of the site. At this location negligible (low) to moderate impacts are anticipated; high or significant impacts are not anticipated.

There is limited risk that site operations will generate significant impacts, however the elevated (and in one case non-compliant) noise levels presented above indicates a need to consider additional noise control mitigation and/or management measures to those already adopted on site; these are addressed below in *Section 7*. The highest calculated noise levels (and any non-compliance) are associated with rail and truck operations occurring concurrently. These are limited to the evening and morning shoulder period only and as such are the focus of recommended noise control mitigation and/or management measures presented in this report.

Shoulder Periods

A key finding of this assessment is the need to provide further analysis of shoulder period results at R8. As stated previously, ERM has adopted the conservative approach of determining shoulder period criterions as the mid-point between the overall daytime and night time RBL values for each monitoring location however a review of noise logging charts has identified a diurnal cycle in this area where existing background noise levels steadily rise in these early morning hours, on each week day.

At this location an estimated overall L90 value between 6am and 7am was calculated to be 42.5 dB(A) and an additional shoulder period criteria to evaluate potential impacts between 6am and 7am determined as: site noise level contribution $L_{Aeq,\ 15\ minute} \leq 47.5$ dB(A).

Based on this additional analysis it is identifiable that there is limited risk that site operations will generate significant impacts during the morning shoulder period.

5.2 *CONSTRUCTION NOISE*

The results of the construction noise impact assessment and comparison to the Noise Management Levels at each assessment location are presented in *Table 5.2*. These results are visually presented as noise contour maps in *Figure 12* and *Figure 13*.

Table 5.3 Construction Noise Levels and Compliance Assessment

Scenario	Receptor	Calculated Noise Level[1]	Noise Affected Management Level[1]	Noise Affected Management Level Compliance[1]	Highly Noise Affected Management Level[1]	Highly Noise Affected Management Level Compliance
Representative	R1	36.4	44	-7.6	75	-38.6
	R2	56.5	65	-8.5	*n/a*	*n/a*
	R3	48.1	47	**1.1**	75	-26.9
	R4	41.8	47	-5.2	75	-33.2
	R5	39.8	47	-7.2	75	-35.2
	R6	46.1	65	-18.9	75	-28.9
	R7	47.7	65	-17.3	75	-27.3
	R8	45.1	48	-2.9	75	-29.9
	R9	51.4	75	-23.6	*n/a*	*n/a*
Worst-Case	R1	41.1	44	-2.9	75	-33.9
	R2	60.4	65	-4.6	*n/a*	*n/a*
	R3	52.2	47	**5.2**	75	-22.8
	R4	45.7	47	-1.3	75	-29.3
	R5	44	47	-3	75	-31
	R6	51.5	65	-13.5	75	-23.5
	R7	53.1	65	-11.9	75	-21.9
	R8	50.6	48	**2.6**	75	-24.4
	R9	56.9	75	-18.1	*n/a*	*n/a*

1. Leq, 15 minute and dB re: 2×10^{-5} Pa; and
2. exceedances to PSNL in **bold** typeset.

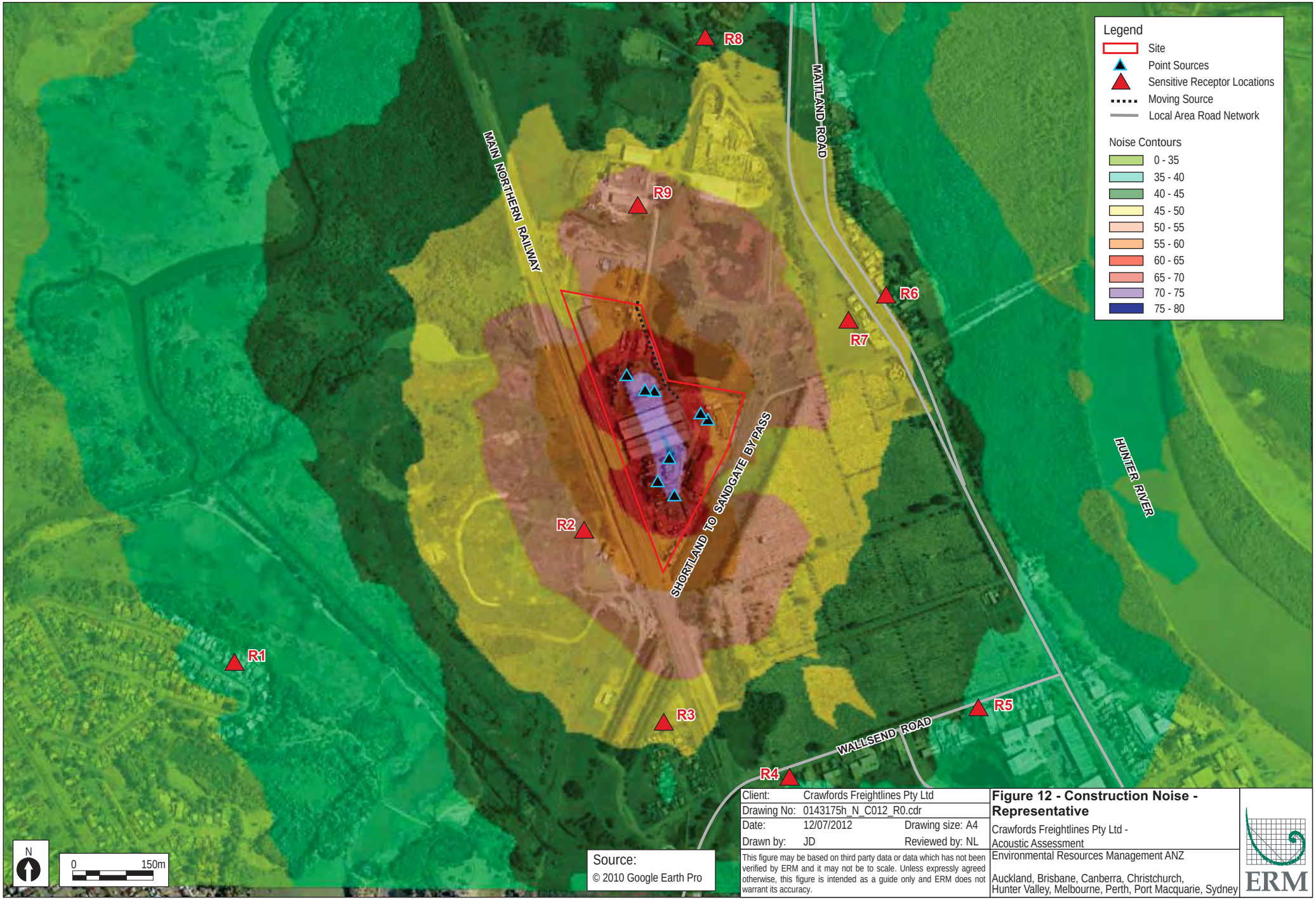

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Figure 12 - Construction Noise - Representative

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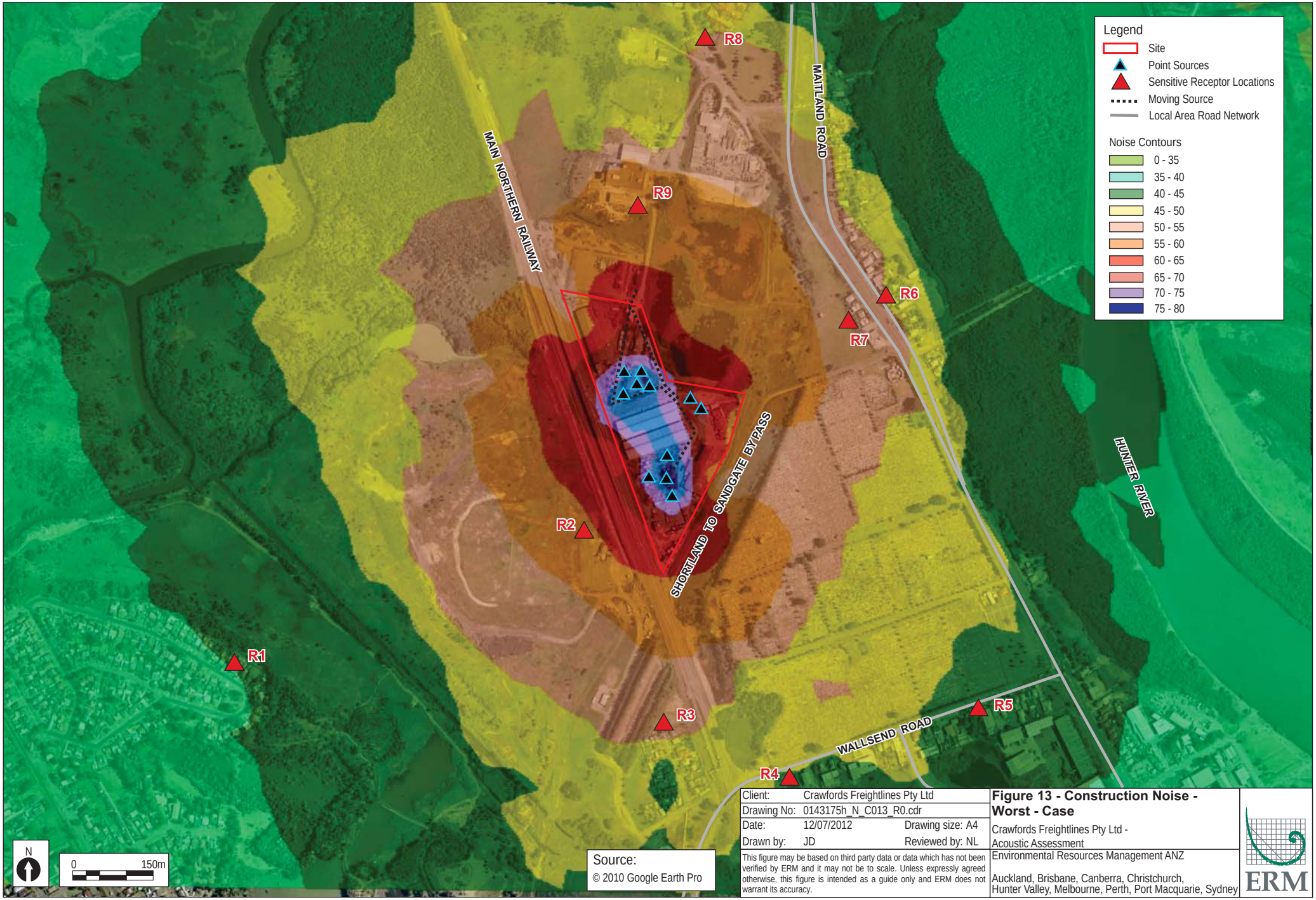

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Figure 13 - Construction Noise - Worst - Case

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5.2.1 *Discussion*

The findings of the construction noise impact assessment presented in *Table 5.3* may be summarised as below:

- during normal construction activity (that may occur as part of civil works within the site) noise levels are expected to comply with the Noise Affected Management Level at the majority of locations. At R3 noise levels are calculated to be approximately 1 dB(A) above this criterion, this is not considered significant. Based on these results negligible (low) impacts are anticipated during normal construction works; and

- during potential worst-case construction activity (civil works) within the site noise levels are expected to comply with the Noise Affected Management Level at the majority of locations. At R3 noise levels are calculated to be approximately 5 dB(A) above this criterion and at R8 approximately 3 dB(A). Based on these results negligible (low) to moderate impacts are anticipated.

It should be noted that during normal (representative) and worst-case construction activity, noise levels are expected to comply with the Highly Noise Affected Management Level at all locations. Based on this high, or significant high impacts are not anticipated.

There is limited or no risk that construction works would generate significant impacts, however the elevated (and in some cases non-compliant) noise levels presented above indicates a need to consider additional noise control mitigation and/or management measures; these are addressed below in *Section 7*.

5.3 *ROAD TRAFFIC NOISE*

To assess road traffic noise levels ERM has adopted the closest (and potentially most affected receptors) located on Old Maitland Road (R8) and The Pacific Highway (R6). In each case the existing road traffic noise level has been determined based on the unattended environmental noise logging data presented in *Section 3*. It should be noted that for residences located on the Pacific Highway the $L_{Aeq, (15\ hour)}$ and $L_{Aeq, (9\ hour)}$ apply for the daytime and night time assessment periods. For residences on Old Maitland Road the $L_{Aeq, (1\ hour)}$ parameter applies for both the daytime and night time periods. Although these values are not directly relevant to determine compliance they offer additional context to this assessment and assist to identify if road traffic noise levels will increase due to site vehicles (product distribution) on public roads.

The results of the road traffic noise impact assessment and comparison to the road traffic noise criteria at each assessment location are presented in *Table 5.3* below.

Table 5.4 Road Traffic Noise Compliance Assessment

ID	Receptor	Existing Road Traffic Noise Level		Calculated Road Traffic Noise Level[2]		Road Traffic Criteria		Road Traffic Compliance		Predicted Increase in Overall Traffic Noise	
		Daytime	Night	Daytime	Night	Daytime	Night	Daytime	Night	Daytime	Night
R6	Residential receptor located on the eastern side of the Pacific Highway	71 LAeq, (15 hour)	67 LAeq, (9 hour)	45 LAeq, (15 hour)	45 LAeq, (9 hour)	60 LAeq, (15 hour)	55 LAeq, (9 hour)	-20	-10	<0.5 LAeq, (15 hour)	<0.5 LAeq, (9 hour)
R8	St Joseph's aged care and independent living	47 LAeq, (1 hour)	42 LAeq, (1 hour)	43 LAeq, (1 hour)	43 LAeq, (1 hour)	55 LAeq, (1 hour)	50 LAeq, (1 hour)	-12	-7	1.5 LAeq, (1 hour)	3.5 LAeq, (1 hour)

1. dB re: 2 x 10^{-5} Pa; and
2. current (2012) and future (+10 years, 2022) road traffic noise levels are expected to be similar.

5.3.1 Discussion

The findings of the road traffic noise impact assessment presented in *Table 5.4* may be summarised as below:

- road traffic noise levels potentially associated with site vehicles (product distribution) on the Pacific Highway are calculated to be significantly below the project-specific road traffic noise criteria during both daytime and night time assessment periods. Furthermore, site vehicle movements are not expected to significantly increase noise levels on this road; and

- road traffic noise levels potentially associated site vehicles (product distribution) on Old Maitland Road are calculated to be significantly below the project-specific road traffic noise criteria during both daytime and night time assessment periods. Furthermore, site vehicle movements are not expected to significantly increase noise levels on this road.

It should be noted that any elevated (but compliant) noise levels are limited to calculations based on the $L_{Aeq,\ (1\ hour)}$ parameter applicable to local roads. These values conservatively represent potential worst-case vehicle movements in any given one hour period during normal operations.

Under normal circumstances actual road traffic noise levels are expected to be below those predicted. For the majority of the time (i.e. for most one our assessment periods where product distribution is not being undertaken) the site will not actually generate road traffic noise.

At the most affected assessment location located on Old Maitland Road (R8) negligible (low) impacts are anticipated (if any at all), moderate, high or significant impacts are not anticipated.

6 VIBRATION IMPACT ASSESSMENT

ERM has predicted ground-borne vibration levels (Peak Particle Velocity (PPV) in mm/s) for the potential worst-case operational and construction scenarios as presented previously and used for noise modelling.

Conservatively and to comprehensively assess vibration levels and any potential impacts, ERM has adopted sheet piling as a vibration source . Such piling will not occur on site during either construction or operation of the site, but has been selected as a conservative guide only. The results of this assessment are presented in *Table 6.1*.

Table 6.1 Calculated Vibration Levels

Sensitive Receptor	Distance from Source, m	Calculated Vibration Level, mm/s	Comply?
R1	907	0.00	Yes
R2	213	0.01	Yes
R3	574	0.00	Yes
R4	726	0.00	Yes
R5	842	0.00	Yes
R6	523	0.00	Yes
R7	448	0.00	Yes
R8	431	0.00	Yes
R9	749	0.00	Yes

6.1 DISCUSSION

The findings presented above clearly indicate that perceptible levels of vibration (and any vibration impacts) are unlikely to be generated at the closest and/or potentially most affected receiver locations in the vicinity of the site. Of the locations assessed R2 is the potentially most affected at a distance of 213 m, however vibration levels are calculated to be approximately 0.01 mm/s; significantly below the relevant structural damage and human annoyance (impulsive) criteria, and the human threshold for the perception of vibration which is typically considered to be 0.2 mm/s.

Intermittent vibration is typically assessed as a Vibration Dose Value (VDV, $m/s^{1.75}$) and as such is dependent on operational periods and the frequency (Hz) generated by the vibration event. Accordingly, ERM has assumed worst case vibration conditions (vibration events generated for 100% of the assessment period) at a frequency of 40 Hz, which is typical for this type of site. Based on these assumptions a resultant VDV value of less than 0.01 $m/s^{1.75}$ has been calculated for R2, which is significantly below the relevant human annoyance (intermittent) criteria.

7 RECOMMENDATIONS

This section presents a consolidated set of noise and vibration control mitigation and/or management measures that are to be considered and implemented by Crawfords where feasible and reasonable. No further recommendations are made by ERM to those presented here or already implemented on site.

7.1 OPERATIONAL NOISE

ERM's review of the operational noise level results presented in *Table 5.1* and *Table 5.2* has identified that operational noise levels are at or below the daytime (7am to 6pm) PSNL at all locations, any marginal exceedances are not significant.

Operational noise levels exceed the more stringent evening and morning shoulder period PSNL by up to 4 dB(A) during potential adverse meteorological conditions. ERM has reviewed the rank file generated by the noise modelling software, which sorts noise emission sources from the highest to the lowest for each scenario. Based on this review ERM has identified that the majority of these non-compliances are associated with heavy vehicle, motion alarm and large forklift (i.e. 36T) usage within the site area.

Based on this ERM makes the following recommendations for noise management measures during the evening and morning shoulder period:

- heavy vehicle drivers should be instructed to quietly enter and exit the site and should be instructed to limit extended periods of vehicle idling time. Where vehicle idling is unavoidable ERM recommends that Crawford's utilise on site structures (eg buildings or shipping containers etc) to obstruct noise sources from the nearest sensitive receptor location, where practical;

- the use of mobile plant motion alarms should be limited. Plant and equipment usage on site should be optimised during these periods to maximise forward motion, which will reduce motion alarms that typically sound in reverse. Where this is not achievable ERM recommends that Crawfords investigate visible alarms (i.e. flashing lights instead of audible alarms) or installs "squashed duck" type alarms which are known to be less intrusive than standard alarms fitted to most plant and equipment, although use of such alarms should still be satisfactory to achieve occupational health and safety requirements; and

- the use of large forklifts (i.e. 36T) should be limited. Furthermore, where large forklift usage is required, the operators should be instructed to quietly operate the equipment following normal good operational practices.

Based on these recommended management measures ERM has re-calculated operational noise levels at R8 for each of the worst-case adverse scenarios presented in *Table 5.2*. The results of this additional (mitigated) noise modelling are presented in *Table 7.1*.

Table 7.1 Mitigated Operational Noise Levels Scenario

Scenario	Calculated Noise Level (mitigated)	Evening PSNL	Morning Shoulder PSNL	Evening Compliance	Morning Shoulder Compliance
Rail	39.9	40	39	-0.1	**0.9**
Trucks	39.6	40	39	-0.4	**0.6**
Rail and Trucks Combined	40.0	40	39	0.0	**1.0**
Trucks and Conveyor Use	39.6	40	39	-0.4	**0.6**

1. all values are dB(A) re: 2 x 10^{-5} Pa.

The results presented above indicate that operational noise levels at R8 may be reduced to be below the evening PSNL and within 1 dB(A) of the most stringent morning shoulder period PSNL (reduction of approximately 3 dB(A)) following the successful implementation of the recommended good practice noise management measures described above.

ERM reiterates that at this location an estimated overall L90 value between 6am and 7am was calculated to be 42.5 dB(A) and an additional shoulder period criteria to evaluate potential impacts between 6am and 7am determined as: site noise level contribution $L_{Aeq,\ 15\ minute} \leq 47.5$ dB(A). Based on this, the mitigated operational noise levels presented above are determined to comply with the INP requirements during all periods.

Based on this, negligible (low) impacts are anticipated at R8 during evening and morning shoulder period operations. Furthermore, noise levels potentially affecting the broader community will be further reduced to those presented in *Table 5.1* and *Table 5.2*.

7.1.1 Operational Noise Monitoring

The results presented above in *Table 7.1* indicate that the site is expected to generally comply with the requirements presented in the INP; however this assumption is based on the successful implementation of the recommended good practice noise management measures described in this report.

Accordingly, ERM recommends that within three months of the recommencement of operations, operator attended noise measurements be undertaken by a qualified and suitable experienced acoustician to verify actual site noise level contributions at a representative number of the closest and/or potentially most affected noise sensitive receptors in near proximity to the site.

The results of these measurements should be compared to the applicable daytime, evening and morning shoulder period PSNL presented in this report to determine INP compliance.

The findings of this INP compliance assessment should be used to verify the effect of noise management measures implemented on site and to identify any additional measures that should be considered by Crawfords to assist in reducing operational noise levels and the risk of potential impacts for sensitive receptors located in the vicinity of the site.

Where measured operational noise levels are determined to comply with the INP criteria, no further actions are required to those already taken to reduce noise at the time of the operator attended noise measurements. These measurements should be undertaken during rail and truck combined operations, where practical and completed with due regard to and in accordance with the requirements specified in AS 1055 and the INP.

7.1.2 Sleep Disturbance

Maximum (or peak) noise level events associated with the site are expected to be below the project-specific sleep disturbance criterion at the majority of residential locations. At a limited number of locations noise levels may increase to be approximately 3 dB(A) above the sleep disturbance criterion. Based on this, the potential risk of sleep disturbance impacts (or awakenings) is limited and the magnitude of any impacts will be insignificant, however the recommended management measures and monitoring described above will assist to further manage this risk and limit any impacts.

ERM does not recommend any additional noise control mitigation and/or management measures to those described above and already implemented on site but notes that Crawfords should continue to manage potential high noise level generating events to occur after the morning shoulder period (i.e. after 7am) to assist in minimising the risk of potential noise impacts.

7.2 CONSTRUCTION NOISE

ERM's review of the construction noise level results presented in *Table 5.3* has identified that noise levels are expected to remain below the highly noise affected management level at all locations. During potential worst-case works noise levels are expected to exceed the noise affected management level at a limited number of locations, any marginal exceedances of the noise affected management level during representative works are not considered significant.

Based on this and in accordance with the ICNG, ERM makes the following in-principle recommendations for noise management measures during construction works:

- apply all feasible and reasonable work practices to meet the noise affected level; and
- inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.

ERM notes that at this stage the actual requirement for construction works and specific details regarding plant and equipment that may be used for this purpose is unknown. As such it is not practical to provide specific noise control and/or mitigation measures for Crawfords consideration.

Should these works be required Crawfords should consider the in-principle recommendations presented above and investigate appropriate measures where practical. Suggested normal good practice construction noise management measures which may be investigated are presented below:

- works should adhere to the standard construction hours of work, with no out of hours works to be undertaken;
- ensure site managers periodically check the site and nearby residences and other sensitive land uses for noise problems so that solutions can be quickly applied;
- regularly instruct workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise. Site workers are to be made aware of the potential noise impacts and are to be encouraged to take practical and reasonable measures to minimise disturbance;
- keep truck drivers informed of designated vehicle routes, parking locations, acceptable delivery hours or other relevant practices (for example, minimising the use of engine brakes, and no extended periods of engine idling);
- equipment should be selected to minimise noise emissions, where feasible and reasonable;

- equipment and plant should be properly maintained to ensure normal operating performance and minimum noise emissions;

- equipment and plant found to produce excessive noise compared to normal industry expectations should be removed from the site or stood down until repairs or modifications can be made;

- noise emissions from reversing alarms should be minimised, although use of such alarms should still be satisfactory to achieve occupational health and safety requirements; and

- consideration for the placement of possible noise sources should be taken into consideration and clustering of noisy plant items avoided. Static plant, for example generators, concrete mixers, etc., will be placed as far as is practicable from potential noise sensitive areas.

Following the successful implementation of normal good practice construction noise management, residual impacts will be insignificant.

7.3 ROAD TRAFFIC NOISE

Road traffic noise levels associated with the site are expected to be significantly below the relevant project-specific road traffic noise level criteria and the site is determined to comply with the requirements presented in the road noise policy. Based on this, the potential risk of road traffic noise impacts is limited and the magnitude of any impacts will be insignificant.

ERM does not recommend any additional road traffic noise control mitigation and/or management measures to those already considered or implemented on site.

7.4 VIBRATION CONTROL MITIGATION AND MANAGEMENT

Vibration levels associated with the site are expected to be significantly below the relevant structural damage safe limits and human annoyance guideline values for both construction and operational phases of the project. Based on this, the potential risk of vibration impacts is limited and the magnitude of any impacts will be insignificant.

ERM does not recommend any additional vibration control mitigation and/or management measures to those already considered or implemented on site.

To ensure ongoing compliance with the relevant structural damage and human annoyance criteria ERM suggests that vibration generating activities (if they arise) should not be conducted within a distance of 50m of any significant off-site structure or within 100m of any occupied off-site residence.

Further guidance is provided in *Table 7.2* which presents predicted levels over a range of distances for potentially high vibration generating operational activities or construction works.

Table 7.2 General Vibration Levels and Safe Distances

Distance from source, m	Calculated Vibration Level, mm/s
10	40.62
20	23.00
30	13.02
40	7.37
50	4.20
60	2.90
70	2.01
80	1.39
90	0.96
100	0.67
110	0.46
120	0.32
130	0.22
140	0.15
150	0.11

8 *CONCLUSION*

Environmental Resources Management Australia Pty Ltd (ERM) on behalf of Crawfords Freightlines Pty Ltd (Crawfords) has completed a detailed acoustic assessment of environmental noise and vibration associated with the ammonium nitrate storage facility site located at Lot 12 Old Maitland Road, Sandgate in New South Wales (NSW).

The scope of this assessment included operational noise and vibration, construction noise and vibration and operational road traffic noise impact assessments. The methodology, findings and recommendations for the proposed and existing operations under assessment are presented here and included areas of interest in the vicinity of the ammonium nitrate storage facility site. Specifically, the assessment considered potential acoustic impacts generated by uses at storage Shed A, Shed B, Shed C, Shed D and the outdoor compound; each situated within the broader site area.

The assessment was completed to reflect the intent and requirements of the applicable local, state and Australian standards, acoustic documents and relevant noise guidelines endorsed by NSW regulators.

ERM has made recommendations for noise management measures for Crawfords to consider and implement on site where feasible and reasonable. In addition to these measures ERM has recommnded operational noise monitoring. Following the successful implementation of the recommended measures, and operational noise monitoring undertaken to evaluate their effect the potential risk of noise impacts will be limited and the magnitude of any impacts will become insignificant.

REFERENCES

NSW Environment Protection Authority – NSW Environmental Noise Management – **Industrial Noise Policy** (INP), January 2000 and relevant application notes

NSW Department of Environment and Climate Change – NSW **Interim Construction Noise Guideline** (ICNG), July 2009

NSW Department of Environment, Climate Change and Water – **NSW Road Noise Policy** (the road noise policy), March 2011

NSW Department of Environment, Climate Change and Water – NSW **Noise Guide for Local Government** (the noise guide), October 2010

Roads and Traffic Authority – **Environmental Noise Management Manual** (ENMM), December 2001

Standards Australia AS1055–1997™ (AS1055) – D**escription and Measurement of Environmental Noise**, Parts 1, 2 and 3

Standards Australia AS IEC 61672.1–2004™ (AS61672) – **Electro Acoustics - Sound Level Meters Specifications Monitoring**

Standards Australia AS 2436–2010™ (AS2436) – **Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites**

International Organisation for Standardisation (ISO) 9613-2:1996 (ISO9613:2) - **Acoustics – Attenuation of Sound during Propagation Outdoors - Part 2: General Method of Calculation**

NSW Department of Environment and Conservation – NSW Environmental Noise Management – **Assessing Vibration: a Technical Guideline** (the vibration guideline), February 2006

German Institute for Standardisation – DIN 4150 (1999-02) Part 3 (DIN4150-3) – **Structural Vibration - Effects of Vibration on Structures**

'**Crawford Freightlines Pty Ltd - Hazard Analysis (Revision 2)**' prepared by Health & Safety Essential Pty Ltd, dated 22 May 2012 (May 2012 hazard analysis)

Annex A

Acoustic Glossary

A.1 ACOUSTICS - GLOSSARY OF TERMS, DEFINITIONS AND METHODOLOGY

A.1.1 What Is Noise And Vibration?

Noise

Noise is often defined as a sound, especially one that is loud or unpleasant or that causes disturbance[3] or simply as unwanted sound, but technically, noise is the perception of a series of compressions and rarefactions above and below normal atmospheric pressure.

Vibration

Vibration refers to the oscillating movement of any object. In a sense noise is the movement of air particles and is essentially vibration, though in regards to an environmental assessment vibration is typically taken to refer to the oscillation of a solid object(s). The impact of noise on objects can lead to vibration of the object, or vibration can be experienced by direct transmission through the ground, this is known as ground-borne vibration.

Essentially, noise can be described as what a person hears, and vibration as what they feel.

A.1.2 How To Measure And Describe Noise?

Noise is measured using a specially designed 'sound level' meter which must meet internationally recognised performance standards. Audible sound pressure levels vary across a range of 10^7 Pascals (Pa), from the threshold of hearing at 20μPa to the threshold of pain at 200Pa. Scientists have defined a statistically described logarithmic scale called Decibels (dB) to more manageably describe noise.

To demonstrate how this scale works, the following points give an indication of how the noise levels and differences are perceived by an average person:

- 0 dB - represents the threshold of human hearing (for a young person with ears in good condition);
- 50 dB – represents average conversation;
- 70 dB – represents average street noise, local traffic etc;
- 90 dB – represents the noise inside an industrial premises or factory;
- 140 dB - represents the threshold of pain – the point at which permanent hearing damage may occur.

[3] Copyright © 2011 Oxford University Press

A.1.3 What Factors Contribute To Environmental Noise?

The noise from an activity, like construction works, at any location can be affected by a number of factors, the most significant being:

- how loud the activity is;
- how far away the activity is from the receiver;
- what type of ground is between the activity and the receiver location eg concrete, grass, water or sand;
- how the ground topography varies between the activity and the receiver (is it flat, hilly, mountainous) as blocking the line of sight to a noise source will generally reduce the level of noise; and
- any other obstacles that block the line of sight between the source to receiver eg buildings or purpose built noise walls.

A.1.4 How To Calculate Or Model Noise Levels?

There are two recognised methods which are commonly adopted to determine the noise at particular location from a proposed activity. The first is to undertake noise measurements whilst the activity is in progress and measure the noise, the second is to calculate the noise based on known noise emission data for the activity in question.

The second option is preferred as the first option is largely impractical in terms of cost and time constraints, notwithstanding the meteorological factors that may also influence its quantification. Furthermore, it is also generally considered unacceptable to create an environmental impact simply to measure it. In addition, the most effective mitigation measures are determined and implemented during the design phase and often cannot be readily applied during or after the implementation phase of a project.

Because a number of factors can affect how 'loud' a noise is at a certain location, the calculations can be very complex. The influence of other ambient sources and the contribution from a particular source in question can be difficult to ascertain. To avoid these issues, and to quantify the direct noise contribution from a source/site in question, the noise level is often calculated using noise modelling software packages. The noise emission data used in each noise model of this assessment has been obtained from ERM's database of measured noise emissions.

A.1.5 Acoustic Terminology & Statistical Noise Descriptors

Environmental noise levels such as noise generated by industry, construction and road traffic are commonly expressed in dB(A). The A-weighting scale follows the average human hearing response and enables comparison of the intensity of noise with different frequency characteristics. Time varying noise sources are often described in terms of statistical noise descriptors. The following descriptors are commonly used when assessing noise and are referred to throughout this acoustic assessment:

- **Decibel (dB is the adopted abbreviation for the decibel) –** The unit used to describe sound levels and noise exposure. It is equivalent to 10 times the logarithm (to base 10) of the ratio of a given sound pressure to a reference pressure;

- **dB(A)** - unit used to measure 'A-weighted' sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear;

- **dB(C) –** unit used to measure 'A-weighted' sound pressure levels. C-weighting is an adjustment made to sound-level measurements which takes account of low-frequency components of noise within the audibility range of humans;

- **dB(Z) or dB(L) –** unit used to measure 'Z-weighted' sound pressure levels with no weighting applied, linear;

- **Hertz (Hz)** - the measure of frequency of sound wave oscillations per second. 1 oscillation per second equals 1 hertz;

- **Octave –** a division of the frequency range into bands, the upper frequency limit;

- **1/3 Octave –** single octave bands divided into three parts;

- **Leq** - this level represents the equivalent or average noise energy during a measurement period. The $L_{eq, 15min}$ noise descriptor simply refers to the L_{eq} noise level calculated over a 15 minute period. Indeed, any of the below noise descriptors may be defined in this way, with an accompanying time period (eg $L_{10, 15\ minute}$) as required;

- **Lmax** - the absolute maximum noise level in a noise sample;

- **LN -** the percentile sound pressure level exceeded for N% of the measurement period calculated by statistical analysis;

- **L10 -** the noise level exceeded for 90 per cent of the time and is approximately the average of the maximum noise levels;

- **L_{90}** - the noise level exceeded for 90 per cent of the time and is approximately the average of the minimum noise levels. The L_{90} level is often referred to as the "background" noise level and is commonly used as a basis for determining noise criteria for assessment purposes;

- **Sound Power Level (L_W)** - this is a measure of the total power radiated by a source. The Sound Power of a source is a fundamental property of the source and is independent of the surrounding environment;

- **Sound Pressure Level (L_P)** - the level of sound pressure; as measured at a distance by a standard sound level meter with a microphone. This differs from L_W in that this is the received sound as opposed to the sound 'intensity' at the source;

- **Background noise** – the underlying level of noise present in the ambient noise, excluding the noise source under investigation, when extraneous noise is removed. This is described using the L_{A90} descriptor;

- **Ambient noise** – the all-encompassing noise associated within a given environment. It is the composite of sounds from many sources, both near and far;

- **Cognitive noise** – noise in which the source is recognised as being annoying; and

- **Masking** – the phenomenon of one sound interfering with the perception of another sound. For example, the interference of traffic noise with use of a public telephone on a busy street.

A.1.6 Terms to Describe the Perception of Noise

The following concepts offer qualitative guidance in respect of the average response to changes in noise levels:

- differences in noise levels of less than approximately 2 dB(A) are generally imperceptible in practice, an increase of 2 dB is hardly perceivable;

- differences in noise levels of around 5 dB(A) are considered to be significant;

- differences in noise levels of around 10 dB(A) are generally perceived to be a doubling (or halving) of the perceived loudness of the noise. An increase of 10 dB is perceived as twice as loud. Therefore an increase of 20 dB is four times as loud and an increase of 30 dB is eight times as loud etc;

- the addition of two identical noise levels will increase the dB level by about 3 dB. For example, if one car is idling at 40 dB and then another identical car starts idling next to it, the total dB level will be about 43 dB;

- the addition of a second noise level of similar character which is at least 8 dB lower than the existing noise level will not add significantly to the overall dB level; and

- a doubling of the distance between a noise source and a receiver results approximately in a 3 dB decrease for a line source (for example, vehicles travelling on a road); and a 6 dB decrease for a point source (for example, the idling car discussed above). A doubling of traffic volume for a line source results approximately in a 3 dB increase in noise, halving the traffic volume for a line source results approximately in a 3 dB decrease in noise.

The following terms offer quantitative and qualitative guidance in respect of the audibility of a noise source:

- **Inaudible / Not Audible** - the noise source and/or event could not be heard by the operator, masked by extraneous noise sources not associated with the source. If a noise source is 'inaudible' its noise level may be quantified as being less than the measured L_{A90} background noise level, potentially by 10 dB or greater;

- **Barely Audible –** the noise source and/or event are difficult to define by the operator, typically masked by extraneous noise sources not associated with the source. If a source is 'barely audible' its noise level may be quantified as being 5 - 7 dB below the measured L_{A90} or L_{Aeq} noise level, depending on the nature of the source eg constant or intermittent;

- **Just Audible –** the noise source and/or event may be defined by the operator. However there are a number of extraneous noise sources contributing to the measurement. The noise level should be quantified based on instantaneous noise level contributions, noted by the operator;

- **Audible** - the noise source and/or event may be easily defined by the operator. There may be a number of extraneous noise sources contributing to the measurement. The noise level should be quantified based on instantaneous noise level contributions, noted by the operator; and

- **Dominant –** the noise source and/or event are noted by the operator to be significantly 'louder' than all other noise sources. The noise level should be quantified based on instantaneous noise level contributions, noted by the operator.

The following terms offer qualitative guidance in respect of acoustic terms used to describe the frequency of occurrence of a noise source during an operator attended environmental noise measurements:

- **Constant –** this indicates that the operator has noted the noise source(s) and/or event to be constantly audible for the duration of the noise measurement eg an air-conditioner that runs constantly during the measurement;

- **Intermittent** – this indicates that the operator has noted the noise source(s) and/or event to be audible, stopping and starting intervals for the duration of the noise measurement eg car pass-bys; and

- **Infrequent** – this indicates that the operator has noted the noise source(s) and/or event to be constantly audible, however; not occurring regularly or at intervals for the duration of the noise measurement eg a small number of aircraft are noted during the measurement.

Industrial Noise Policy Terminology

- **Assessment Background Level (ABL)** - is defined in the INP as a single figure background level representing each assessment period (day, evening and night). Its determination is by the tenth percentile method (of the measured L_{A90} statistical noise levels) described in *Appendix B* on the INP;

- **Rating Background Level (RBL)** - is defined in the INP as the overall single figure background level representing each assessment period (day, evening and night) over the whole monitoring period (as opposed to over each 24hr period used for the ABL). 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;

  - all the evening assessment background levels over the monitoring period for the evening; or

  - all the night assessment background levels over the monitoring period for the night.

- **Extraneous noise** – noise resulting from activities that are not typical of the area. Atypical INP activities may include construction, and traffic generated by holiday periods and by special events such as concerts or sporting events. Normal daily traffic is not considered to be extraneous;

- **Most affected location(s)** – locations that experience (or will experience) the greatest noise impact from the noise source under consideration. In determining these locations, one needs to consider existing background levels, exact noise source location(s), distance from source (or proposed source) to receiver, and any shielding between source and receiver;

- **Noise criteria** – the general set of non-mandatory noise level targets for protecting against intrusive noise (for example, background noise plus 5 dB) and loss of amenity (for example, noise levels for various land uses).

- **Noise limits** – enforceable noise levels that appear in conditions on consents and licences. The noise limits are based on achievable noise levels which the proponent has predicted can be met during the environmental assessment. Exceedance of the noise limits can result in the requirement for either the development of noise management plans or legal action;

- **Project Specific Noise Levels** – target noise levels for a particular noise generating facility. They are based on the most stringent of the intrusive criteria or amenity criteria. Which of the two criteria is the most stringent is determined by measuring the level and nature of existing noise in the area surrounding the actual or propose noise generating facility;

- **Compliance** – the process of checking that source noise levels meet with the noise limits in a statutory context;

- **Non-compliance** – development is deemed to be in non-compliance with its noise consent/ licence conditions if the monitored noise levels exceed its statutory noise limit by more than 2 dB;

- **Feasible and Reasonable measures** – feasibility relates to engineering considerations and what is practical to build; reasonableness relates to the application of judgement in arriving at a decision, taking into account the following factors:

    - noise mitigation benefits (amount of noise reduction provided, number of people protected);

    - cost of mitigation (cost of mitigation versus benefit provided);

    - community views (aesthetic impacts and community wishes); and

    - noise levels for affected land uses (existing and future levels, and changes in noise levels).

- **Meteorological Conditions** – wind and temperature inversion conditions;

- **Temperature Inversion** – an atmospheric condition in which temperature increases with height above the ground; and

- **Adverse Weather** – weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).

A.1.7 Operator Attended Noise Measurements

Table A.1 presents noise level deductions that are typically applied based on the percentage contribution of a noise source(s).

Table A.1 Noise Level Deductions – Noted Percentile Contribution

Percentage Contribution	Noise Level Deduction, dB(A)
5%	-13.0
10%	-10.0
15%	-8.2
20%	-7.0
25%	-6.0
30%	-5.2
35%	-4.6
40%	-4.0
45%	-3.5
50%	-3.0
55%	-2.6
60%	-2.2
65%	-1.9
70%	-1.5
75%	-1.2
80%	-1.0
85%	-0.7
90%	-0.5
95%	-0.2
100%	0.0

1. **EXAMPLE:** the measured LAeq, 15 minute noise level is 49 dB and the site contribution was observed to be 10% of this level (extraneous noise sources were noted to dominate the measurement), therefore the LAeq, 15 minute noise level deduction is 10 dB, with a resultant noise level contribution of approximately 39 dB.

Table A.2 presents noise level deductions that may be applied based on the percentage of time that a noise source(s) is audible during a 15 minute measurement.

Table A.2 Noise Level Deductions – Noted Time Contribution

Event Duration (minutes)	Noise Level Deduction, dB(A)
1	-11.8
2	-8.8
3	-7.0
4	-5.7
5	-4.8
6	-4.0
7	-3.3
8	-2.7

Event Duration (minutes)	Noise Level Deduction, dB(A)
9	-2.2
10	-1.8
11	-1.3
12	-1.0
13	-0.6
14	-0.3
15	0.0

1. **EXAMPLE:** the measured LAeq, 15 minute noise level contribution of an excavator was noted to be 56 dB, however it was only audible for 6 minutes during the 15 minute measurement period, therefore the LAeq, 15 minute noise level deduction is 4 dB, with a resultant noise level contribution of approximately 52 dB.

A.2 VIBRATION - GLOSSARY OF TERMS, DEFINITIONS AND METHODOLOGY

A.2.1 How To Measure And Control Vibration

Vibration refers to the oscillating movement of any object. In relation to construction projects, ground-borne vibration is the most likely outcome of works and potentially has three (3) effects on vibration sensitive receivers, these are:

- ground-borne vibration that may cause annoyance;
- ground-borne vibration that may have adverse effect on a structure eg a building; and
- regenerated noise due to ground-borne vibration.

Each of these potential effects can be assessed in accordance with the relevant standard. Perceptible levels of vibration often create concern for the surrounding community at levels well below structural damage guideline values; this issue needs to be managed as part of the vibration monitoring program.

Vibration is typically measured using specific devices that record the velocity or acceleration at a designated receiver location – usually being the closest premises to works. Modern vibration monitoring devices will typically capture amplitude data for the three (3) orthogonal axes being, the transverse, longitudinal and vertical and also the frequency at which the measured vibration event occurs. Monitoring of this level of detail enables analysis of significant vibration events to determine compliance with relevant guidelines such as the NSW *Department of Environment, Climate Change and Water - Vibration: A Technical Guideline* and German Standard *DIN4150 Structural vibration - Part 3: effects of vibration on structures*.

Vibration propagates in a different manner to noise and can be difficult to control depending on the frequency of the source in question, although identifying the strategy best suited to controlling vibration follows a similar approach to that of noise. This includes elimination, control at the source, control along the propagation path and control at the receiver and/or a combination of these, such as no work/respite periods.

A.2.2 Vibration Descriptors

The following terms are often used to describe measured vibration levels.

- **Parameter** – an attribute with a value - for example, weighting;
- **Particle Velocity** – the instantaneous value of the distance travelled by a particle per unit time in a medium that is displaced from its equilibrium state by the passage of a sound or vibration wave;
- **Peak Component Particle Velocity (PCPV)** – is the highest (maximum or peak) particle velocity which is recorded during a particular vibration event over the three (3) axes. PCPV is measured in the unit, mm/s;
- **Phase** – the relative position of a sound wave to some reference point, the phase of a wave is given in radians, degrees, or fractions of a wavelength;
- **Acceleration** – the change in velocity over time. Acceleration is dependent on the velocity and the frequency of the vibration event (velocity is a vector), as such acceleration changes in two ways - magnitude and/or direction. Acceleration is measured in the unit; m/s^2;
- **Perceptible** – vibration levels that a receiver of building occupant may 'feel'. 0.2mm/s is typically considered to be the human threshold for perception of vibration;
- **Geophone or accelerometer** – the transducer/device typically used to measure vibration;
- **Damage** – is defined in DIN 4150-3 (1999-02) *Structural vibration - Effects of vibration on structures* to include minor non-structural effects such as cosmetic damage or superficial cracking in paint or cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls; and

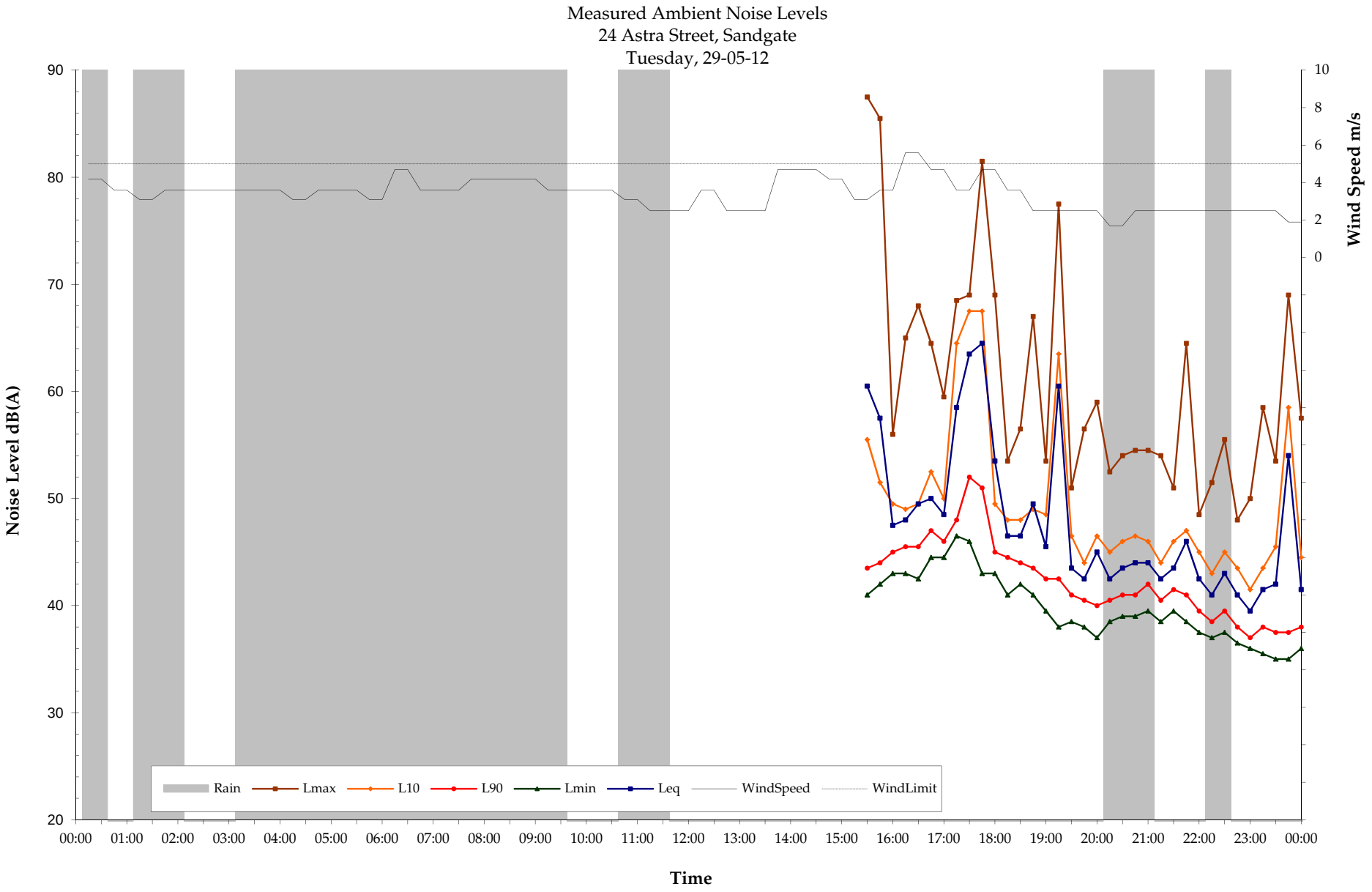
- **Vibration Dose Value (VDV) –** a concept outlined in *Vibration: A Technical Guideline* by the NSW Department of Environment and Climate Change & Water, which is a calculative approach to assessing the impact of intermittent vibration or extended periods of impulsive vibration. VDV require the measurement of the overall weighted RMS (Root Mean Square) acceleration levels over the frequency range 1Hz to 80Hz. To calculate VDV the following formula (refer *section 2.4.1* of "the guideline") is used:

$$VDV = \left[\int_0^T a^4(t)dt \right]^{0.25}$$

Where VDV is the vibration dose value in $m/s^{1.75}$, *a (t)* is the frequency-weighted RMS of acceleration in m/s^2 and *T* is the total period of the day (in seconds) during which vibration may occur.

Annex B

Measured Ambient and Background Noise Levels


Measured Ambient Noise Levels
24 Astra Street, Sandgate
Tuesday, 29-05-12
Noise Level dB(A)
Wind Speed m/s
Time
90
80
70
60
50
40
30
20
10
8
6
4
2
0
00:00
01:00
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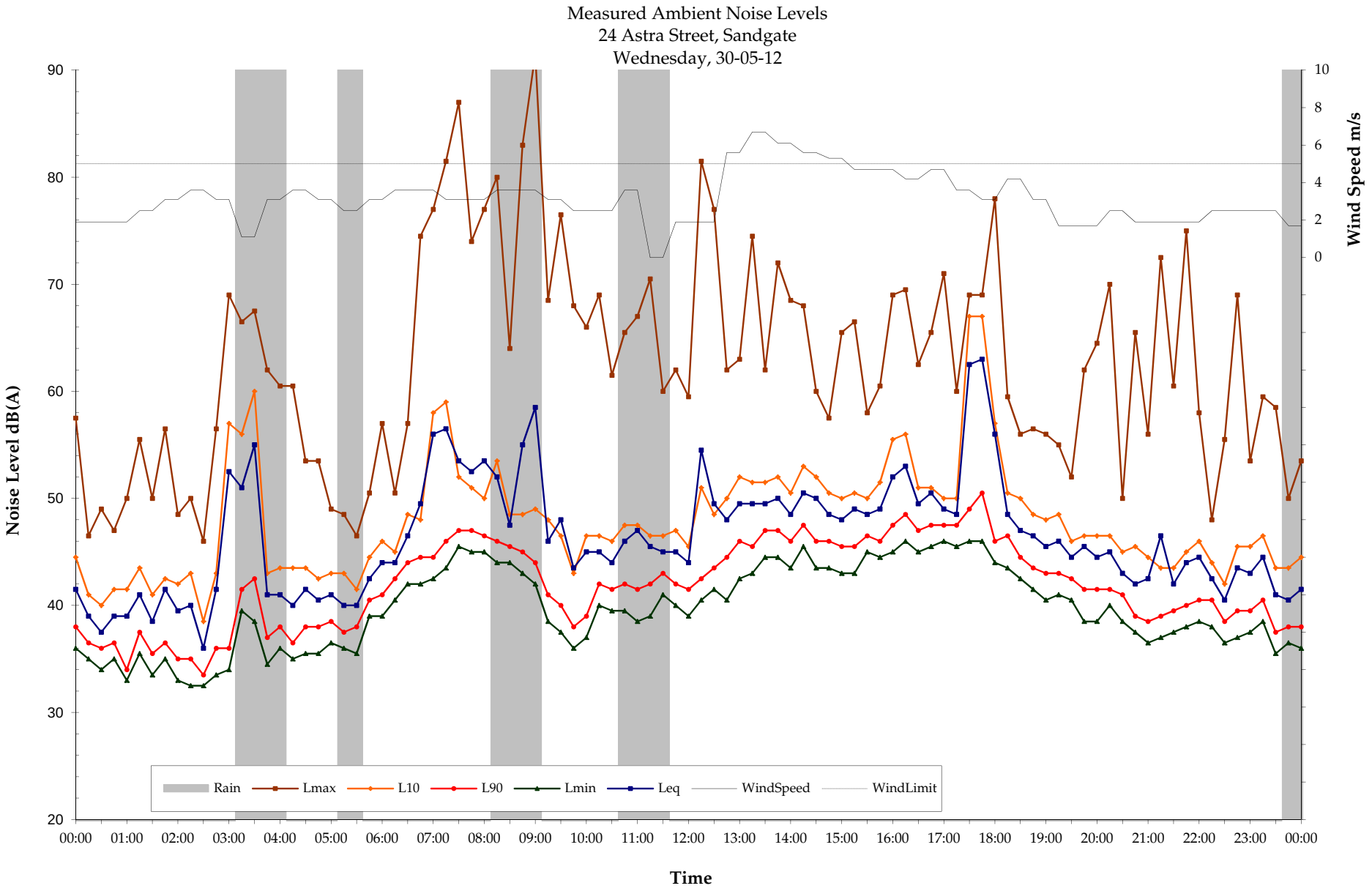
Rain
Lmax
L10
L90
Lmin
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
24 Astra Street, Sandgate
Wednesday, 30-05-12
Noise Level dB(A)
Wind Speed m/s
Time
Rain
Lmax
L10
L90
Lmin
Leq
WindSpeed
WindLimit
90
80
70
60
50
40
30
20
10
8
6
4
2
0
00:00
01:00
02:00
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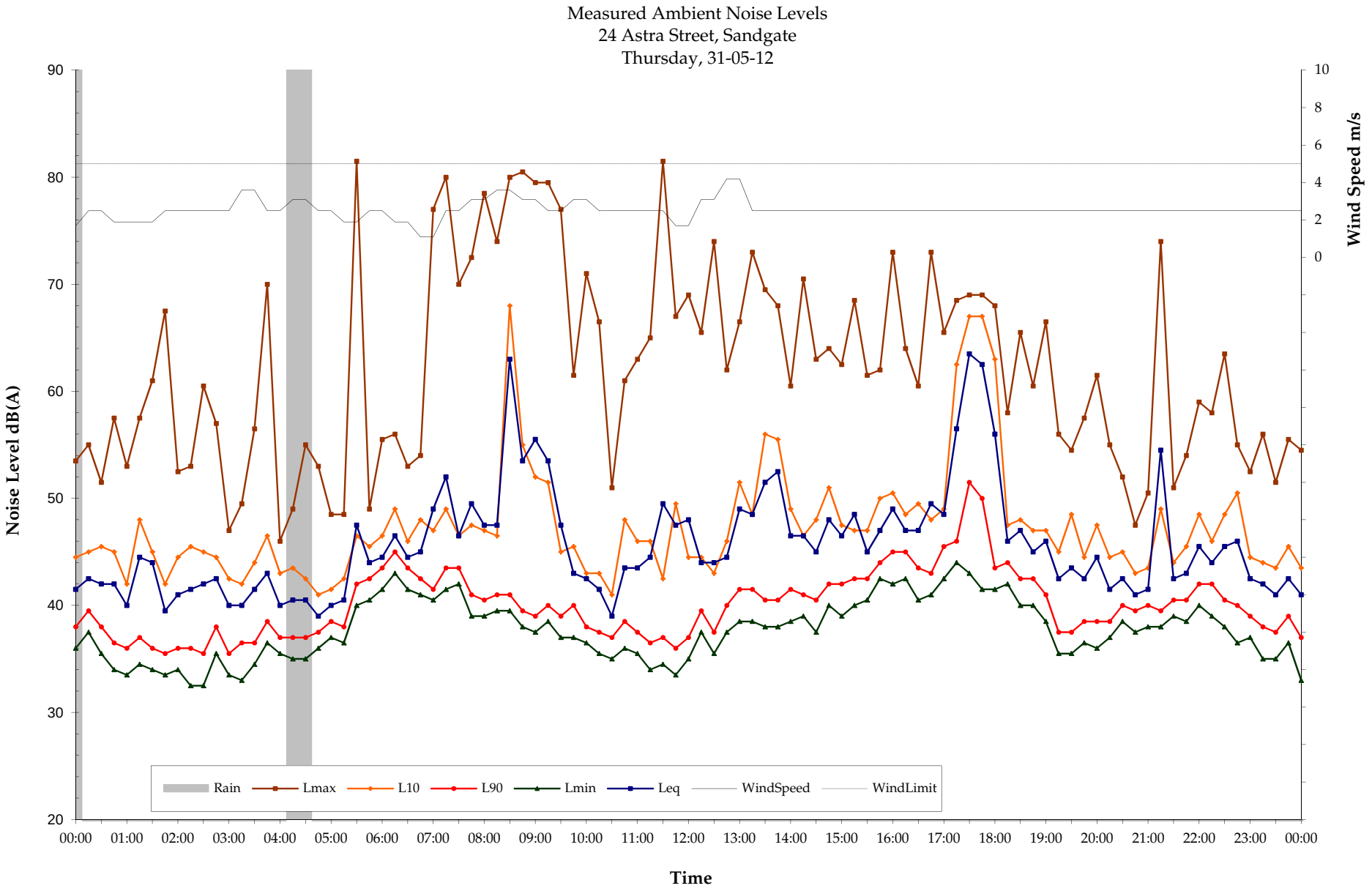
Measured Ambient Noise Levels
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Thursday, 31-05-12
Noise Level dB(A)
Wind Speed m/s
Time
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80
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60
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40
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20
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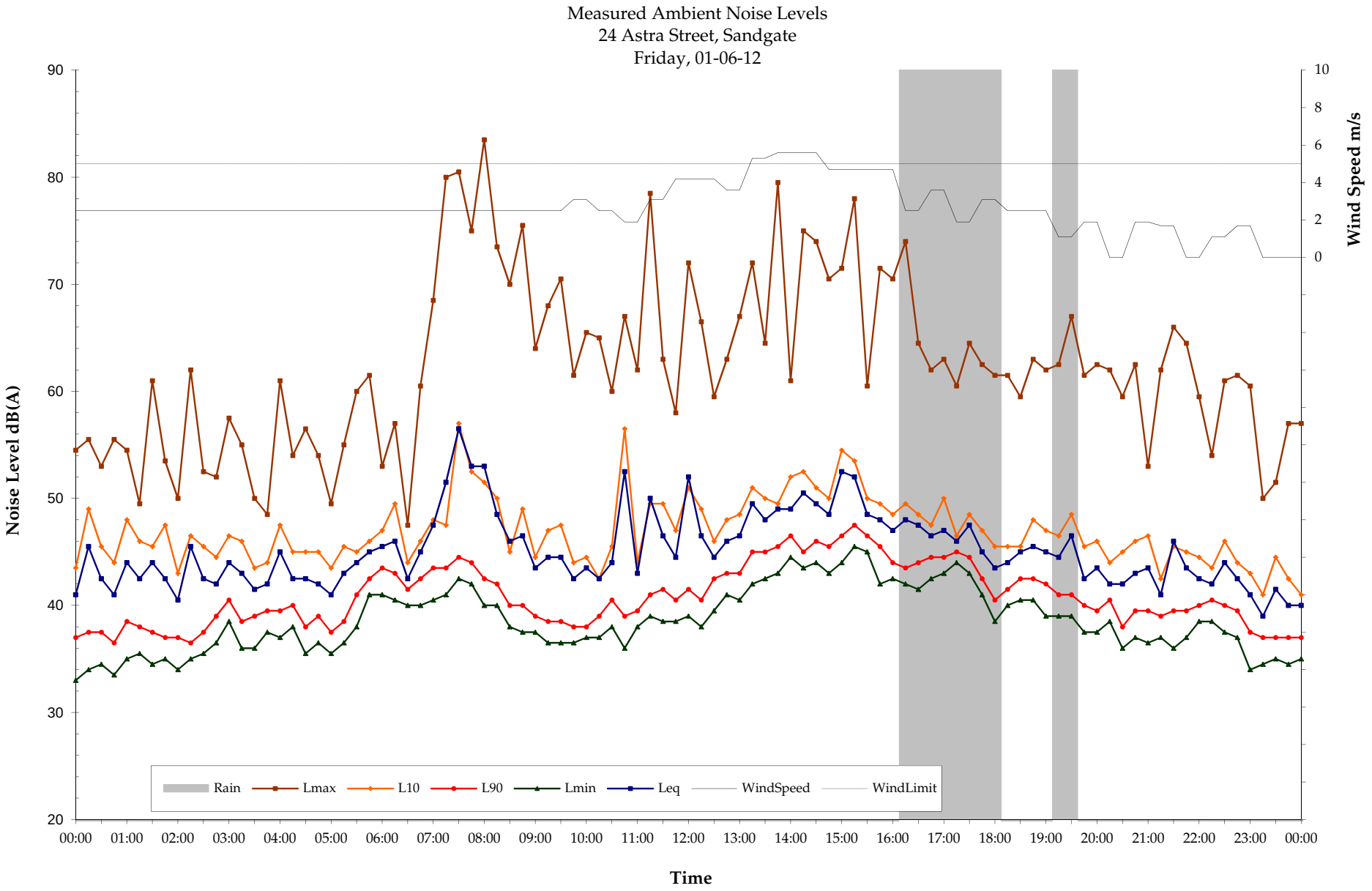
WindSpeed
WindLimit


Measured Ambient Noise Levels
24 Astra Street, Sandgate
Friday, 01-06-12
Noise Level dB(A)
Wind Speed m/s
Time
Rain
Lmax
L10
L90
Lmin
Leq
WindSpeed
WindLimit
90
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60
50
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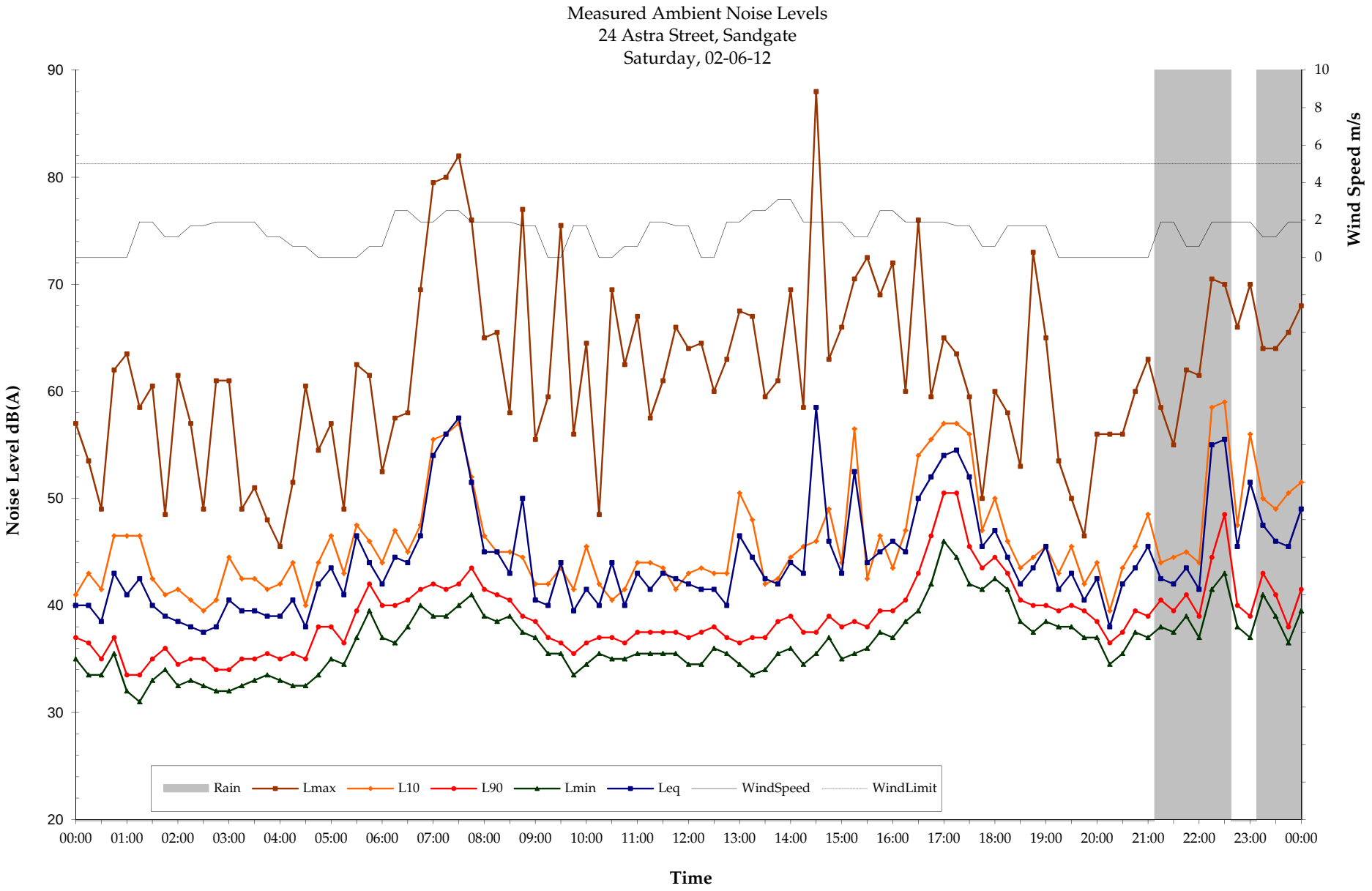
Measured Ambient Noise Levels
24 Astra Street, Sandgate
Saturday, 02-06-12
Noise Level dB(A)
Wind Speed m/s
Time
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80
70
60
50
40
30
20
10
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4
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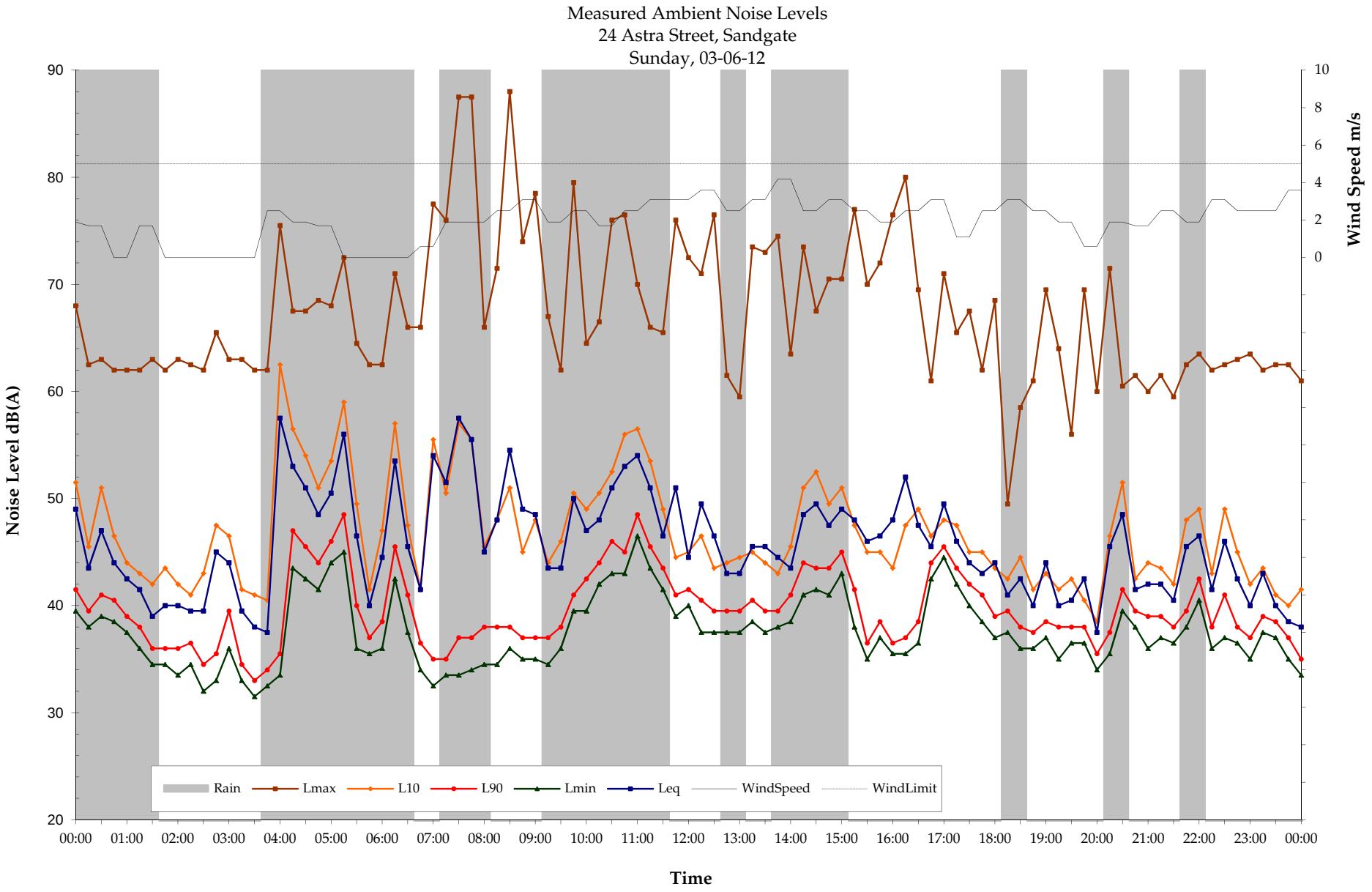
Measured Ambient Noise Levels
24 Astra Street, Sandgate
Sunday, 03-06-12
Noise Level dB(A)
Wind Speed m/s
Time
90
80
70
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50
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30
20
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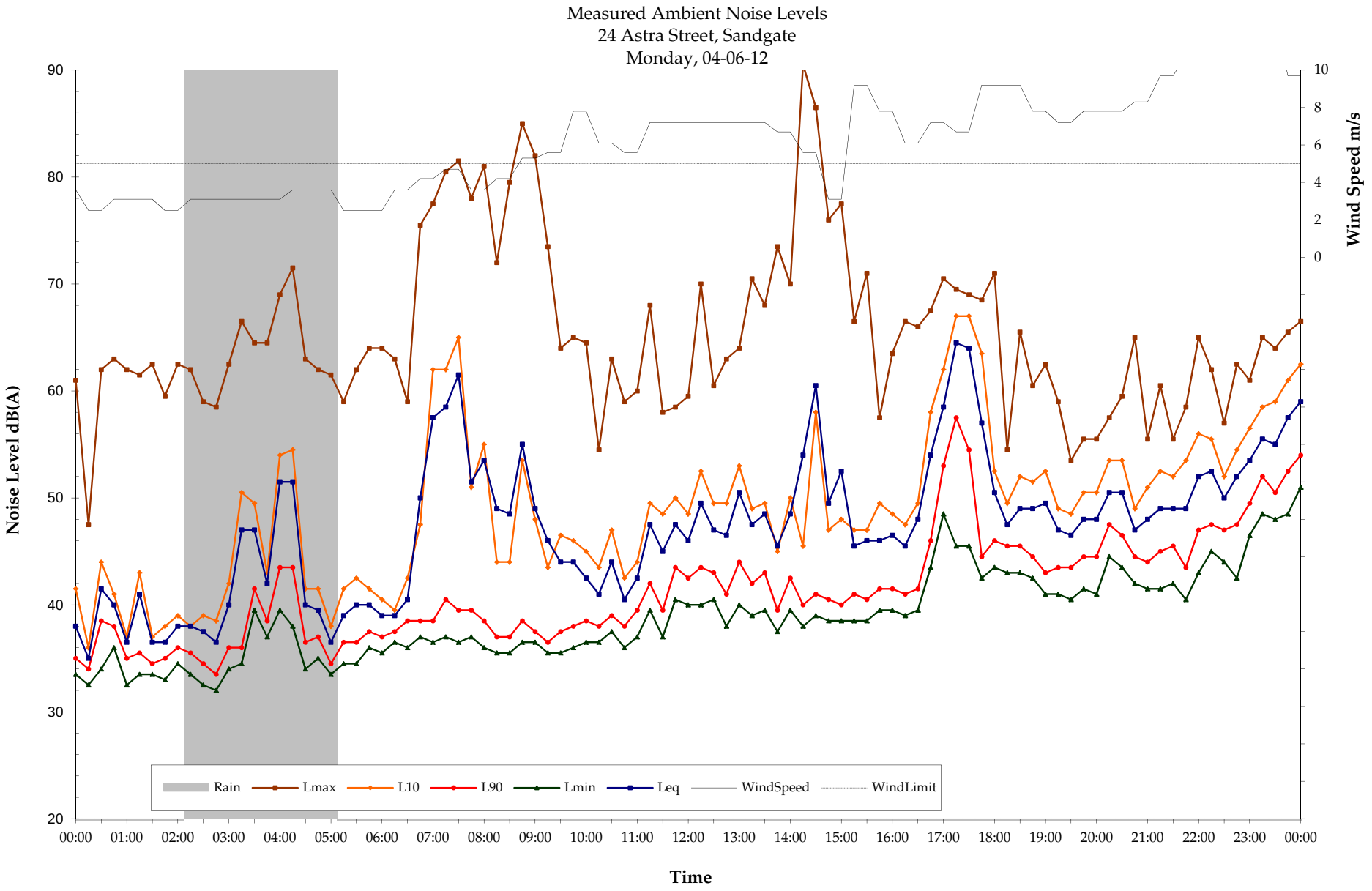
Measured Ambient Noise Levels
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Monday, 04-06-12
Noise Level dB(A)
Wind Speed m/s
Time
Rain
Lmax
L10
L90
Lmin
Leq
WindSpeed
WindLimit
90
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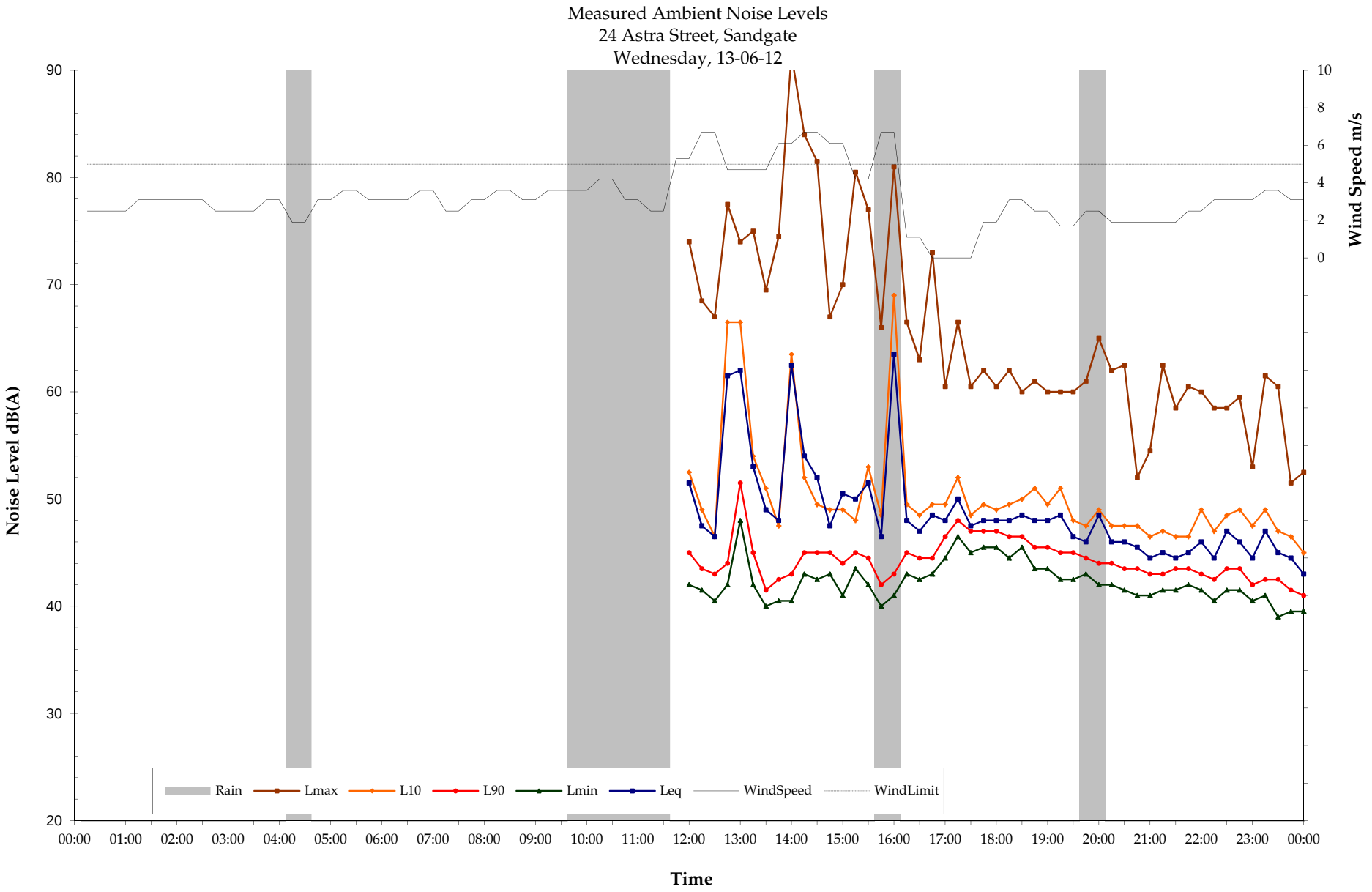
Measured Ambient Noise Levels
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Wednesday, 13-06-12
Noise Level dB(A)
Wind Speed m/s
Time
90
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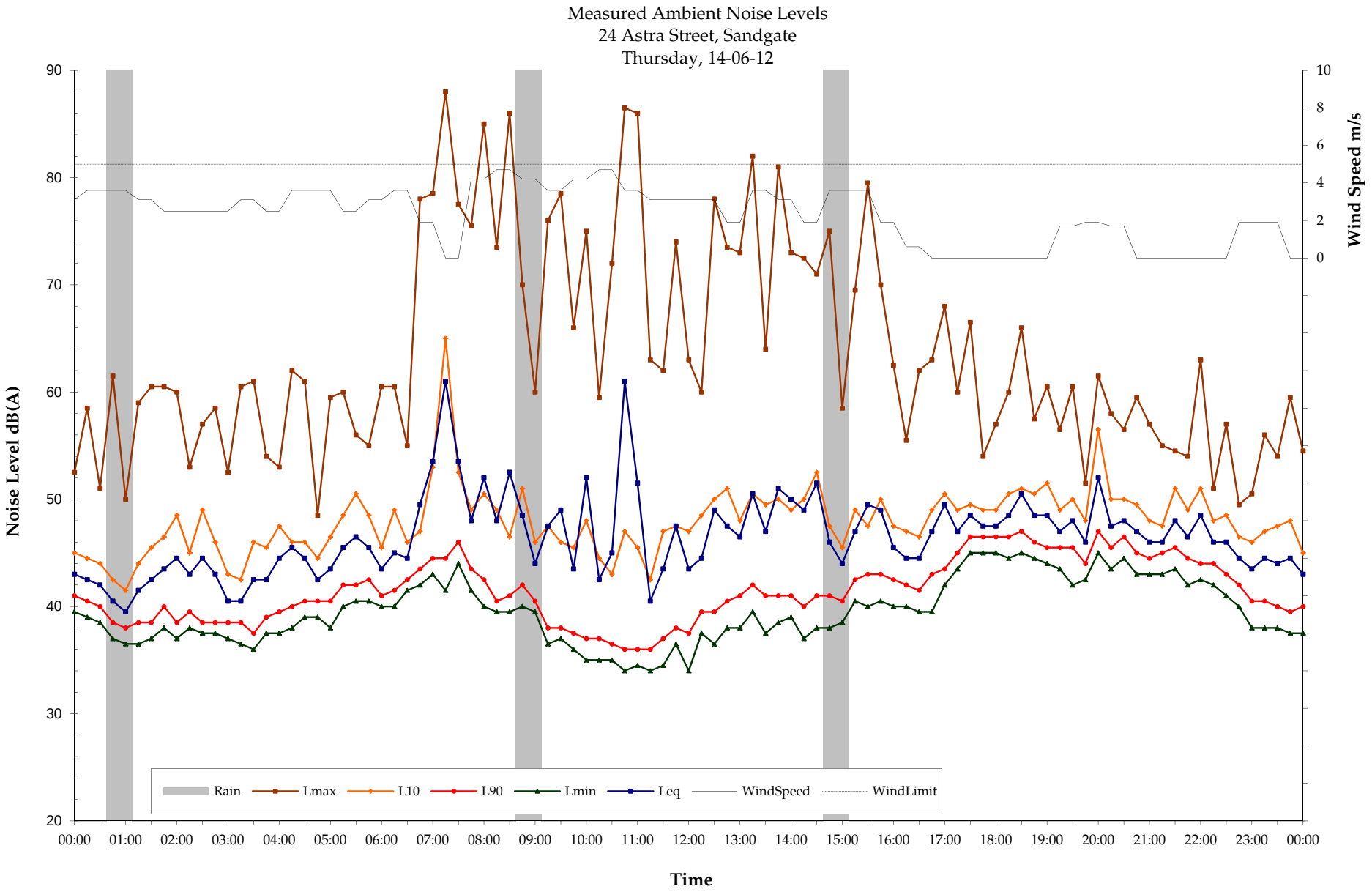
Measured Ambient Noise Levels
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Thursday, 14-06-12
Noise Level dB(A)
Wind Speed m/s
Time
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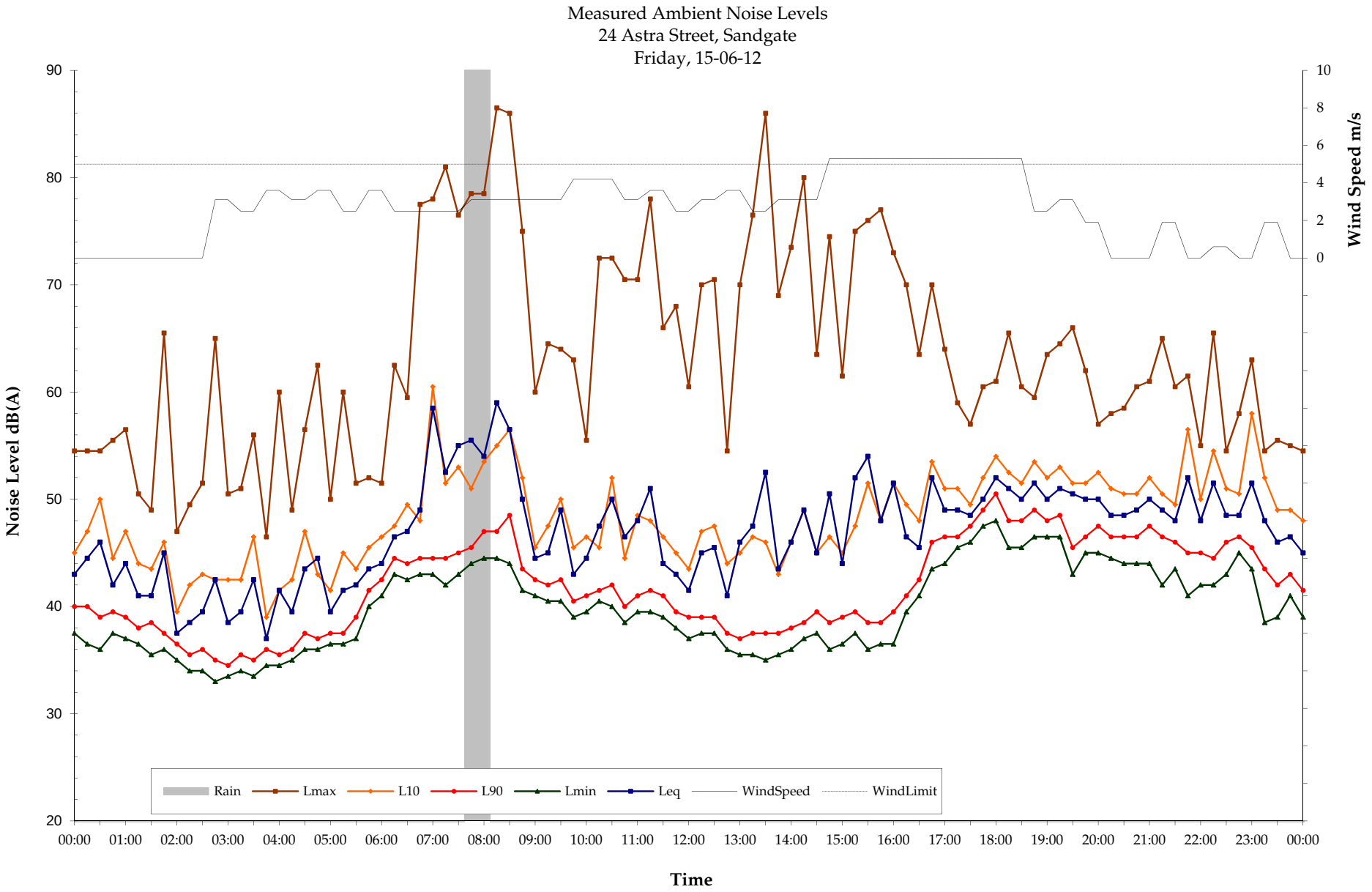
Measured Ambient Noise Levels
24 Astra Street, Sandgate
Friday, 15-06-12
Noise Level dB(A)
Wind Speed m/s
Time
90
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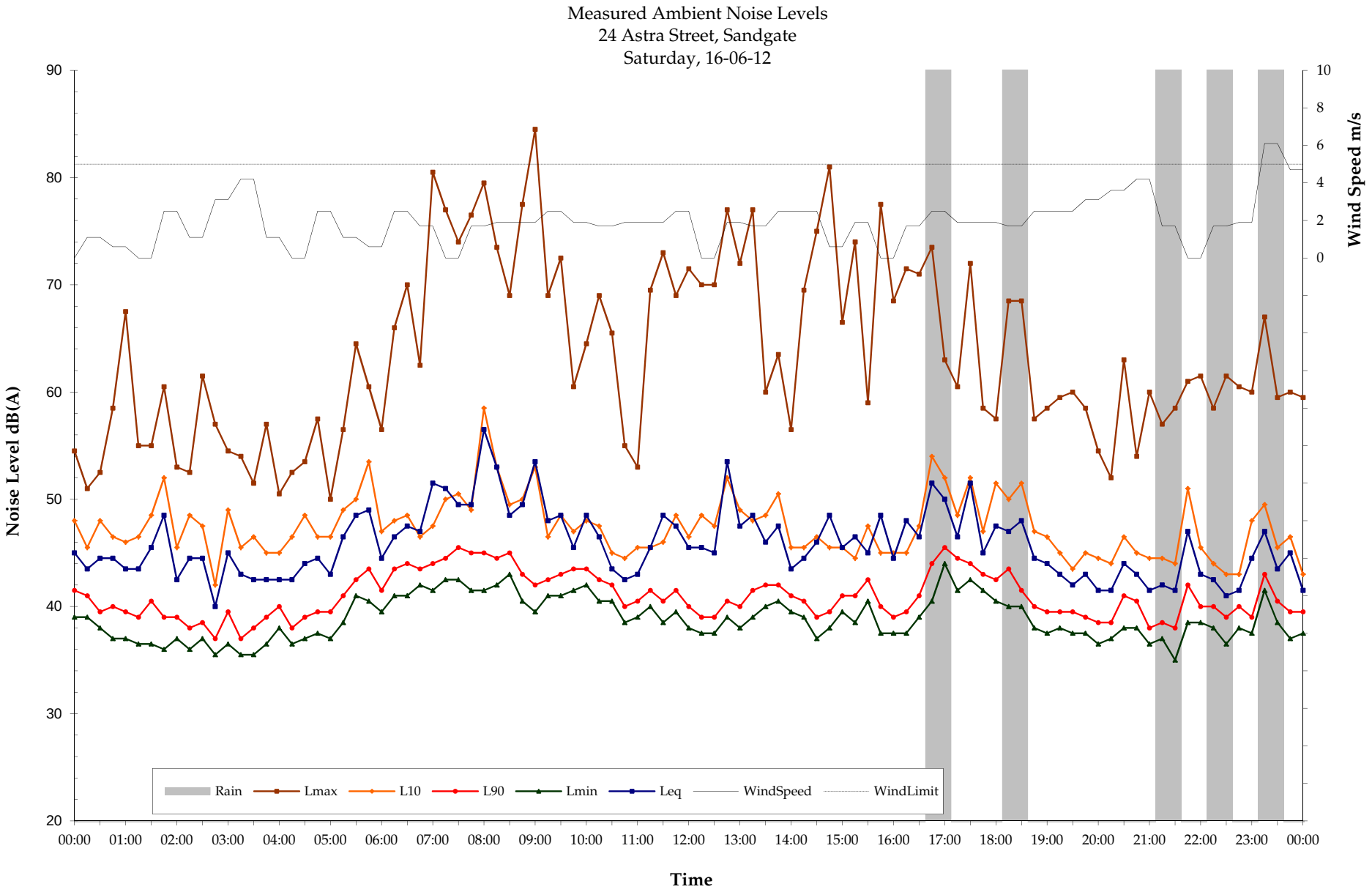
Measured Ambient Noise Levels
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Saturday, 16-06-12
Noise Level dB(A)
Wind Speed m/s
Time
90
80
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20
10
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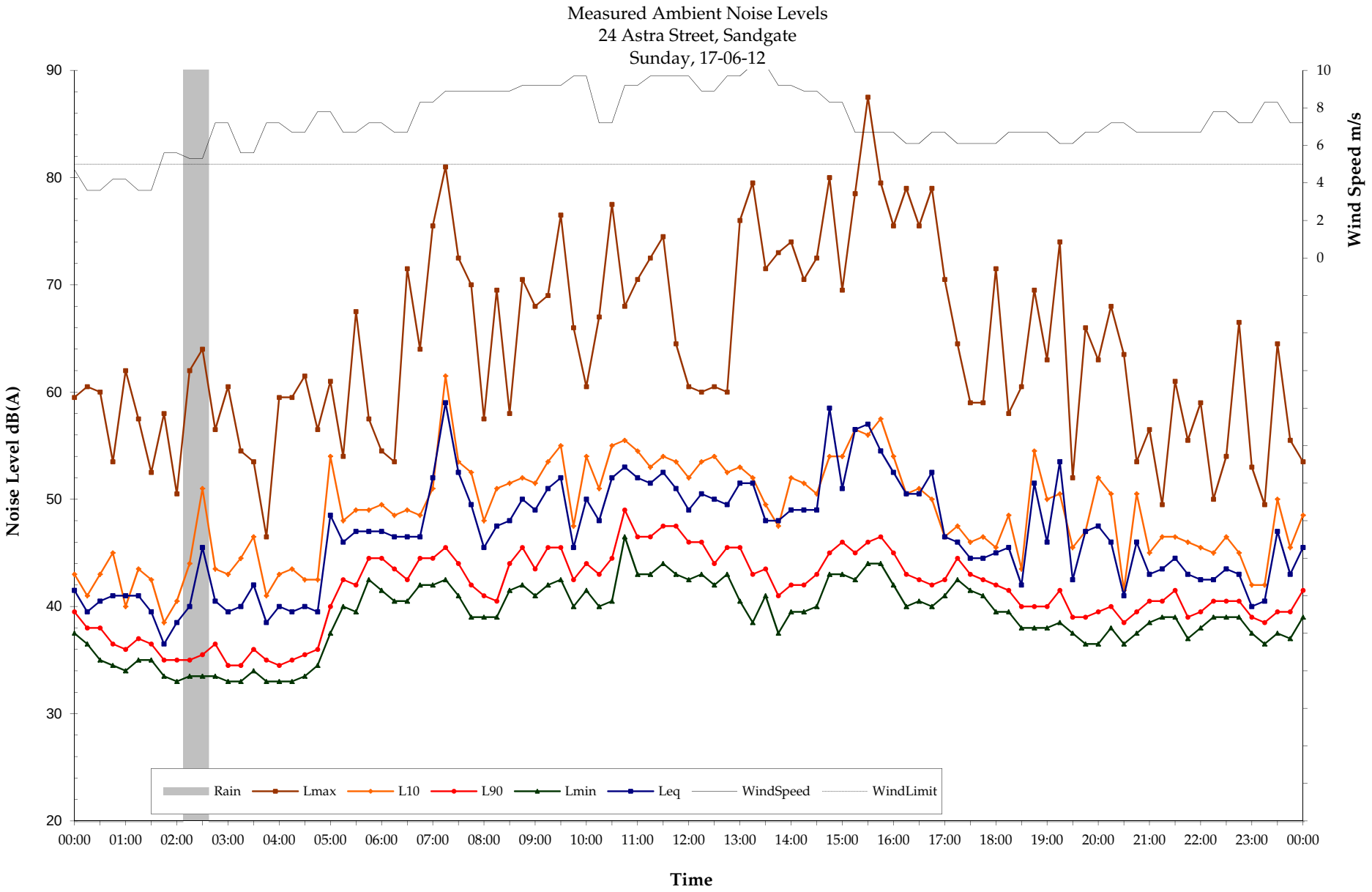
WindSpeed
WindLimit


Measured Ambient Noise Levels
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Sunday, 17-06-12
Noise Level dB(A)
Wind Speed m/s
Time
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Rain
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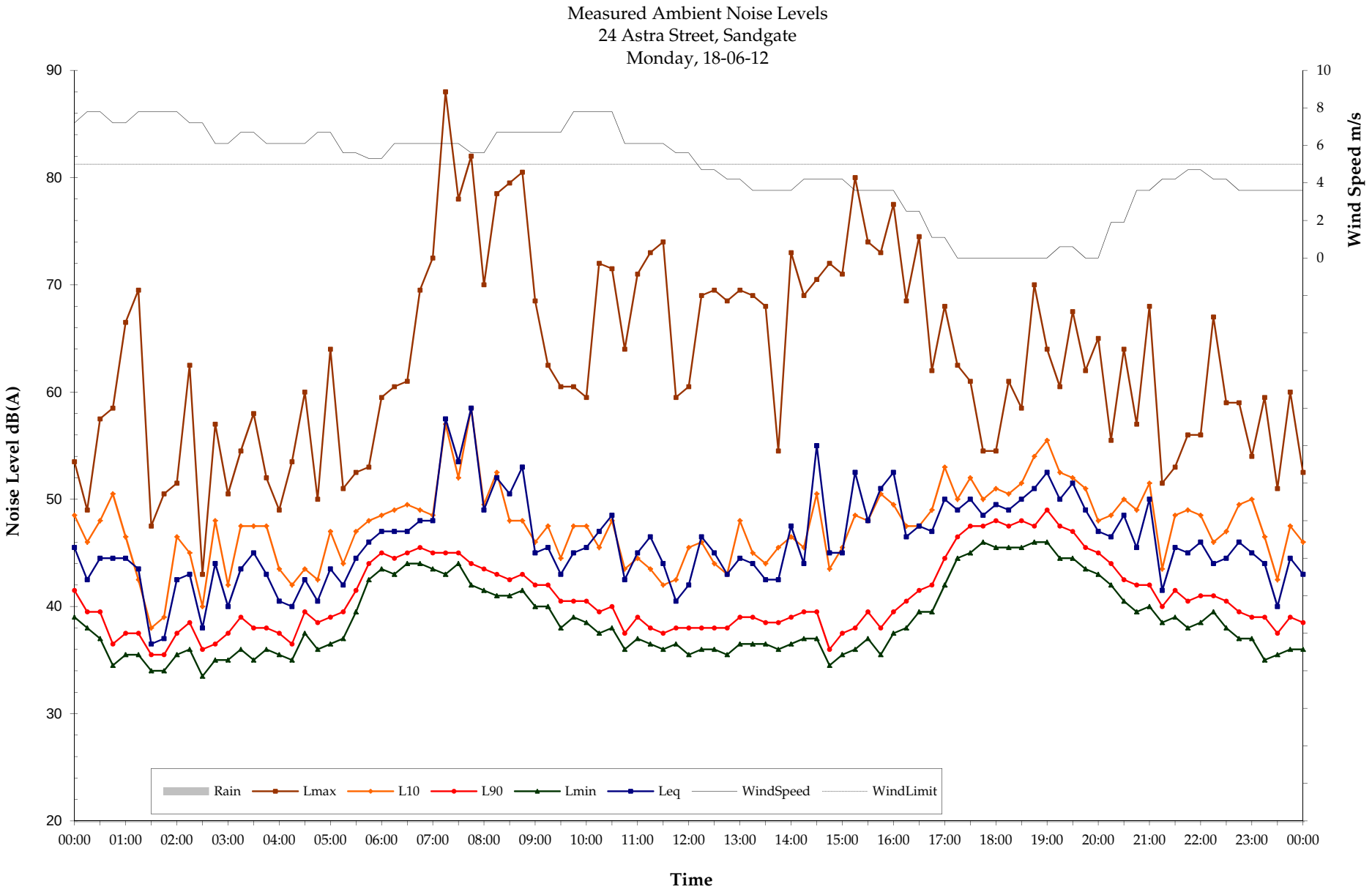
WindSpeed
WindLimit


Measured Ambient Noise Levels
24 Astra Street, Sandgate
Monday, 18-06-12
Noise Level dB(A)
Wind Speed m/s
Time
90
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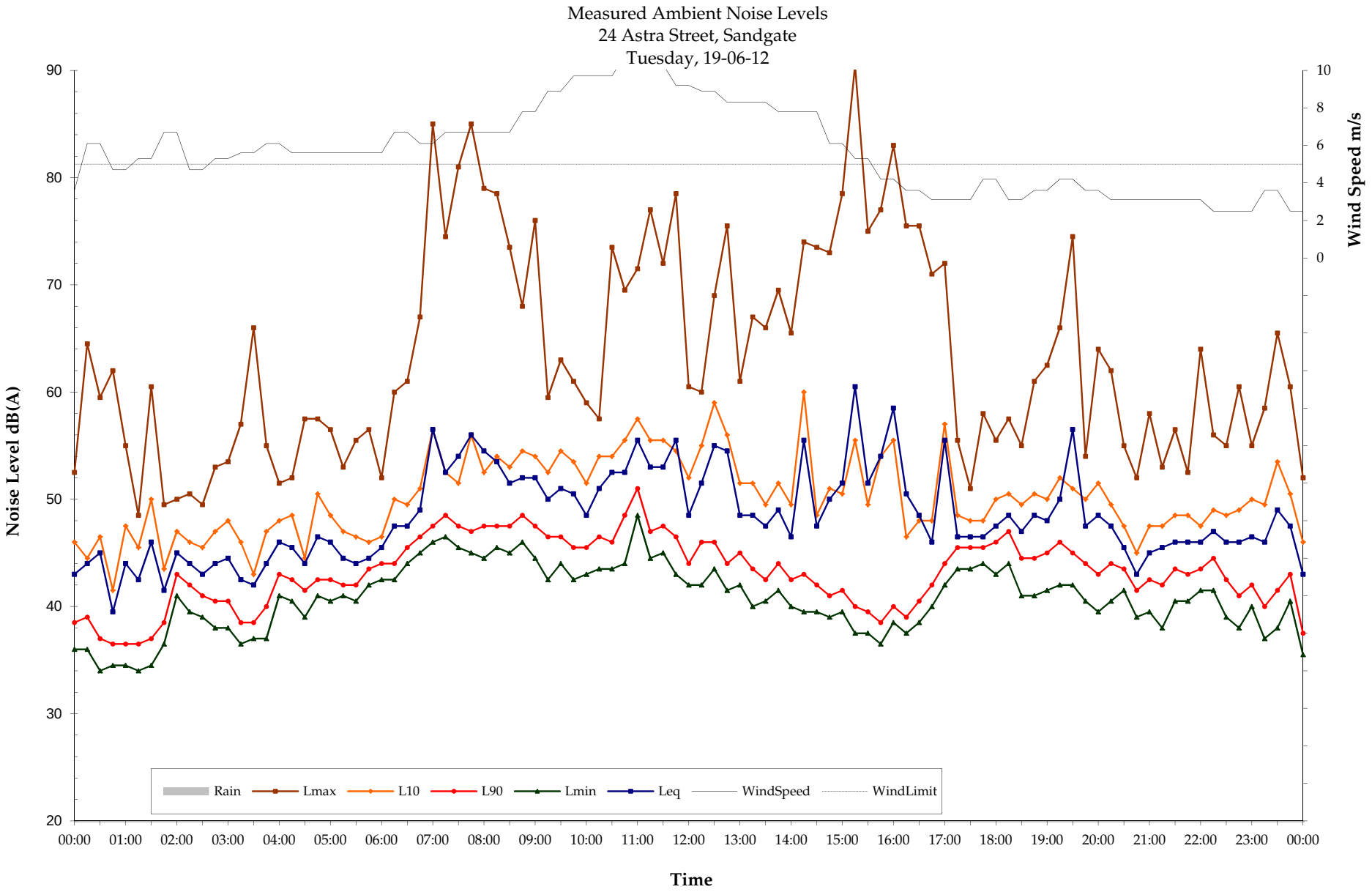
Measured Ambient Noise Levels
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Tuesday, 19-06-12
Noise Level dB(A)
Wind Speed m/s
Time
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30
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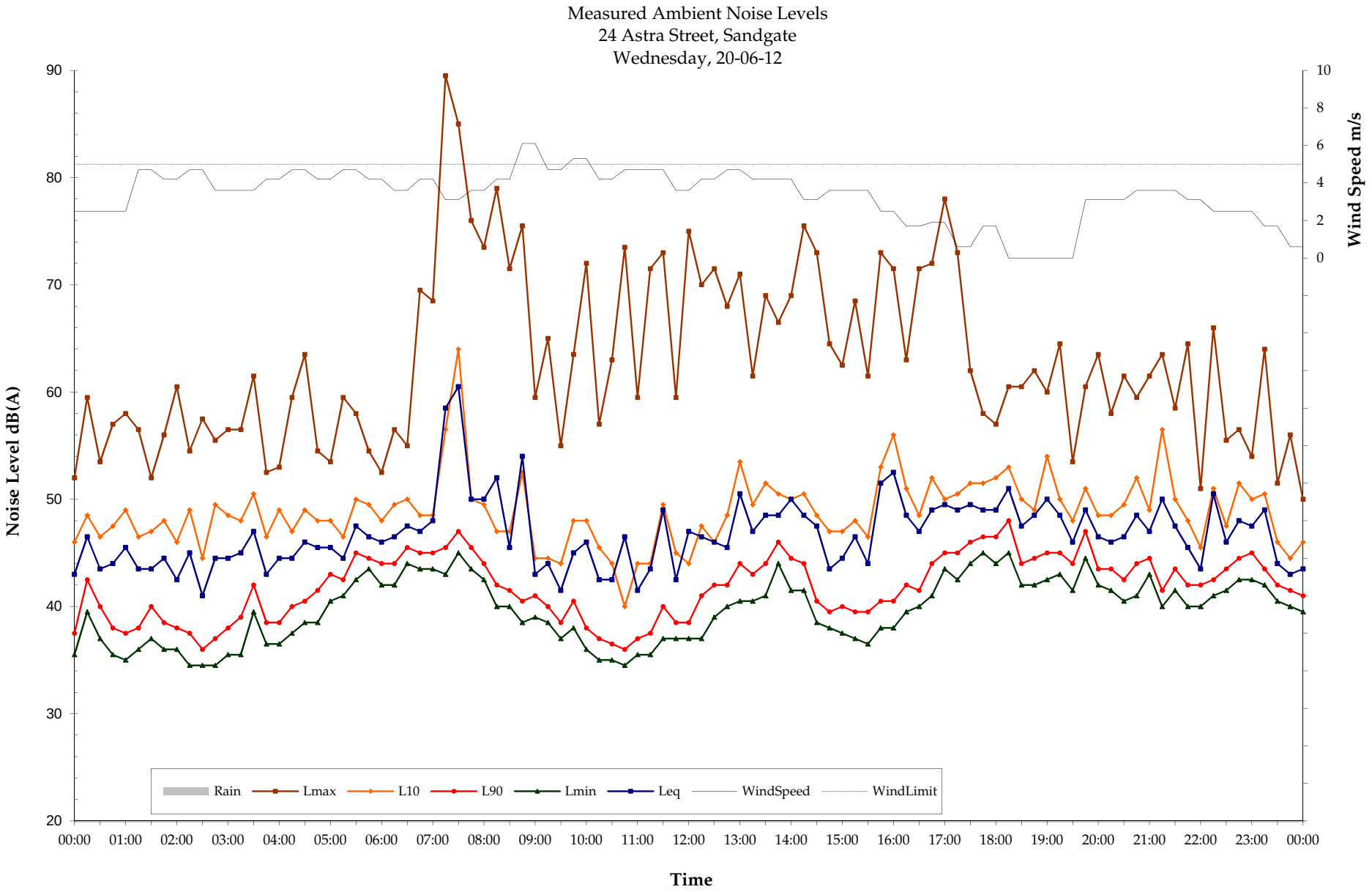
Measured Ambient Noise Levels
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Wednesday, 20-06-12
Noise Level dB(A)
Wind Speed m/s
Time
90
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20
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Rain
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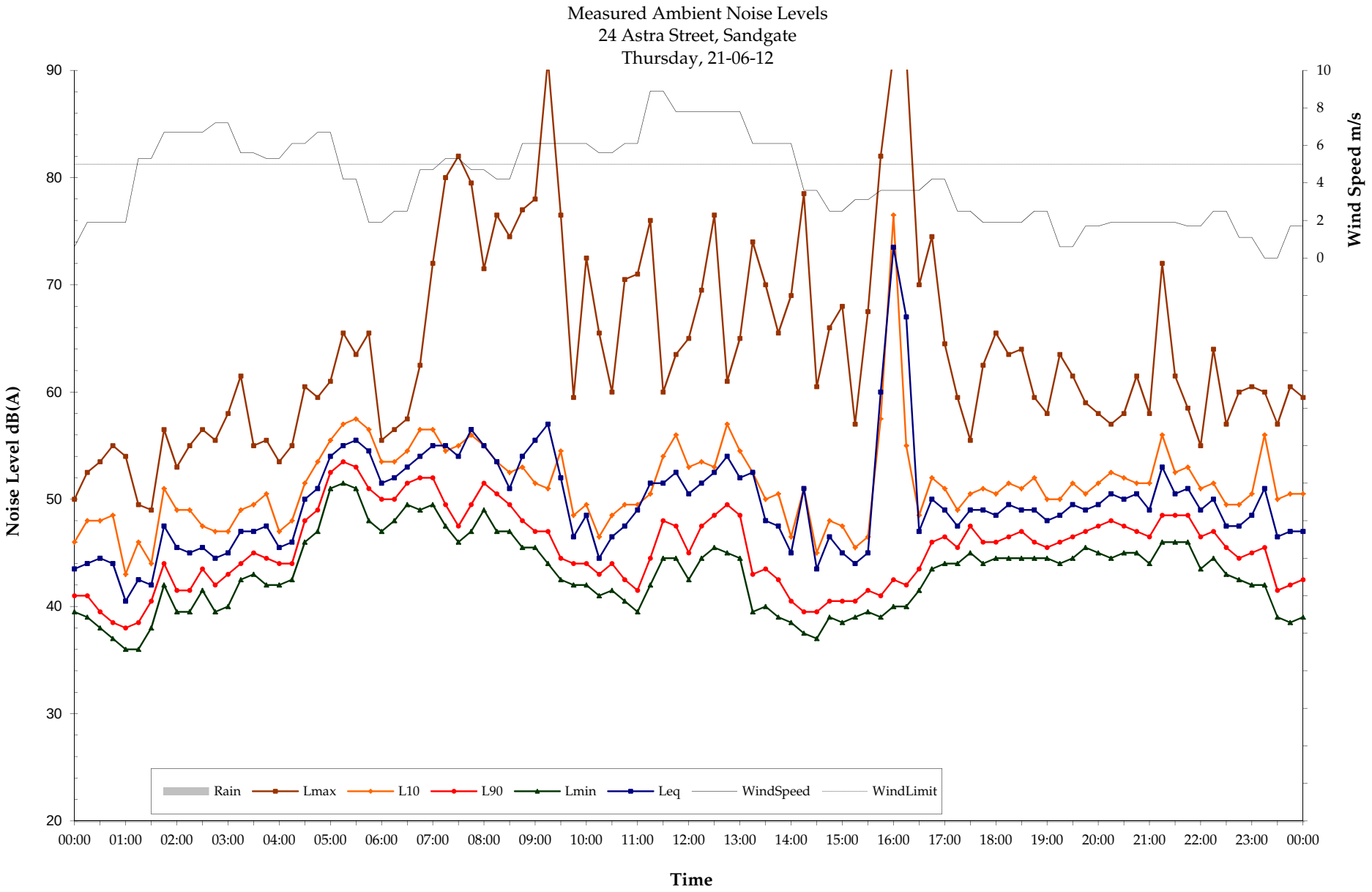
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
24 Astra Street, Sandgate
Thursday, 21-06-12
Noise Level dB(A)
Wind Speed m/s
Time
Rain
Lmax
L10
L90
Lmin
Leq
WindSpeed
WindLimit
90
80
70
60
50
40
30
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10
8
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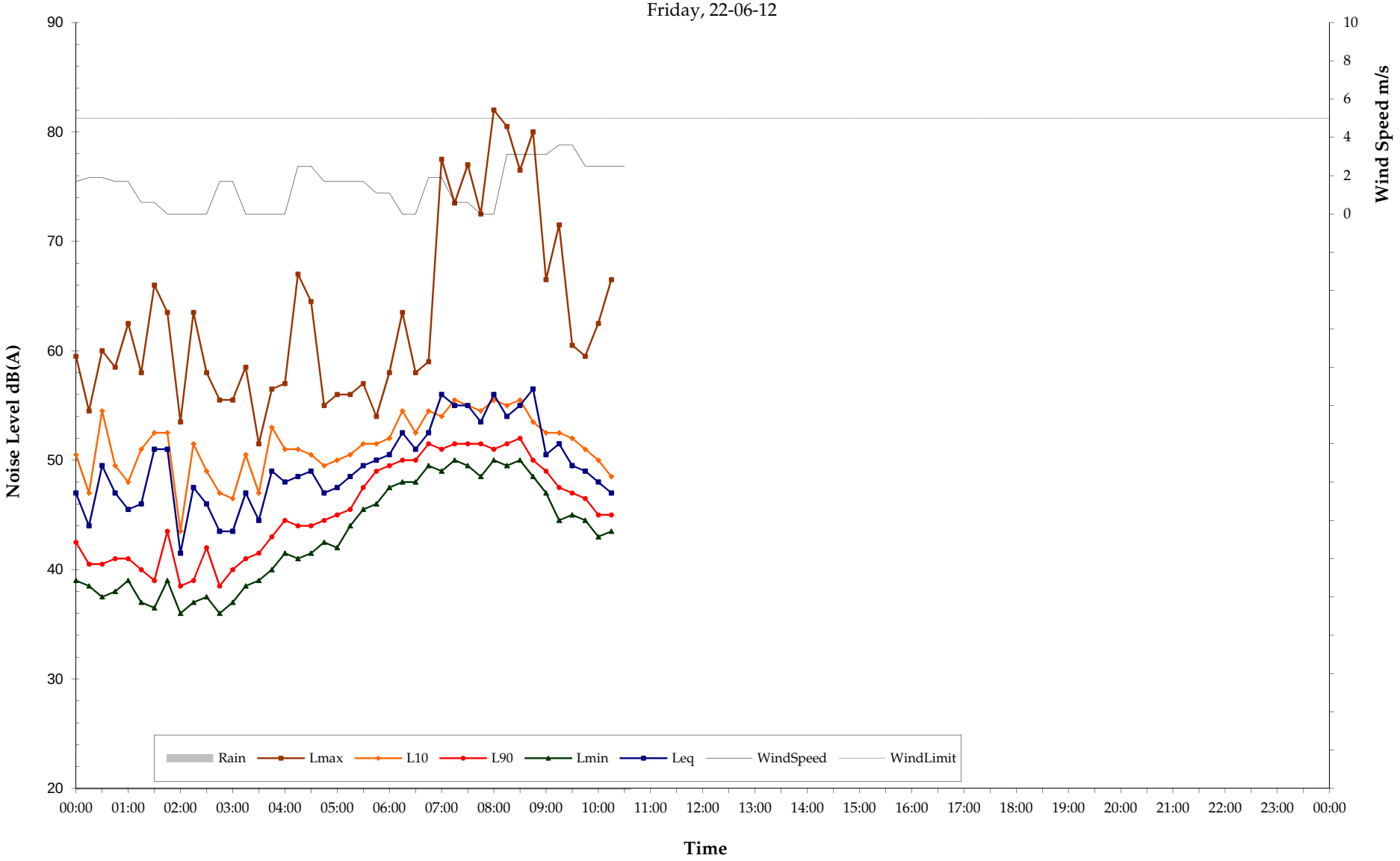
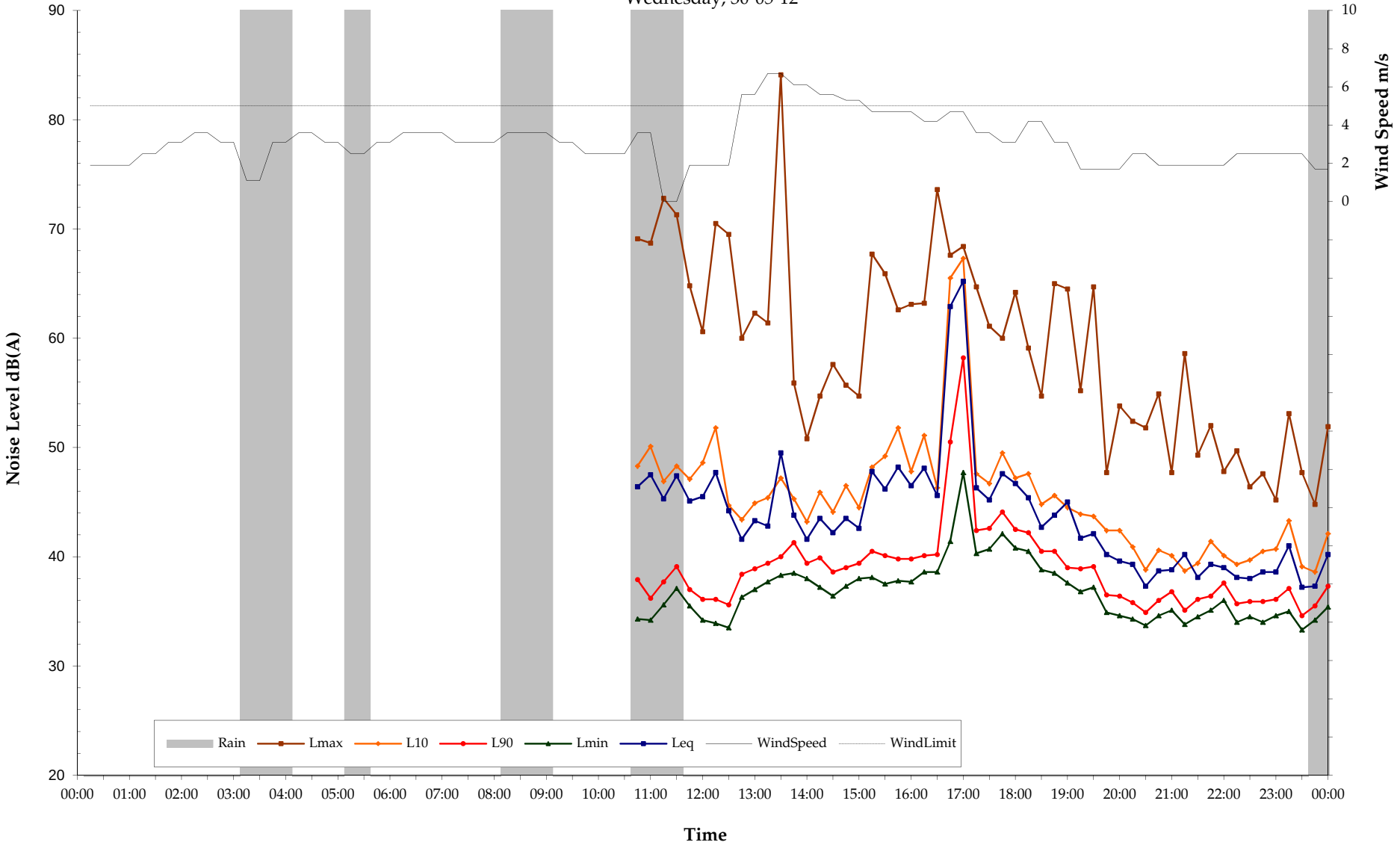
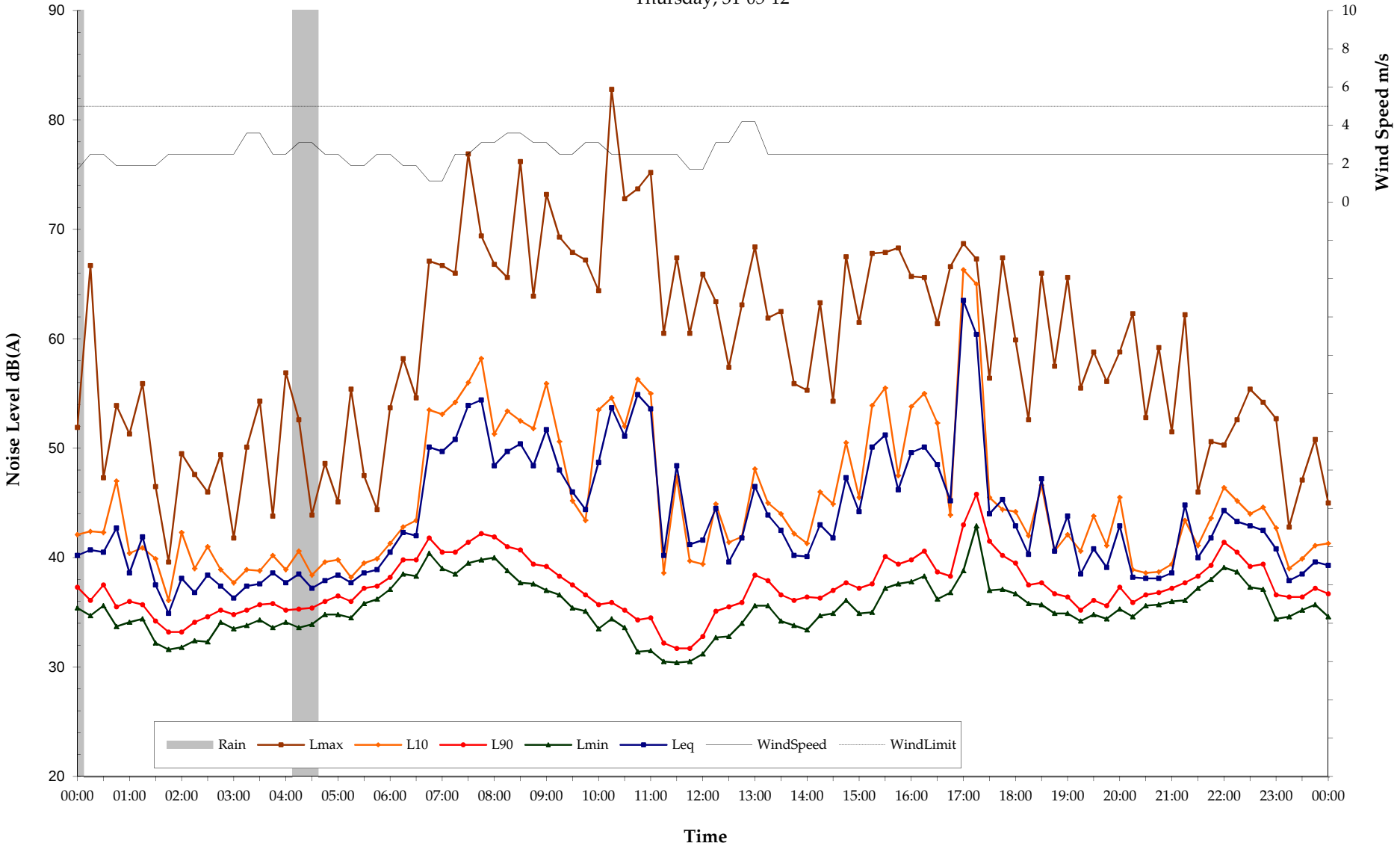
Measured Ambient Noise Levels
24 Astra Street, Sandgate
Friday, 22-06-12



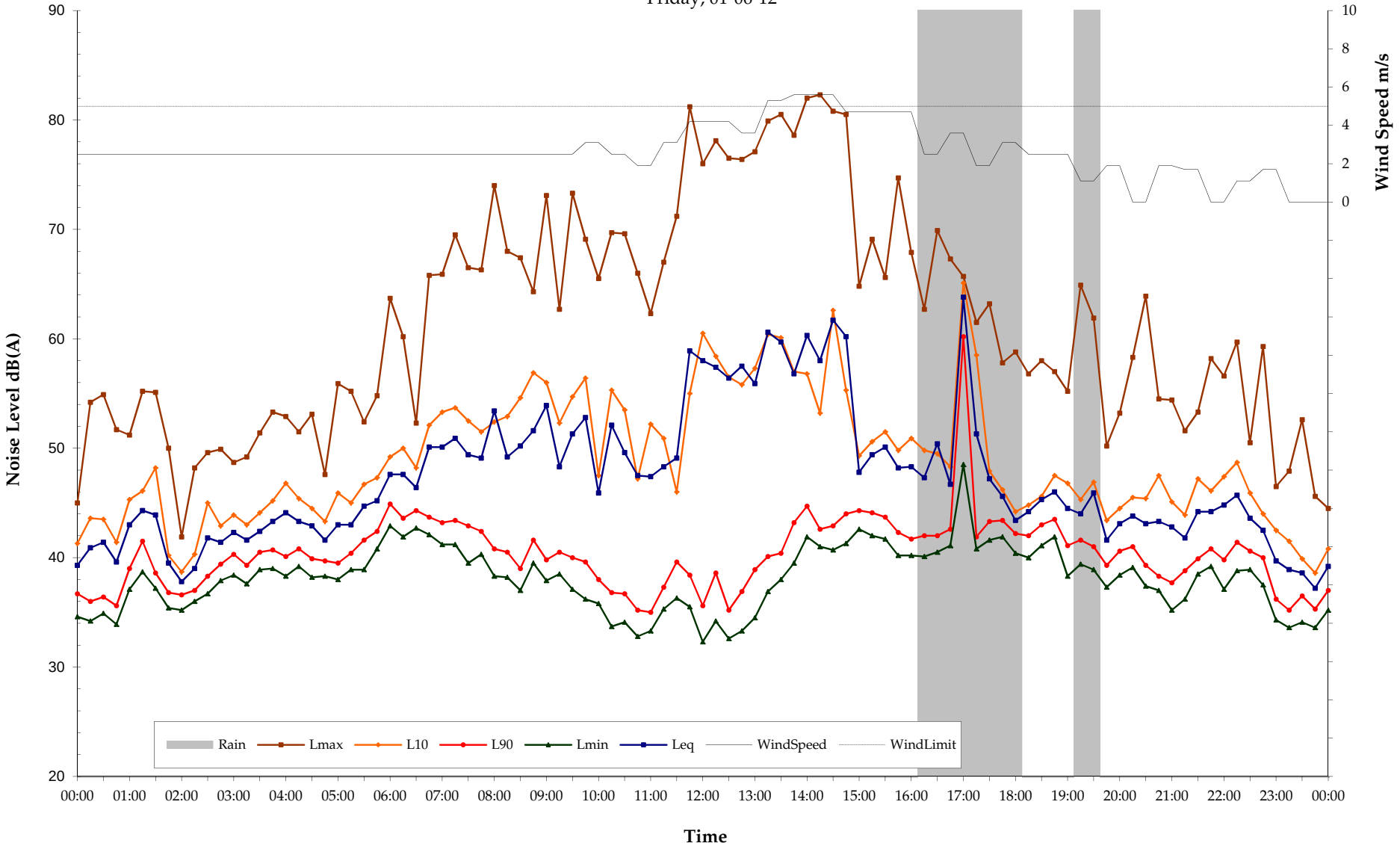
Measured Ambient Noise Levels
49 Blanch Street, Shortland
Wednesday, 30-05-12

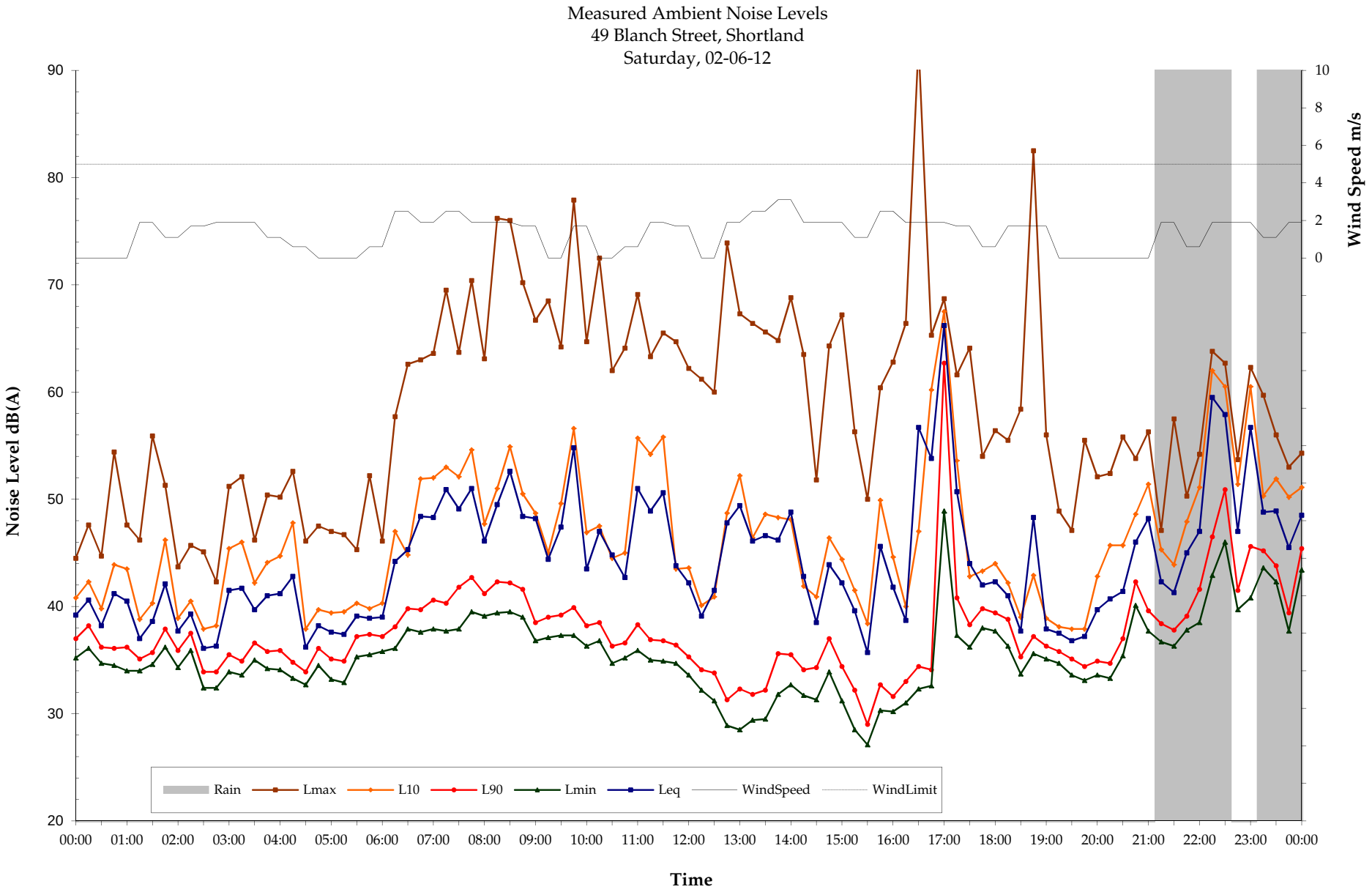


Measured Ambient Noise Levels
49 Blanch Street, Shortland
Thursday, 31-05-12



Measured Ambient Noise Levels
49 Blanch Street, Shortland
Friday, 01-06-12




Measured Ambient Noise Levels
49 Blanch Street, Shortland
Saturday, 02-06-12
Noise Level dB(A)
Wind Speed m/s
Time
90
80
70
60
50
40
30
20
10
8
6
4
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01:00
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Rain
Lmax
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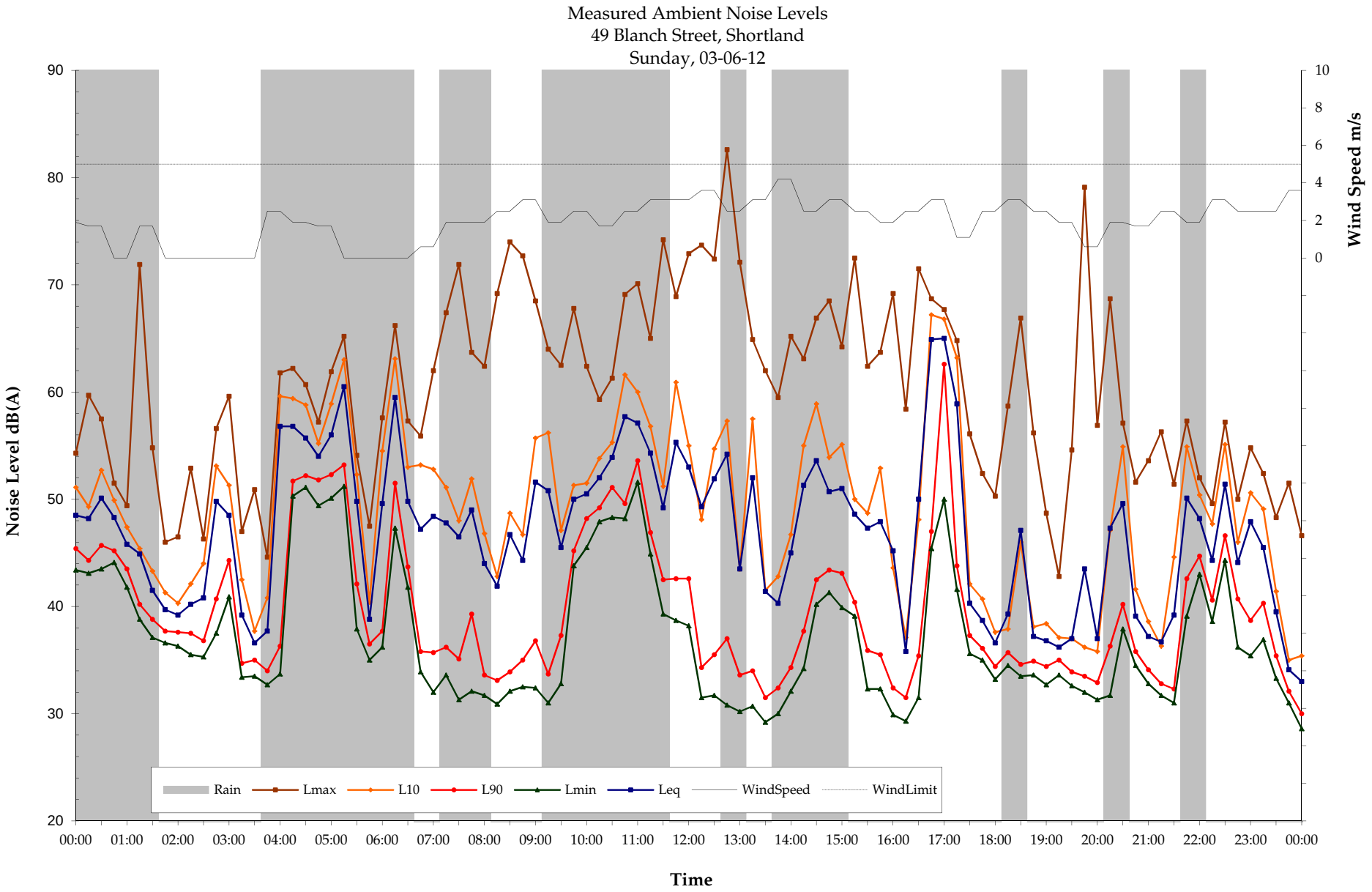
L90
Lmin
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
49 Blanch Street, Shortland
Sunday, 03-06-12
Noise Level dB(A)
Wind Speed m/s
Time
Rain
Lmax
L10
L90
Lmin
Leq
WindSpeed
WindLimit
90
80
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60
50
40
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20
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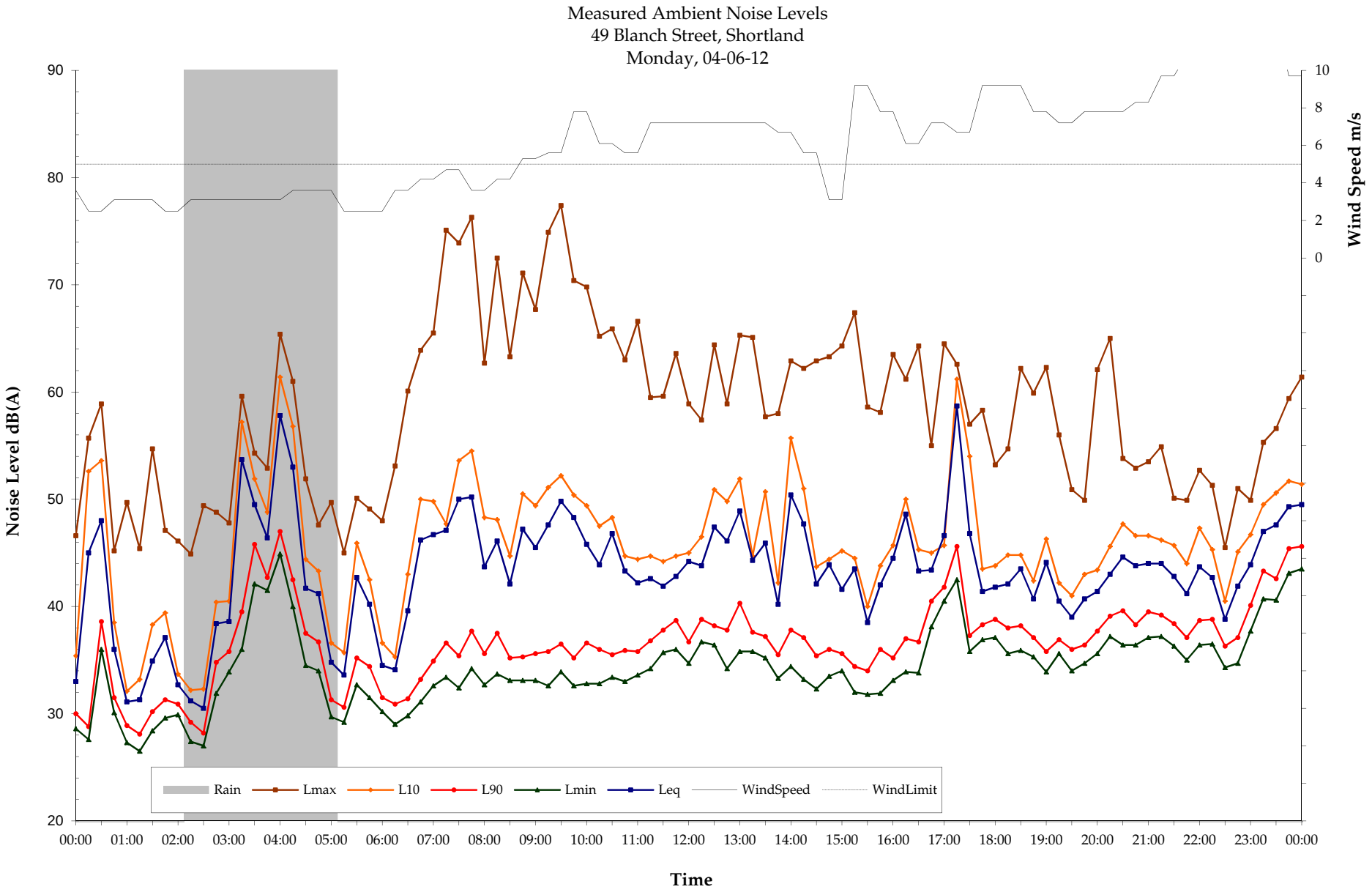
Measured Ambient Noise Levels
49 Blanch Street, Shortland
Monday, 04-06-12
Noise Level dB(A)
Wind Speed m/s
Time
Rain
Lmax
L10
L90
Lmin
Leq
WindSpeed
WindLimit
90
80
70
60
50
40
30
20
10
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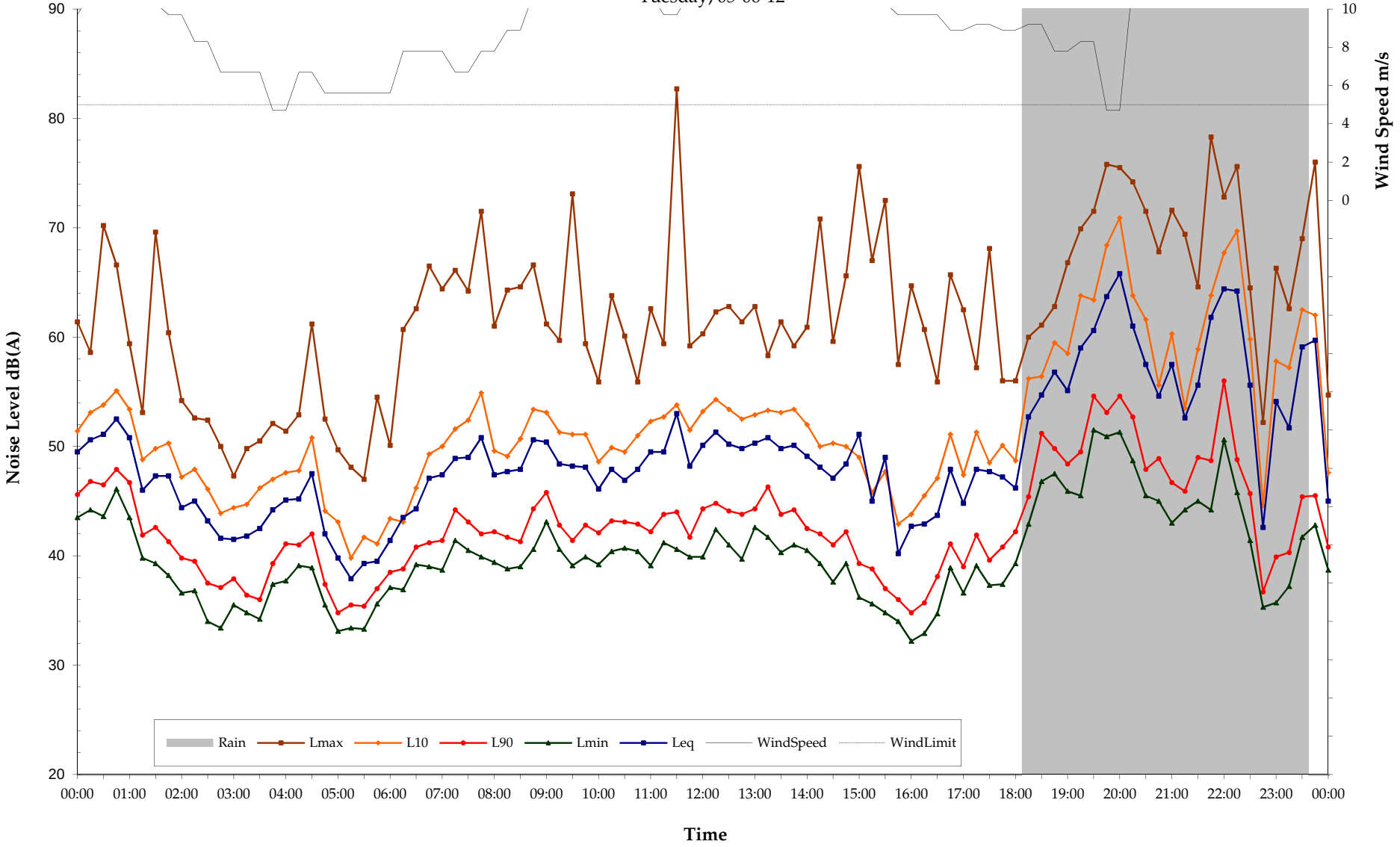
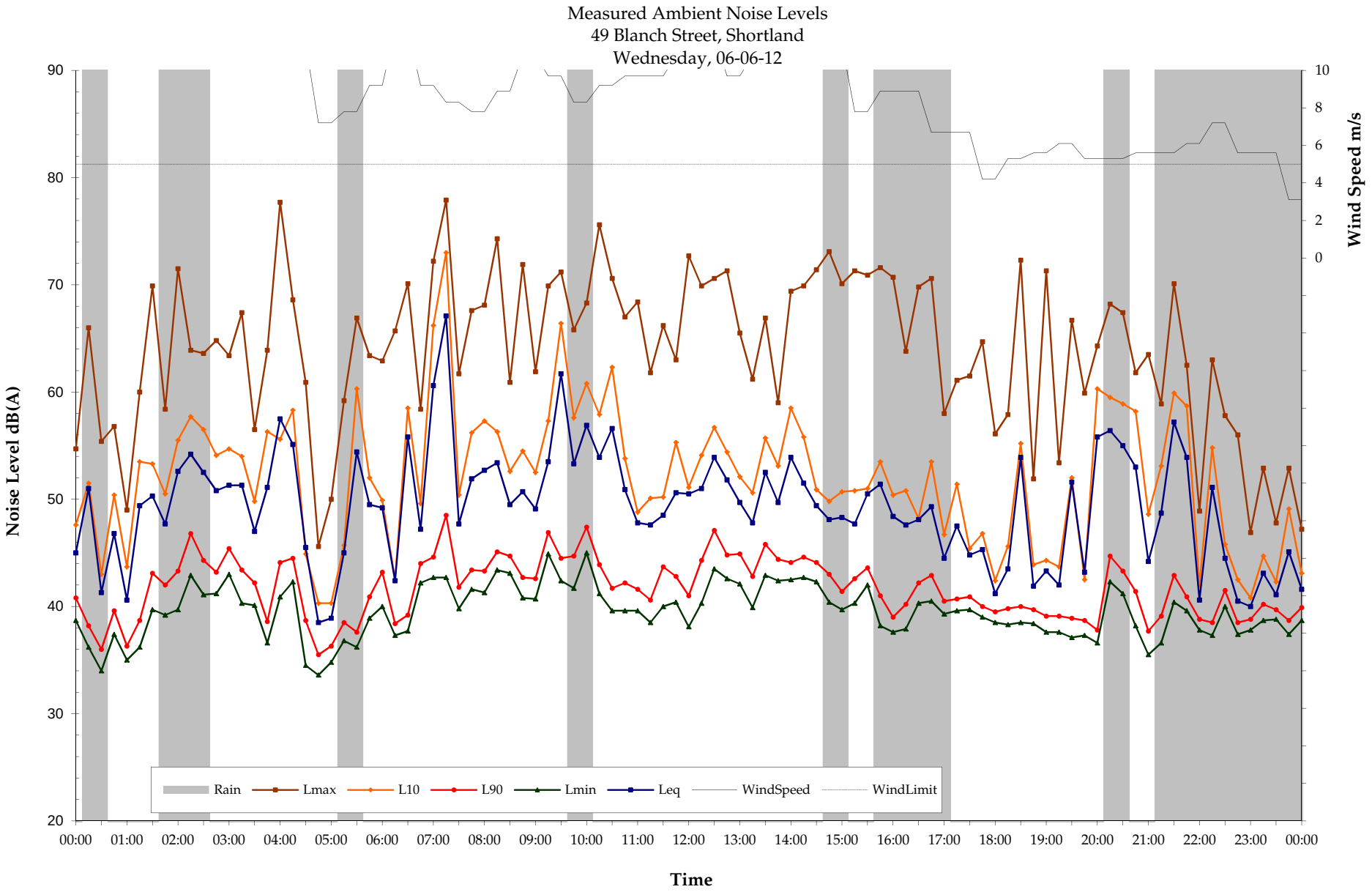
Measured Ambient Noise Levels
49 Blanch Street, Shortland
Tuesday, 05-06-12




Measured Ambient Noise Levels
49 Blanch Street, Shortland
Wednesday, 06-06-12
Noise Level dB(A)
Wind Speed m/s
Time
Rain
Lmax
L10
L90
Lmin
Leq
WindSpeed
WindLimit
90
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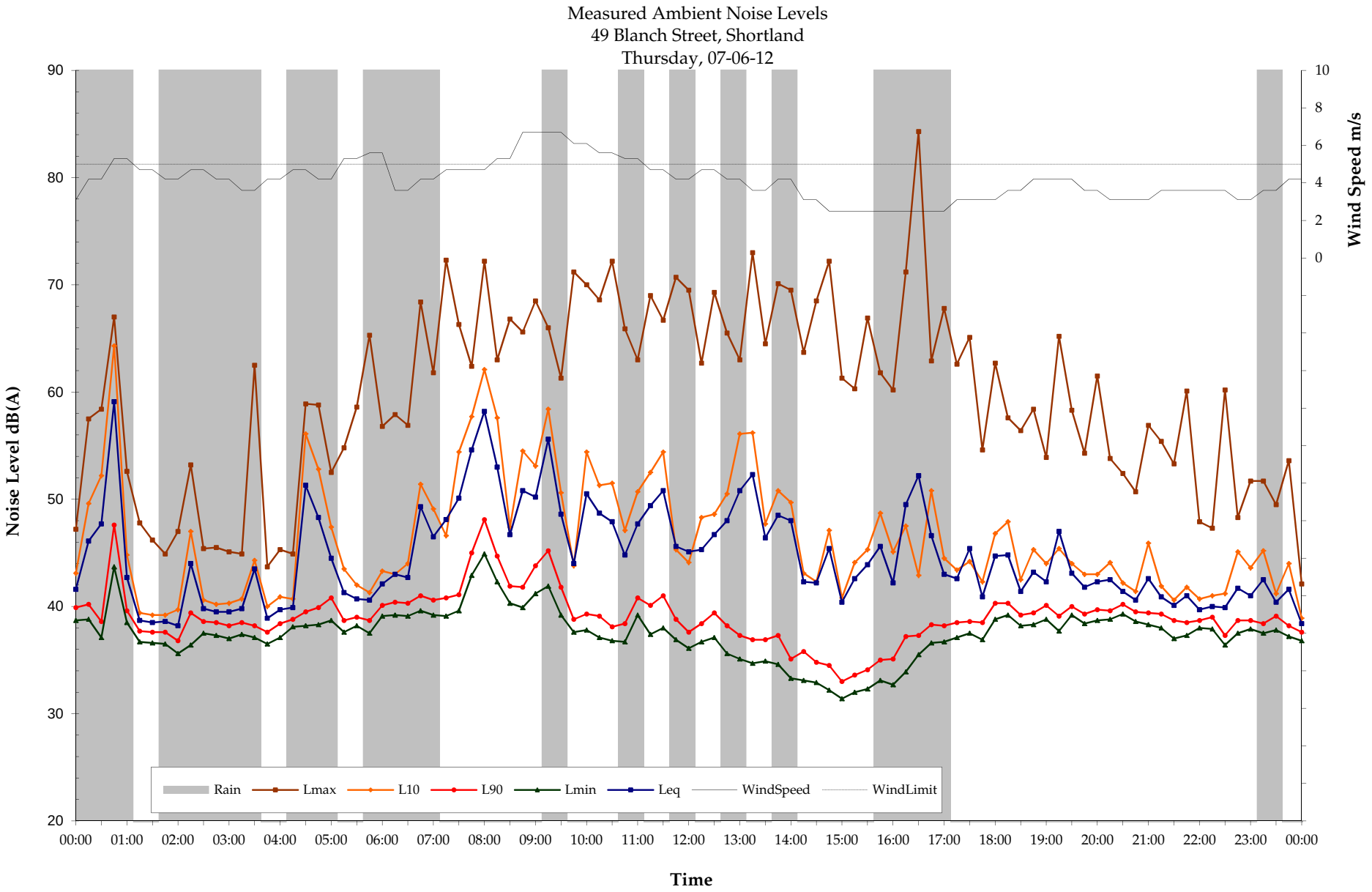
Measured Ambient Noise Levels
49 Blanch Street, Shortland
Thursday, 07-06-12
Noise Level dB(A)
Wind Speed m/s
Time
90
80
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40
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Rain
Lmax
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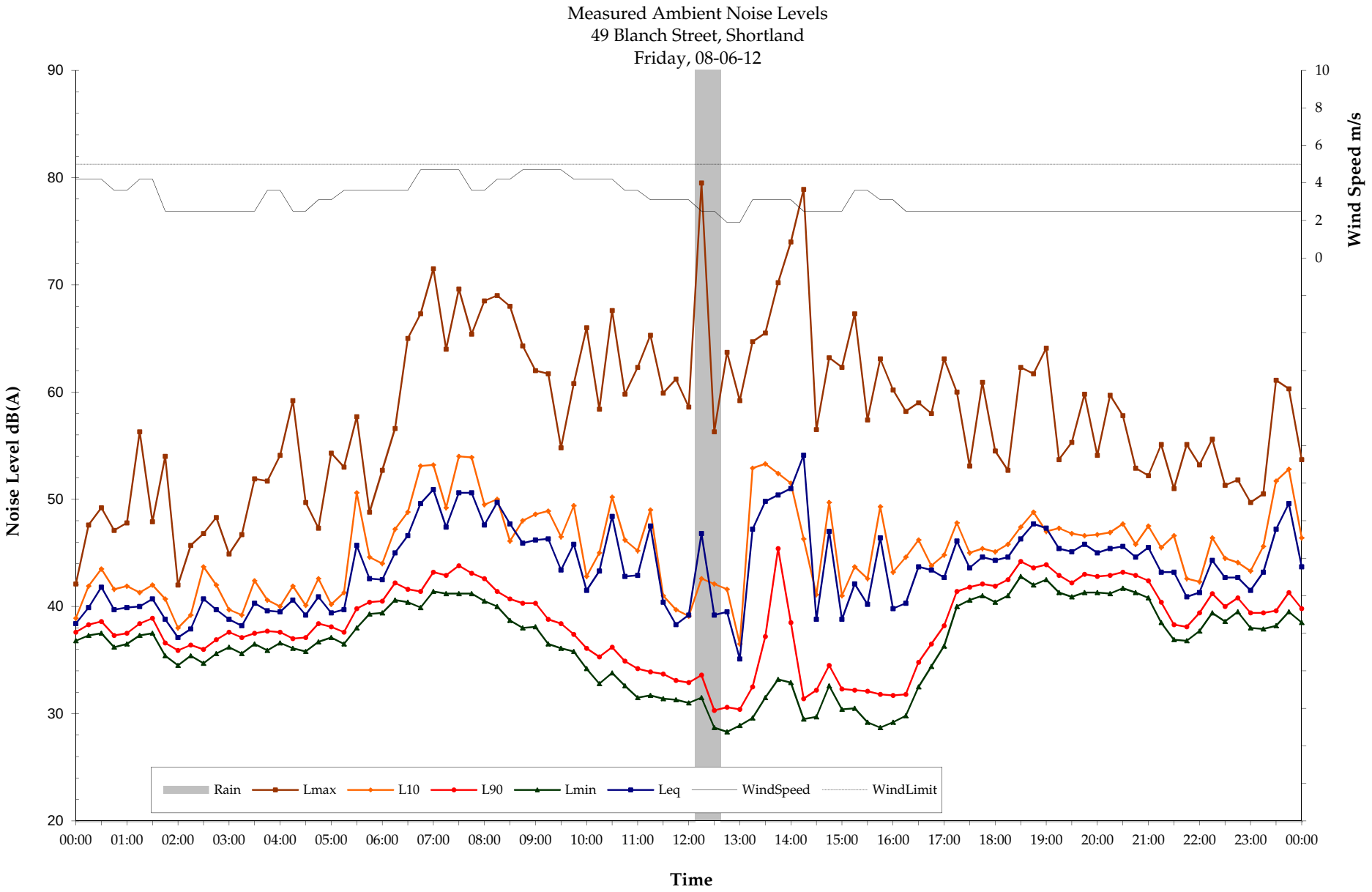
Lmin
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
49 Blanch Street, Shortland
Friday, 08-06-12
Noise Level dB(A)
Wind Speed m/s
Time
90
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40
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20
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Rain
Lmax
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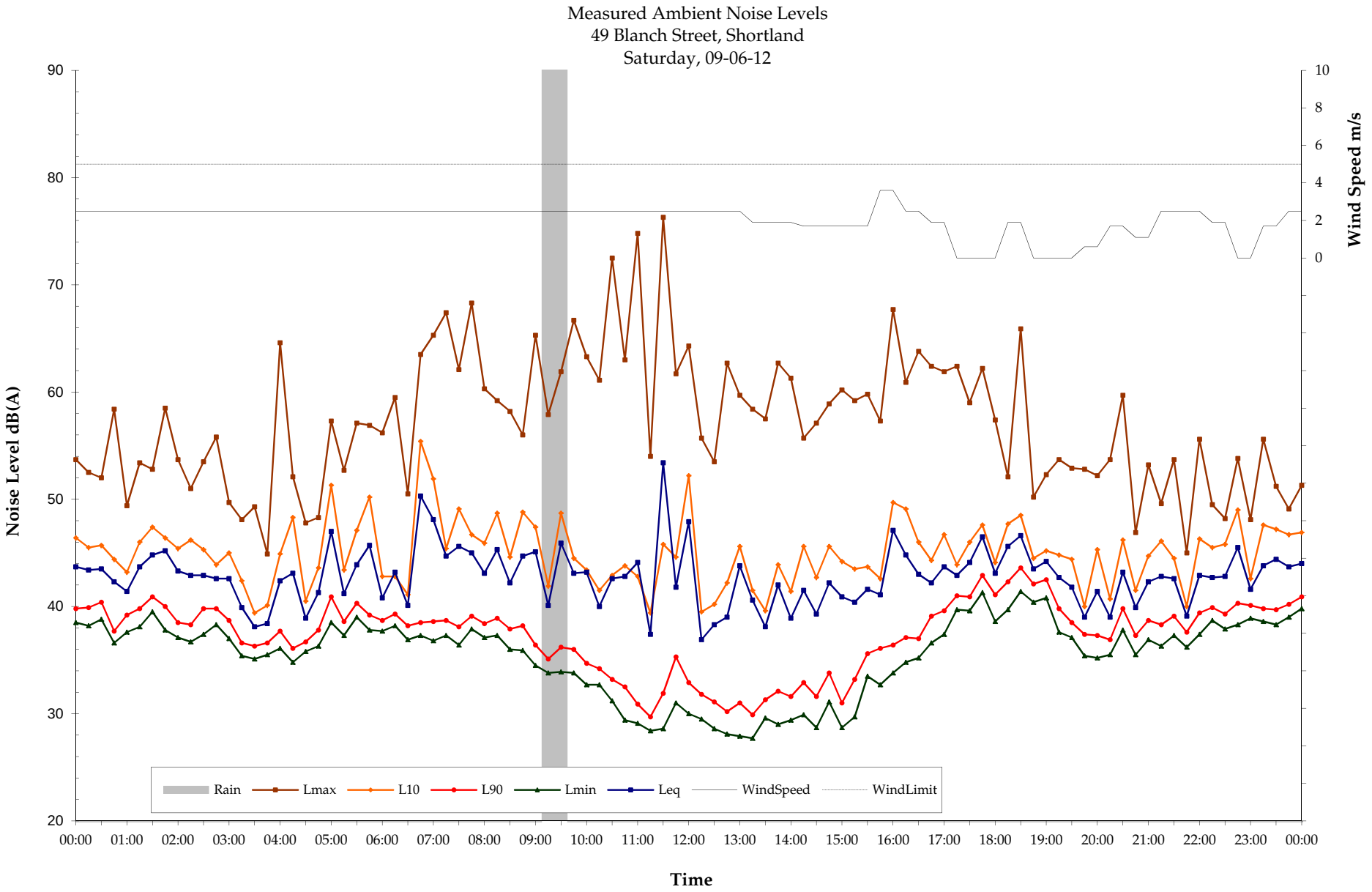
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
49 Blanch Street, Shortland
Saturday, 09-06-12
Noise Level dB(A)
Wind Speed m/s
Time
90
80
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50
40
30
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10
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Rain
Lmax
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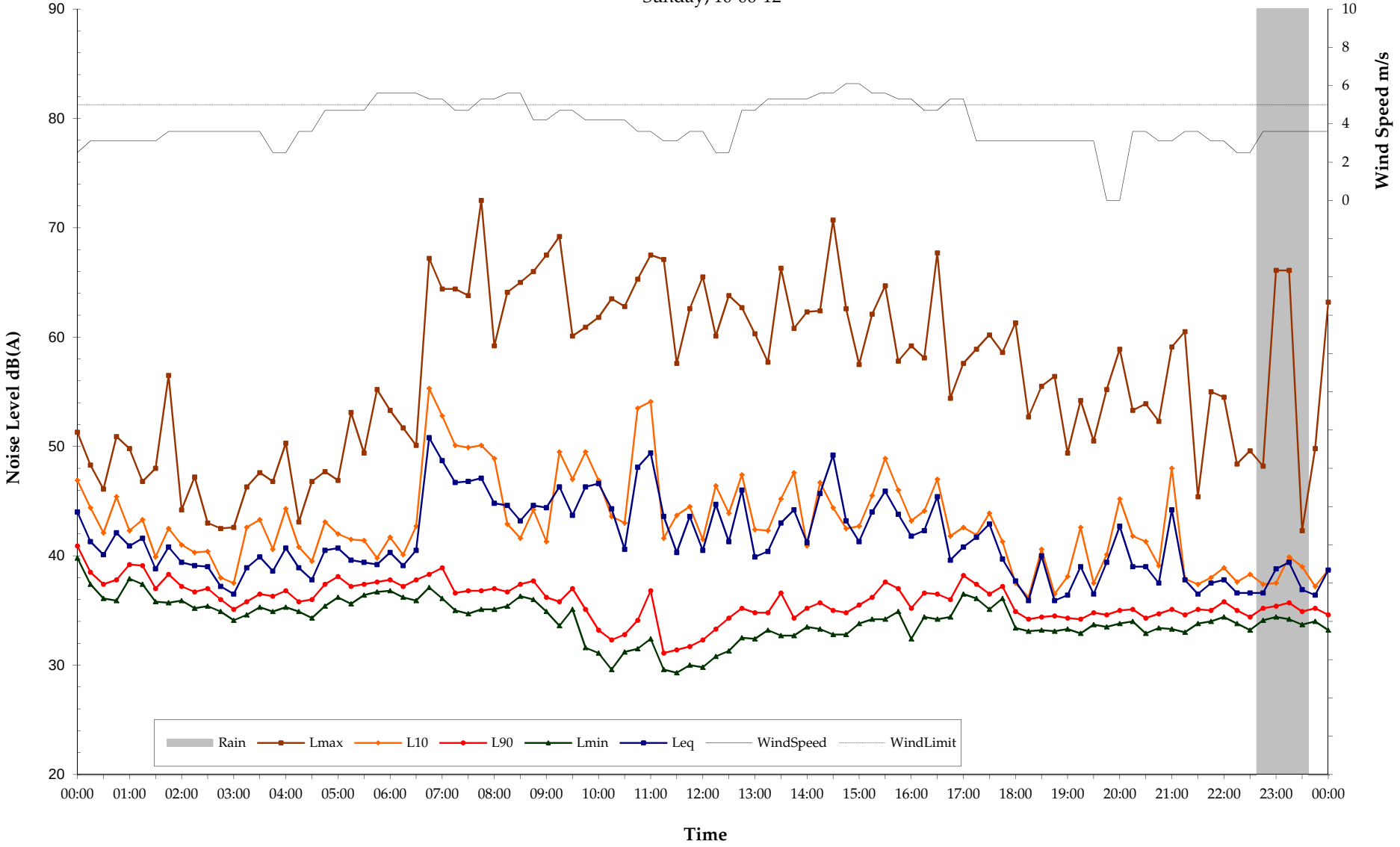
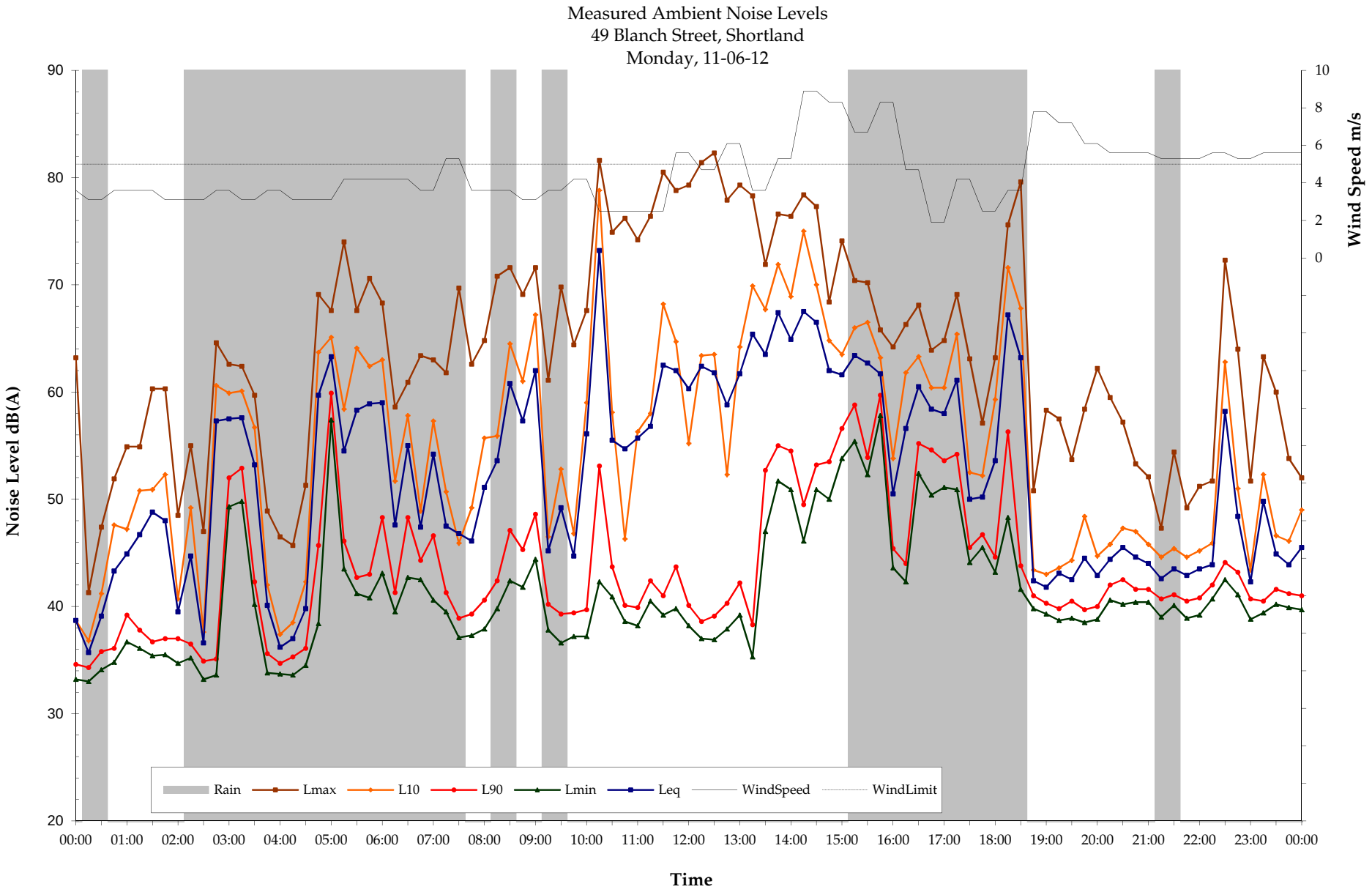
Lmin
Leq
WindSpeed
WindLimit

Measured Ambient Noise Levels
49 Blanch Street, Shortland
Sunday, 10-06-12




Measured Ambient Noise Levels
49 Blanch Street, Shortland
Monday, 11-06-12
Noise Level dB(A)
Wind Speed m/s
Time
Rain
Lmax
L10
L90
Lmin
Leq
WindSpeed
WindLimit
90
80
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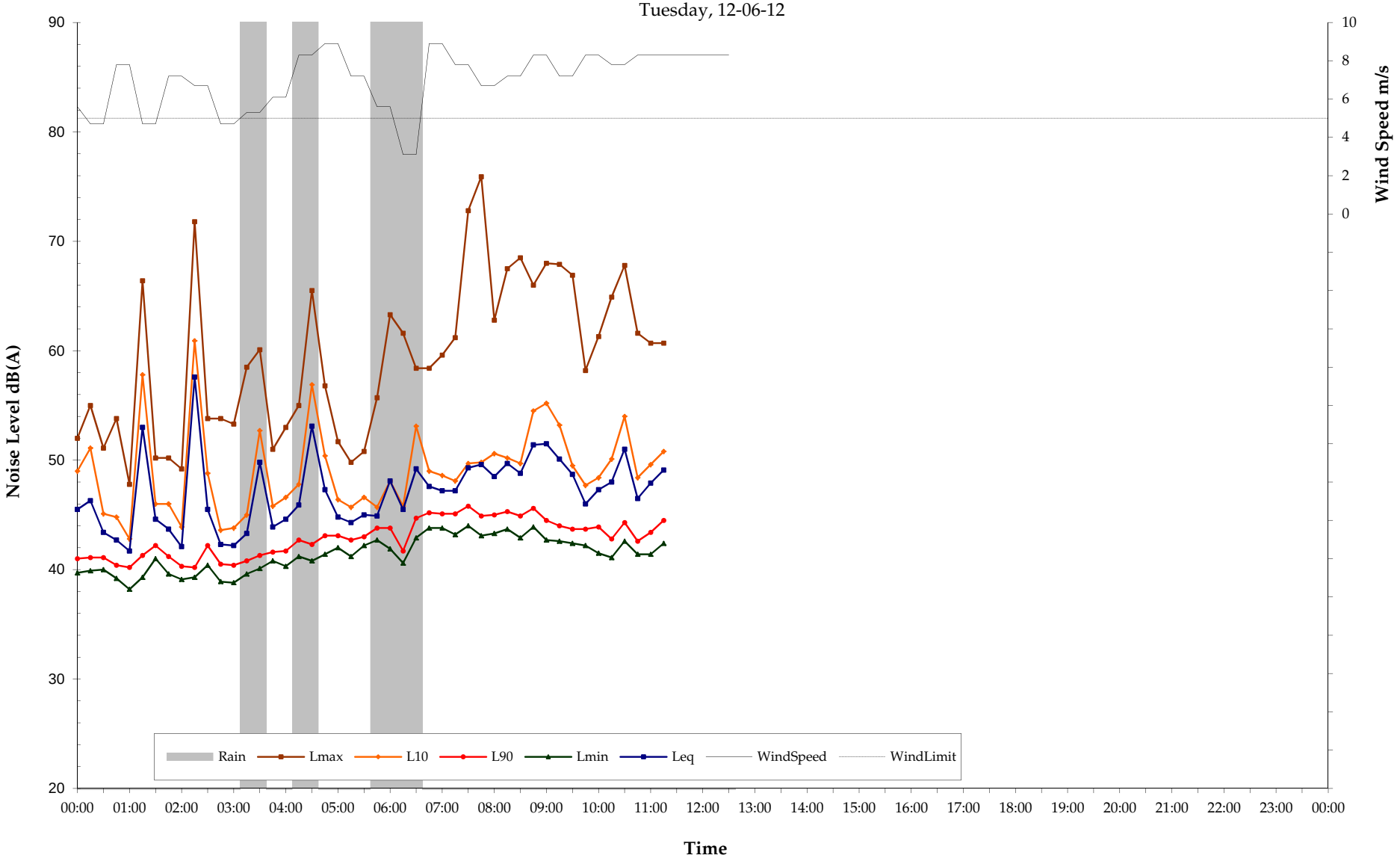
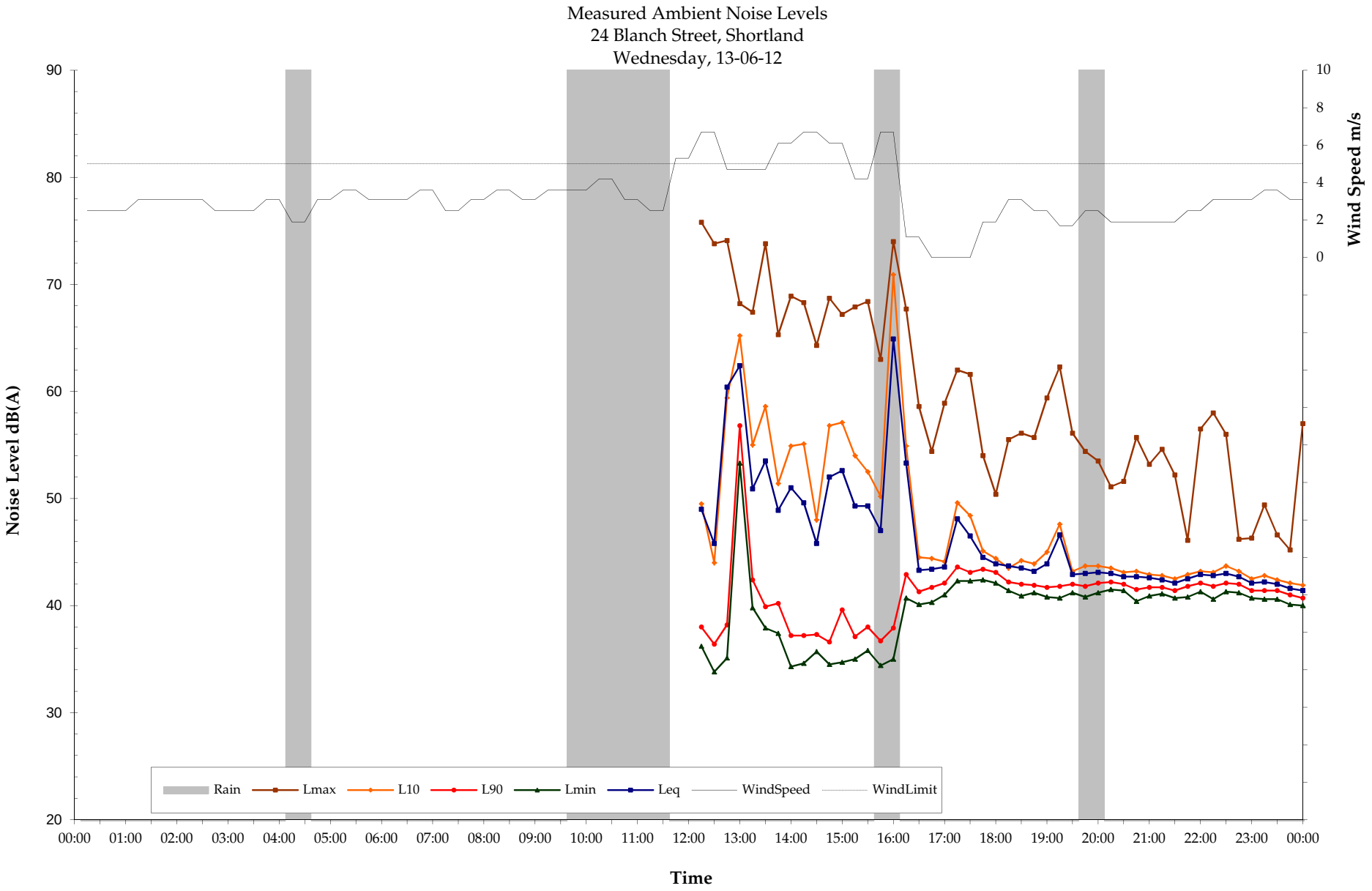
Measured Ambient Noise Levels
49 Blanch Street, Shortland
Tuesday, 12-06-12




Measured Ambient Noise Levels
24 Blanch Street, Shortland
Wednesday, 13-06-12
Noise Level dB(A)
Wind Speed m/s
Time
90
80
70
60
50
40
30
20
10
8
6
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03:00
04:00
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Rain
Lmax
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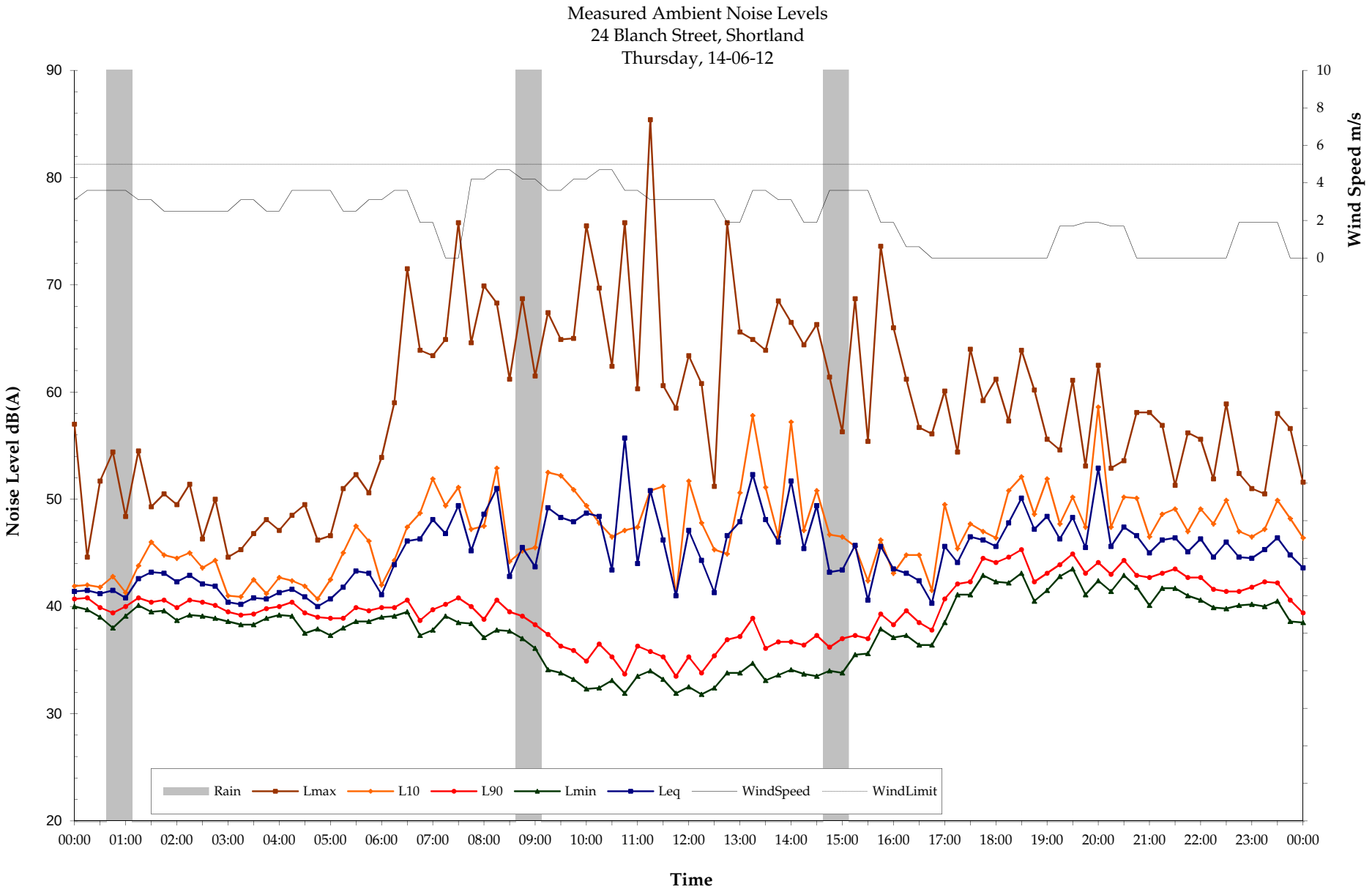
Lmin
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
24 Blanch Street, Shortland
Thursday, 14-06-12
Noise Level dB(A)
Wind Speed m/s
Time
90
80
70
60
50
40
30
20
10
8
6
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22:00
23:00
00:00
Rain
Lmax
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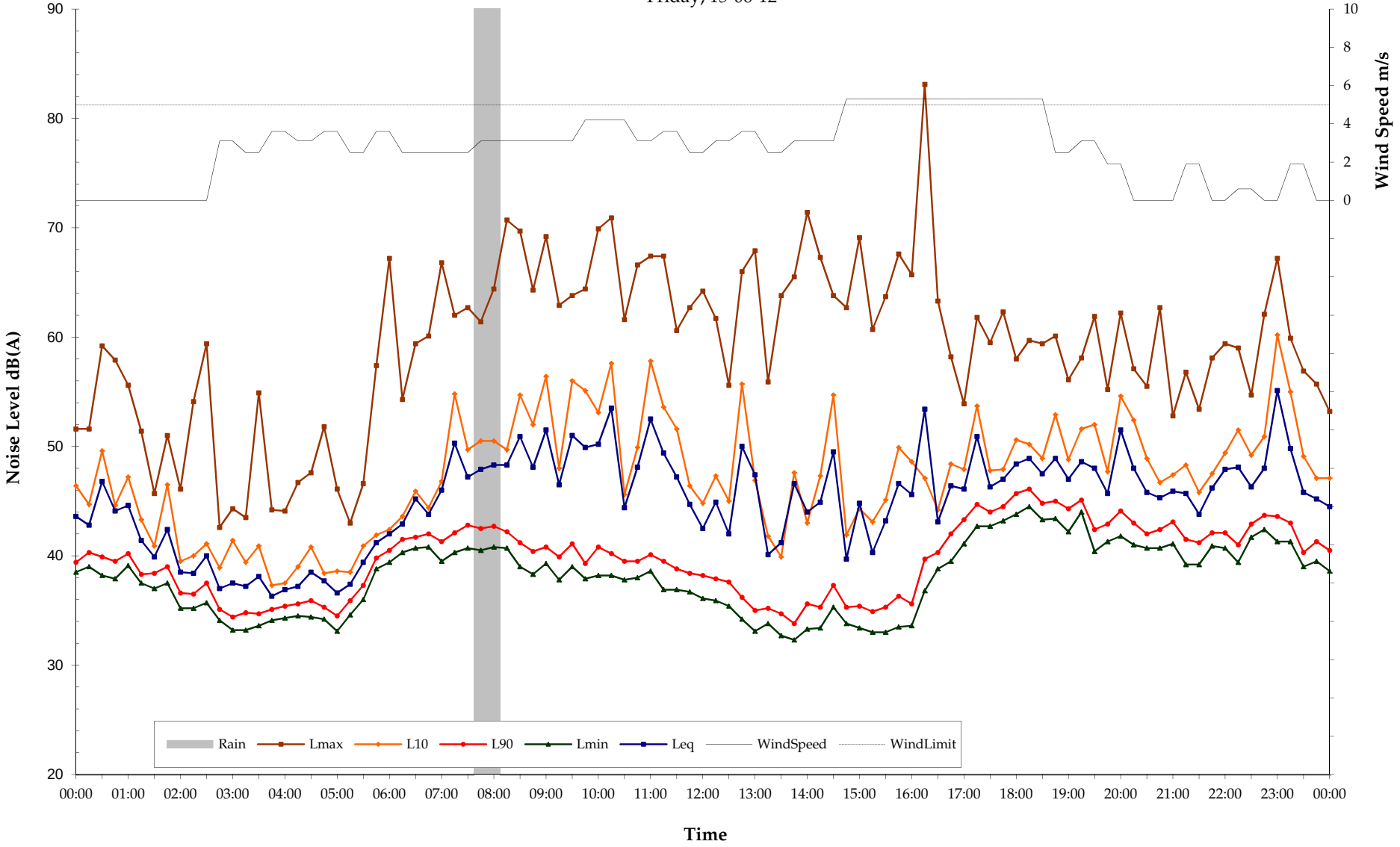
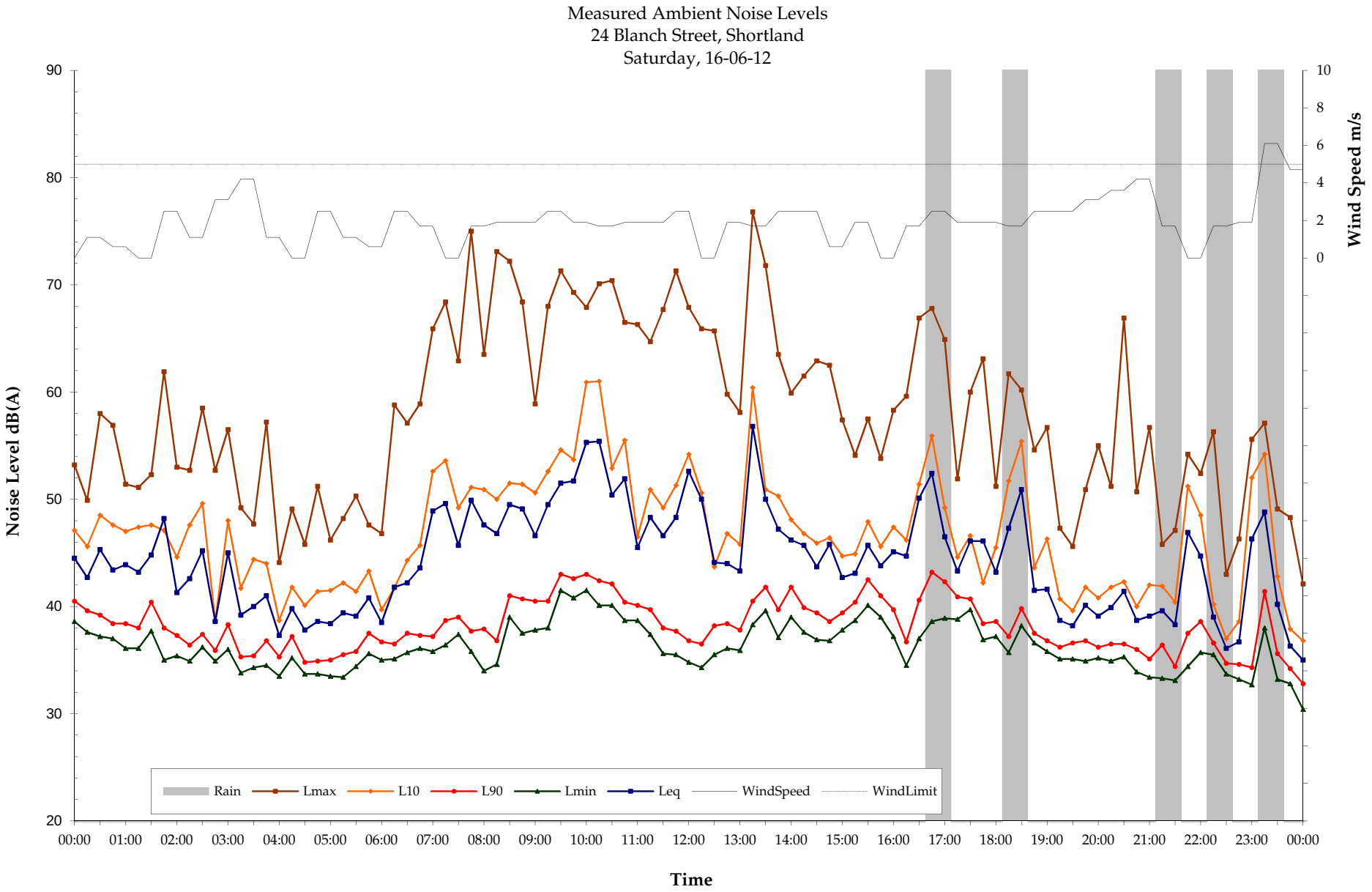
L90
Lmin
Leq
WindSpeed
WindLimit

Measured Ambient Noise Levels
24 Blanch Street, Shortland
Friday, 15-06-12




Measured Ambient Noise Levels
24 Blanch Street, Shortland
Saturday, 16-06-12
Noise Level dB(A)
Wind Speed m/s
Time
90
80
70
60
50
40
30
20
10
8
6
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00:00
Rain
Lmax
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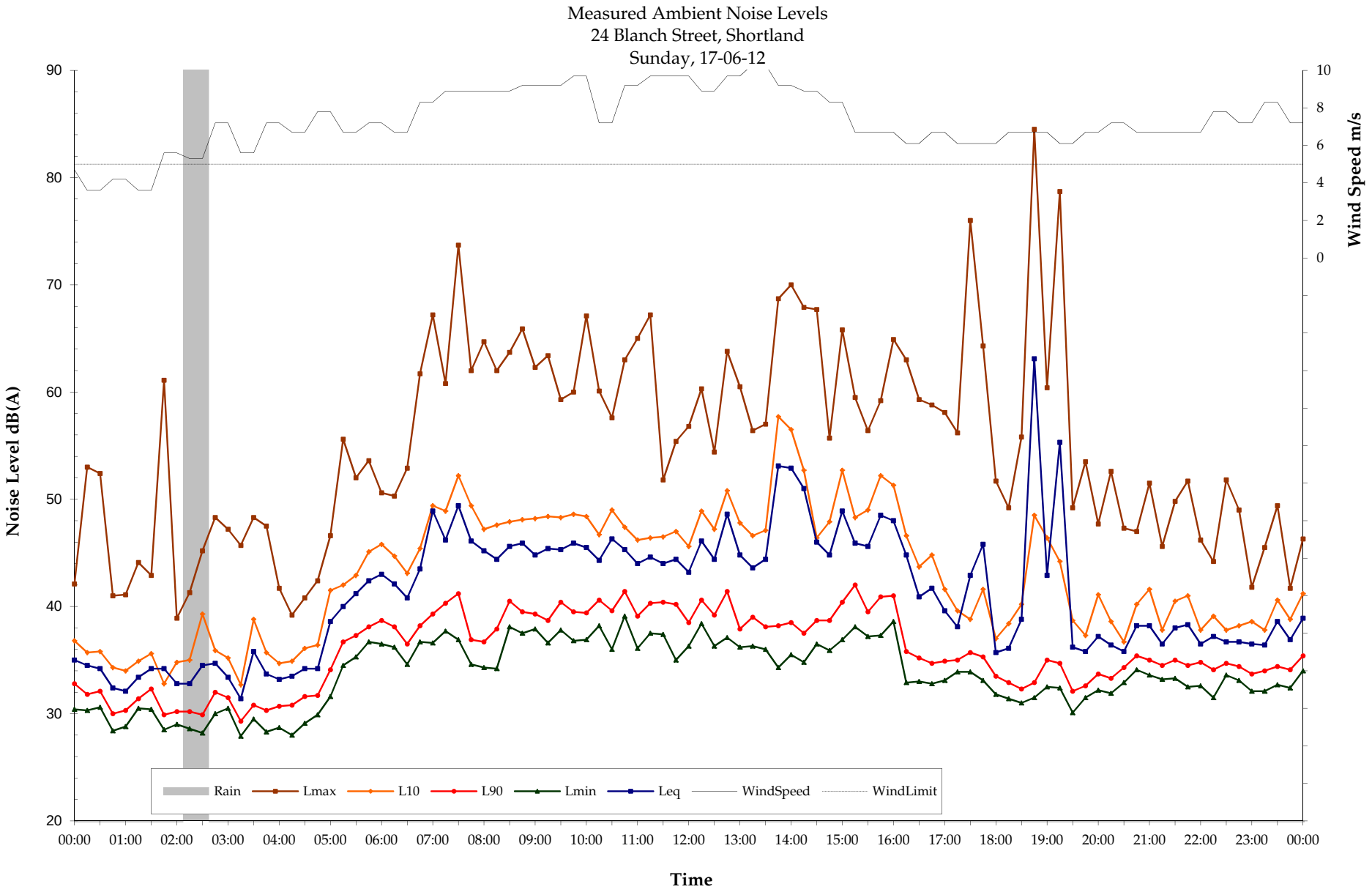
Leq
WindSpeed
WindLimit


Measured Ambient Noise Levels
24 Blanch Street, Shortland
Sunday, 17-06-12
Noise Level dB(A)
Wind Speed m/s
Time
90
80
70
60
50
40
30
20
10
8
6
4
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00:00
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Rain
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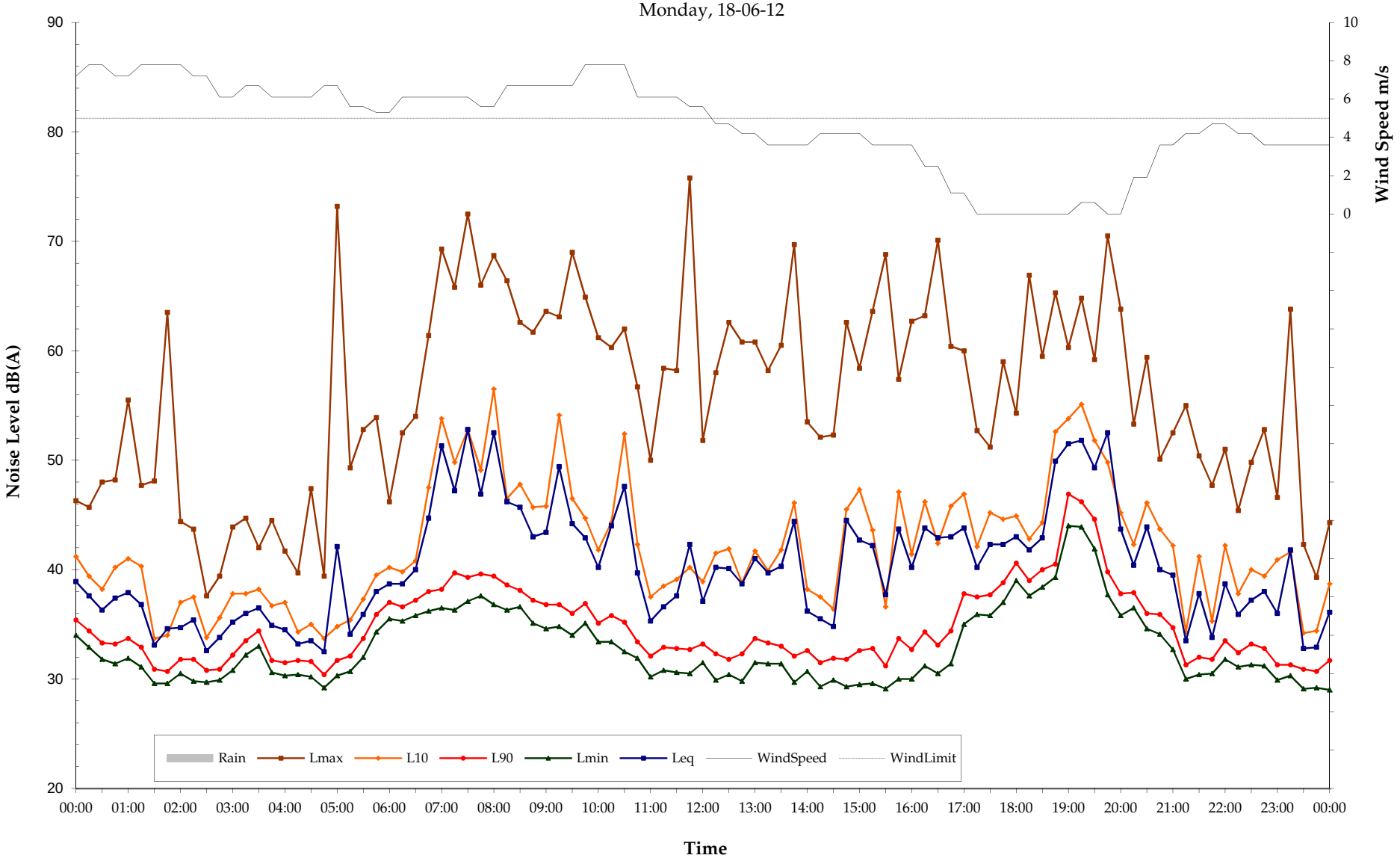
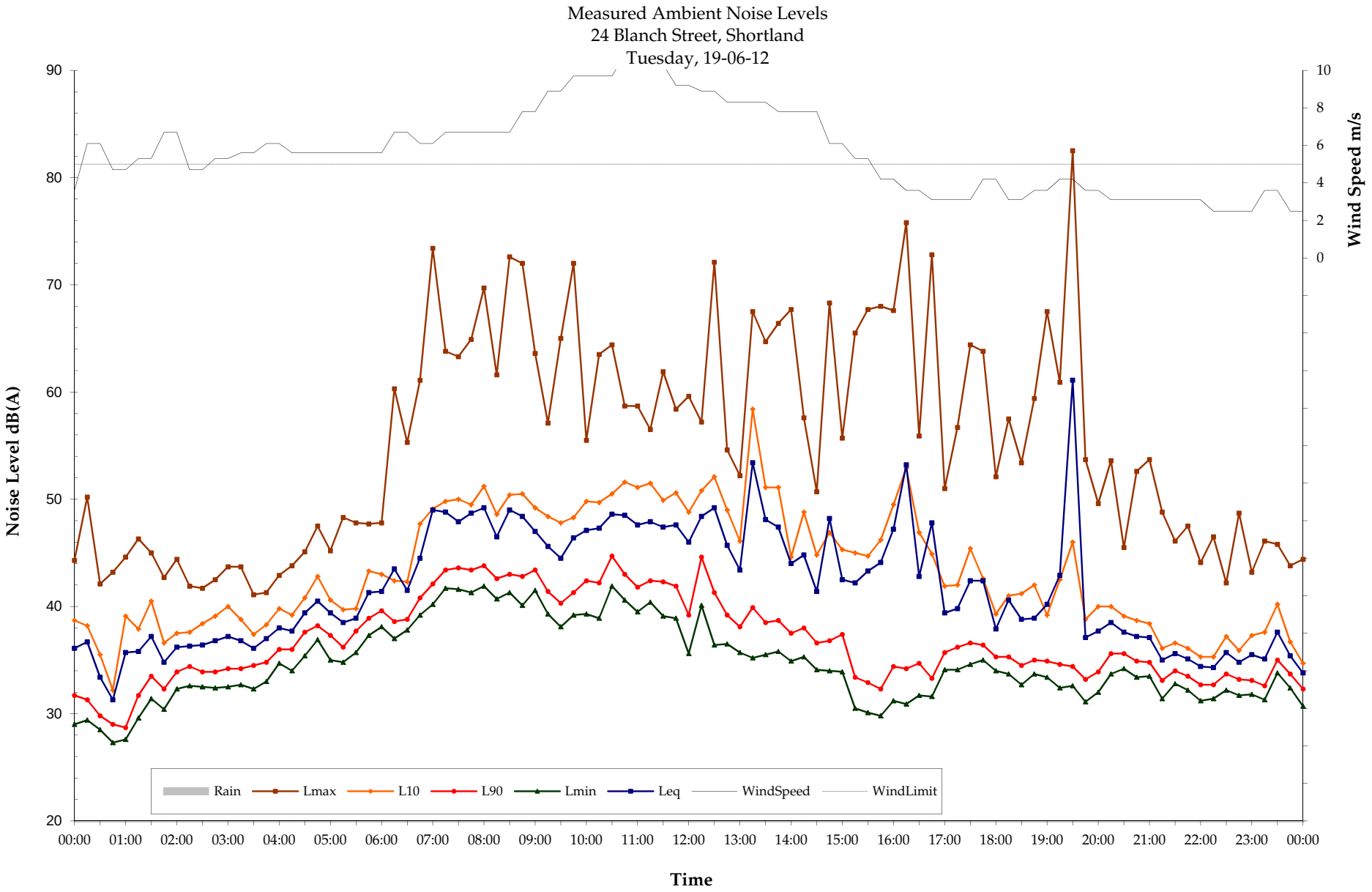
Leq
WindSpeed
WindLimit

Measured Ambient Noise Levels
24 Blanch Street, Shortland
Monday, 18-06-12




Measured Ambient Noise Levels
24 Blanch Street, Shortland
Tuesday, 19-06-12
Noise Level dB(A)
Wind Speed m/s
Time
90
80
70
60
50
40
30
20
10
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Rain
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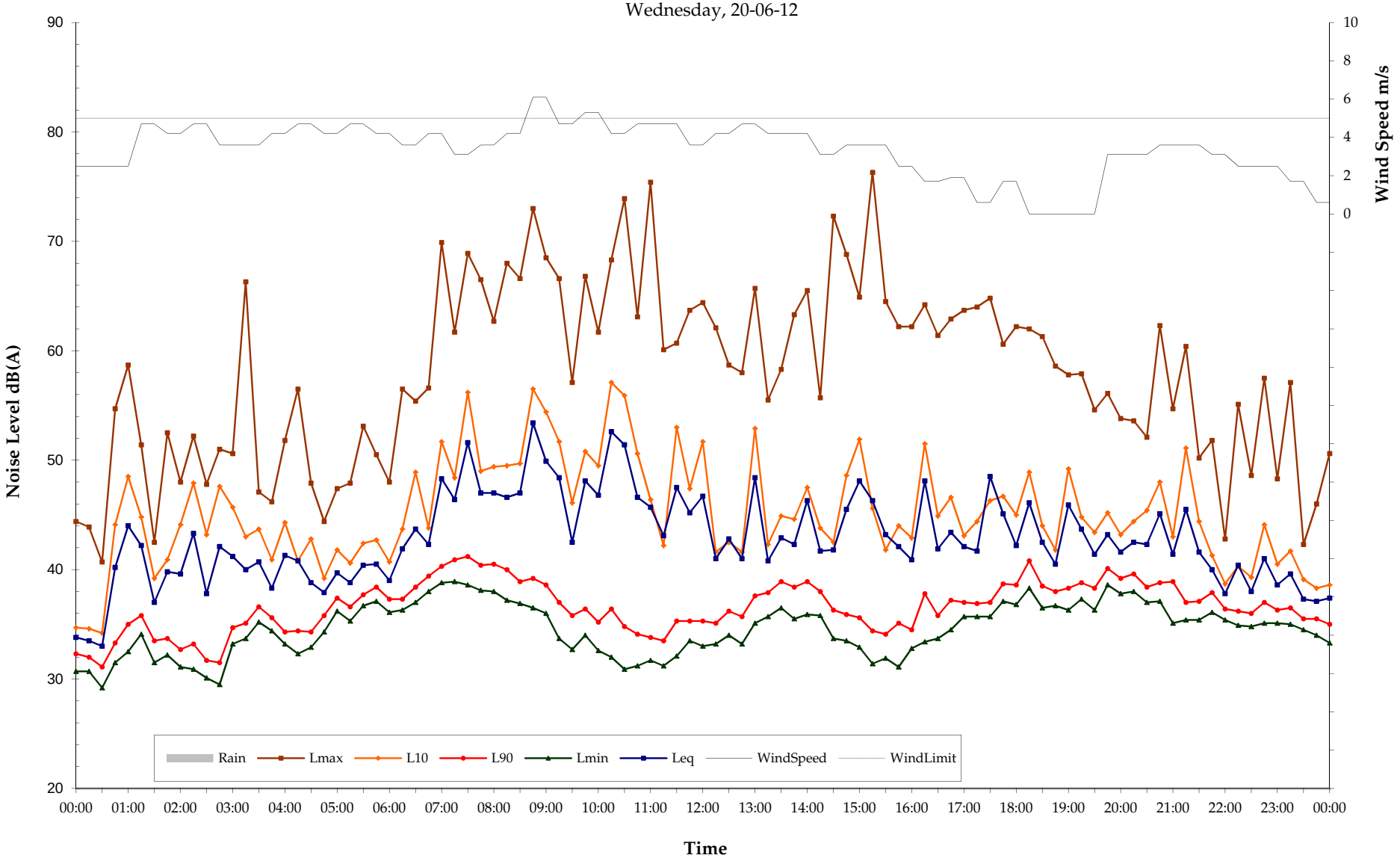
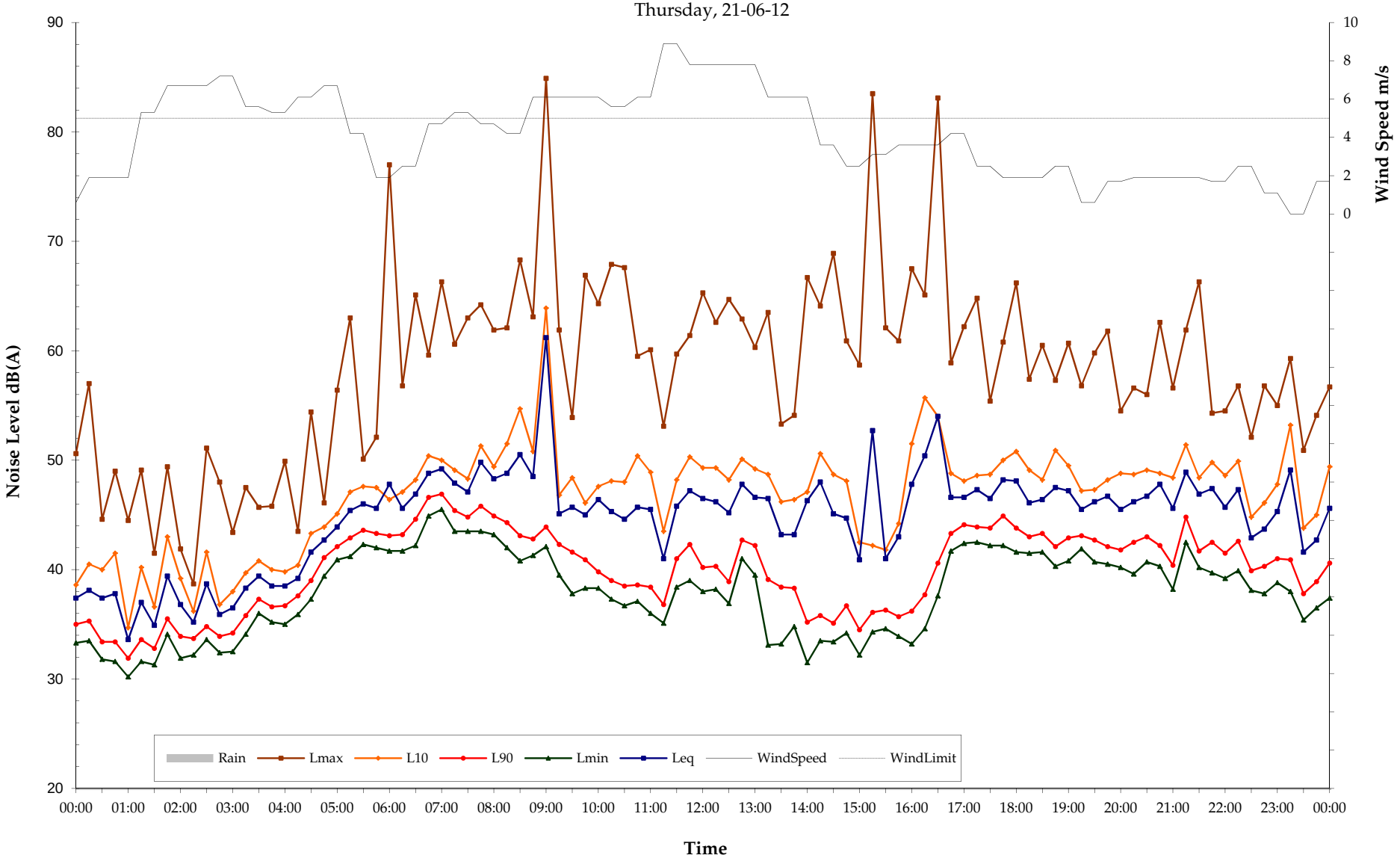
Lmin
Leq
WindSpeed
WindLimit

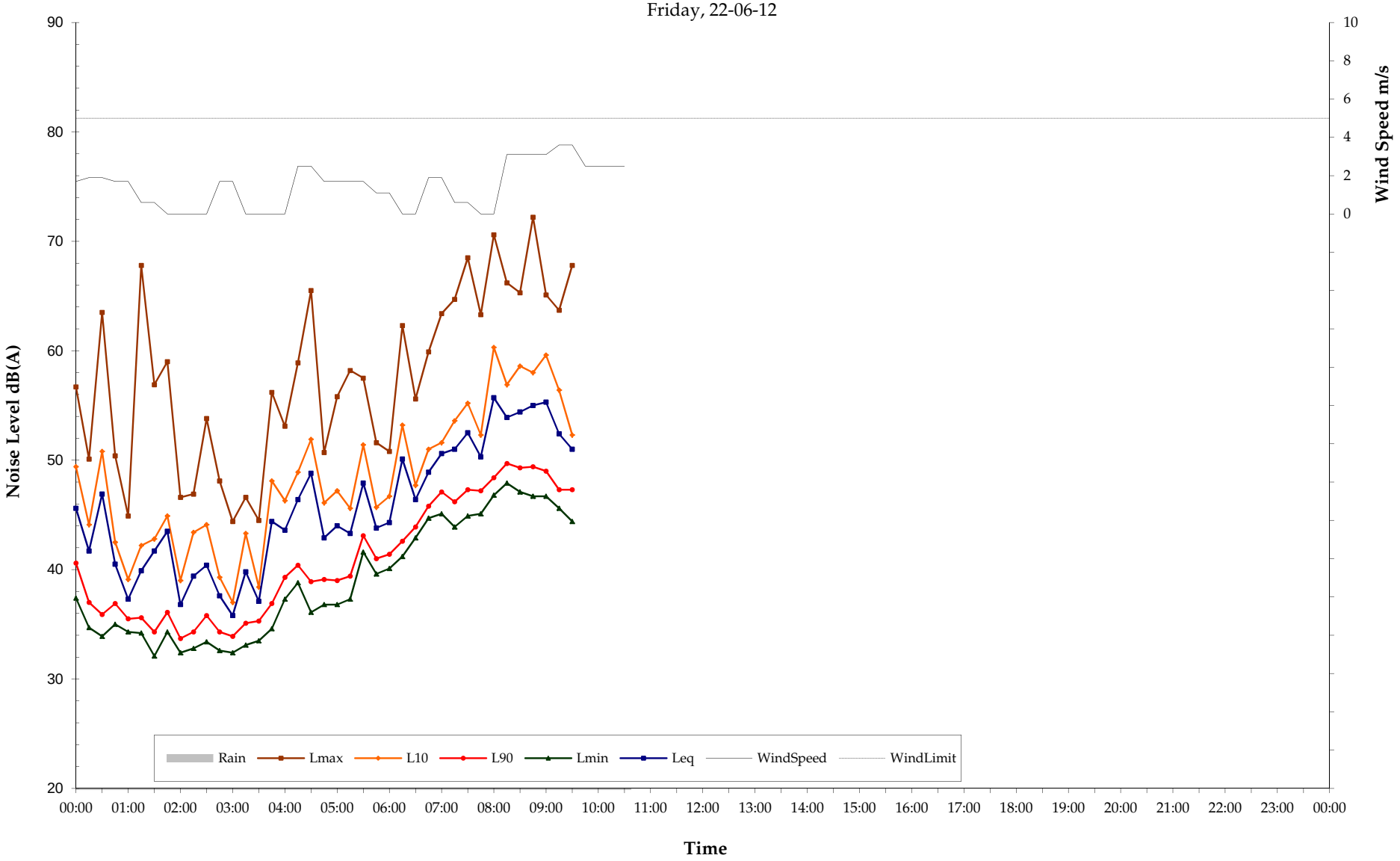
Measured Ambient Noise Levels
24 Blanch Street, Shortland
Wednesday, 20-06-12



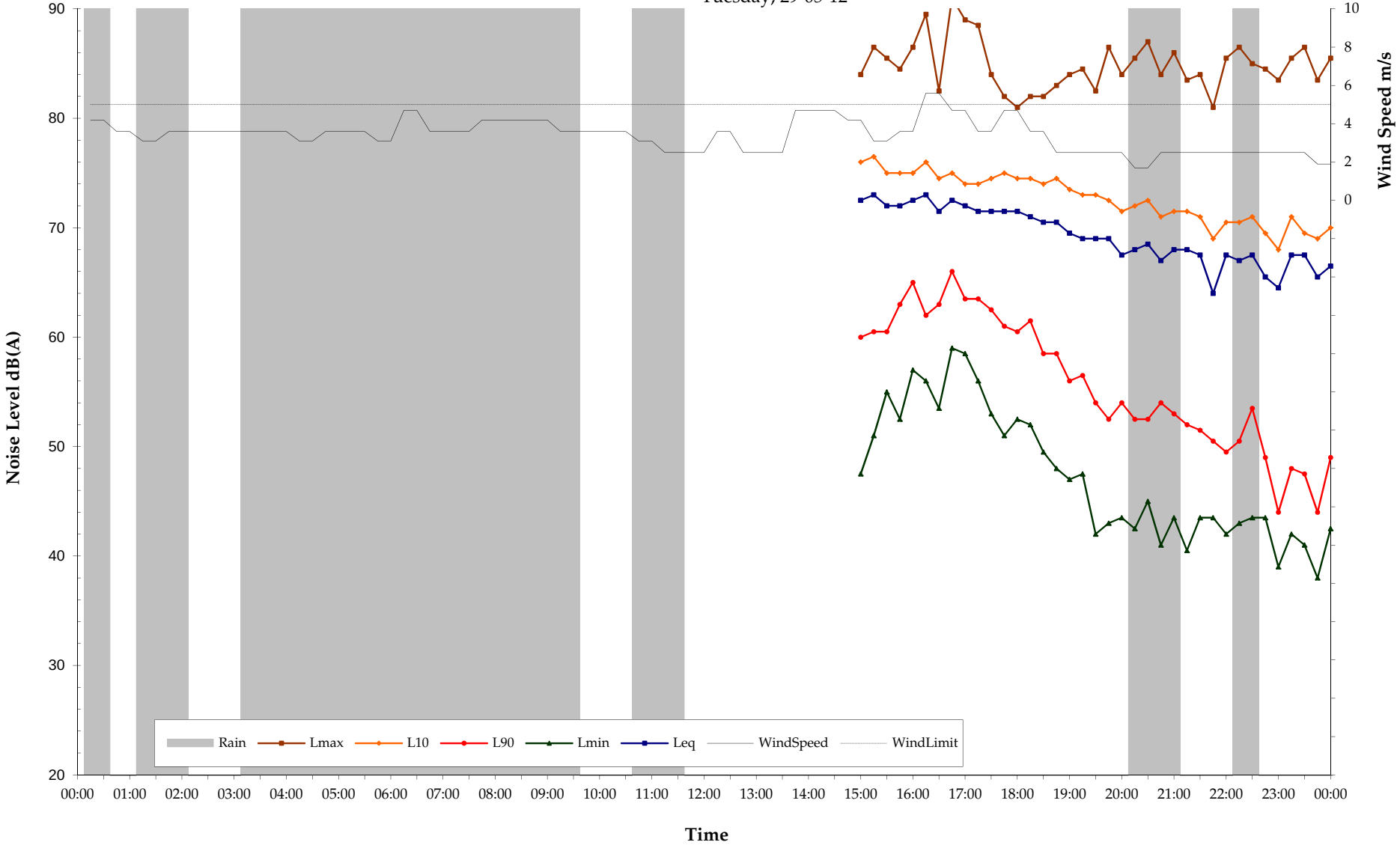
Measured Ambient Noise Levels
24 Blanch Street, Shortland
Thursday, 21-06-12

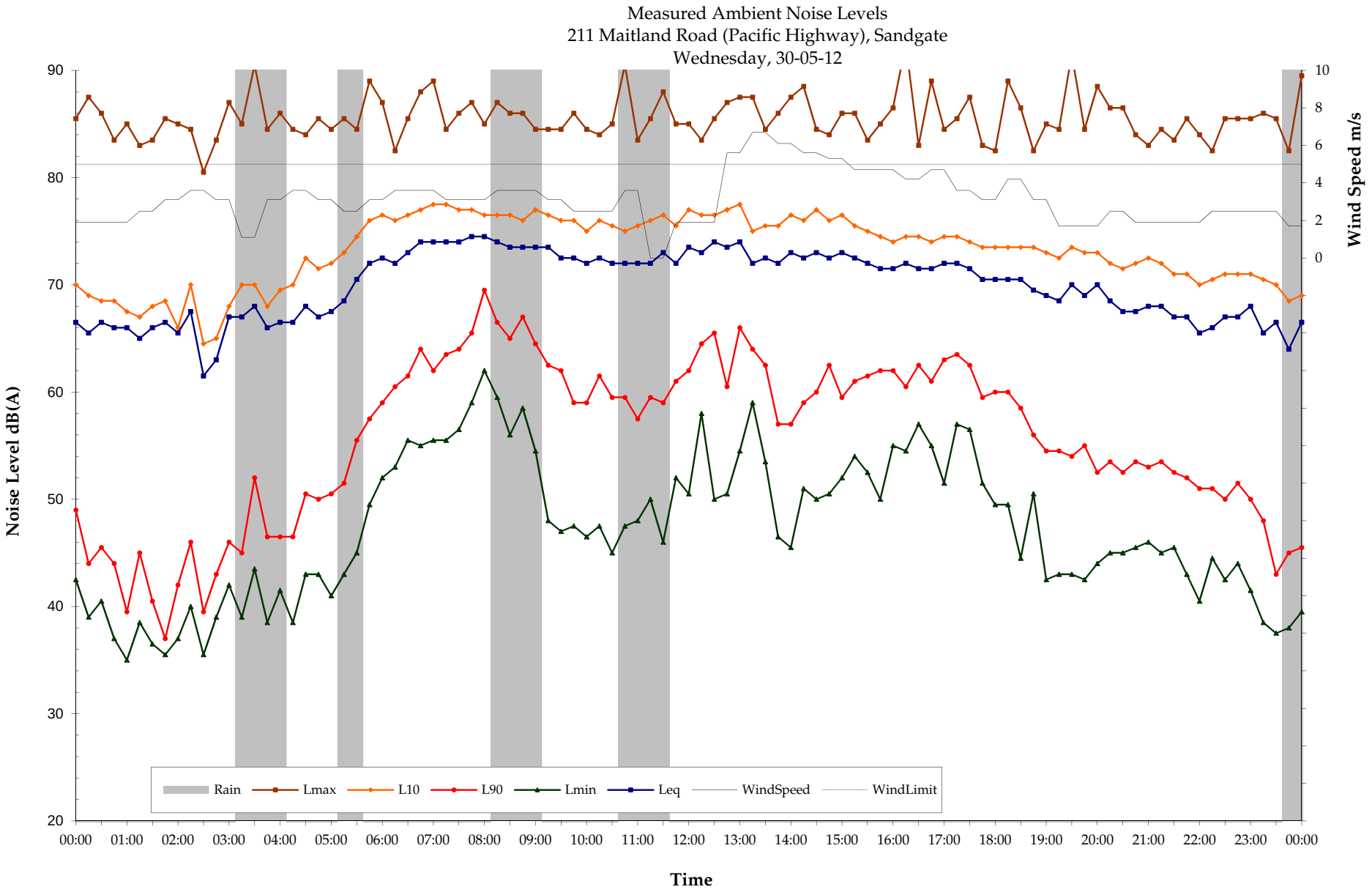


Measured Ambient Noise Levels
24 Blanch Street, Shortland
Friday, 22-06-12



Measured Ambient Noise Levels
211 Maitland Road (Pacific Highway), Sandgate
Tuesday, 29-05-12




Measured Ambient Noise Levels
211 Maitland Road (Pacific Highway), Sandgate
Wednesday, 30-05-12
Noise Level dB(A)
Wind Speed m/s
Time
Rain
Lmax
L10
L90
Lmin
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WindSpeed
WindLimit
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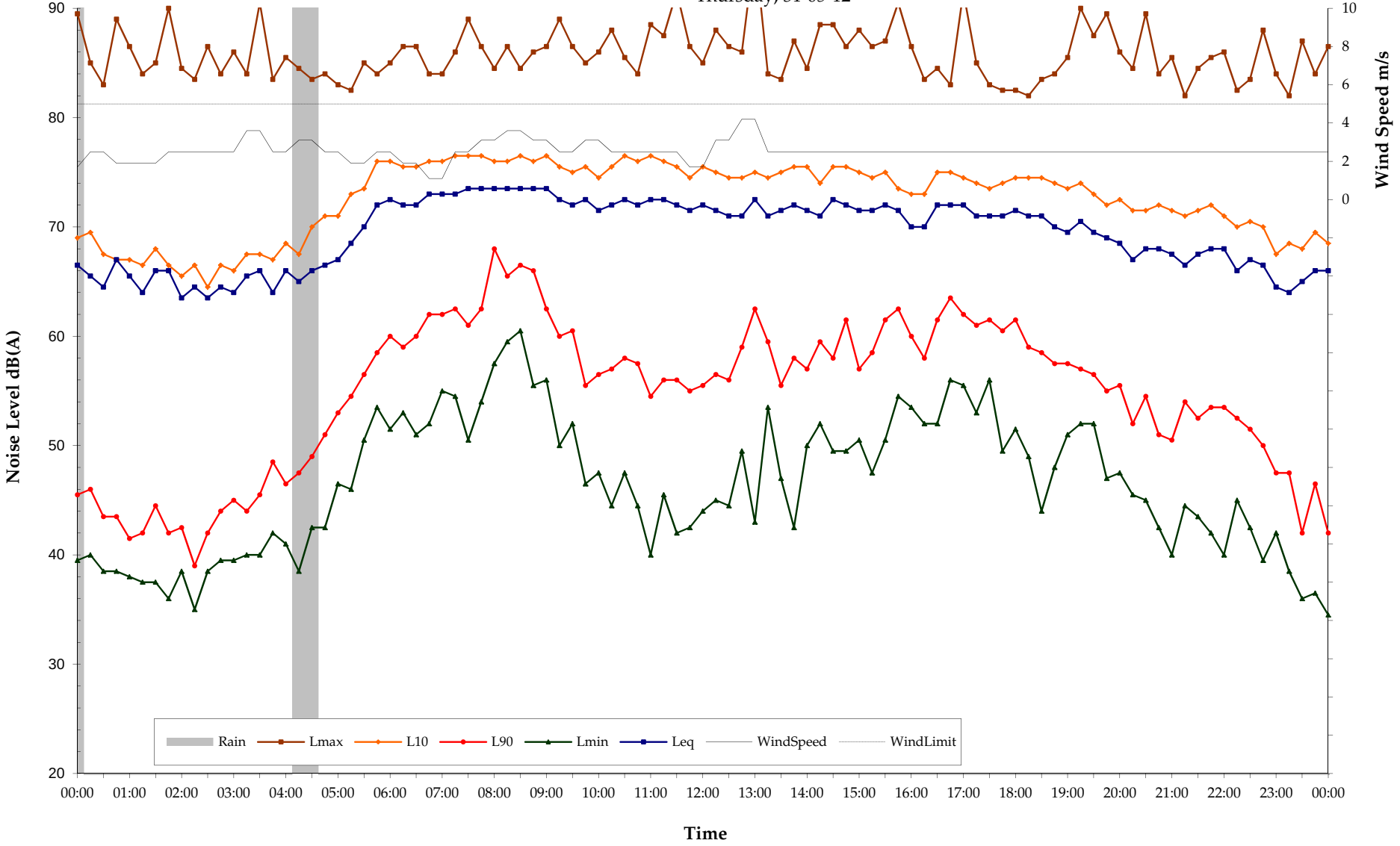
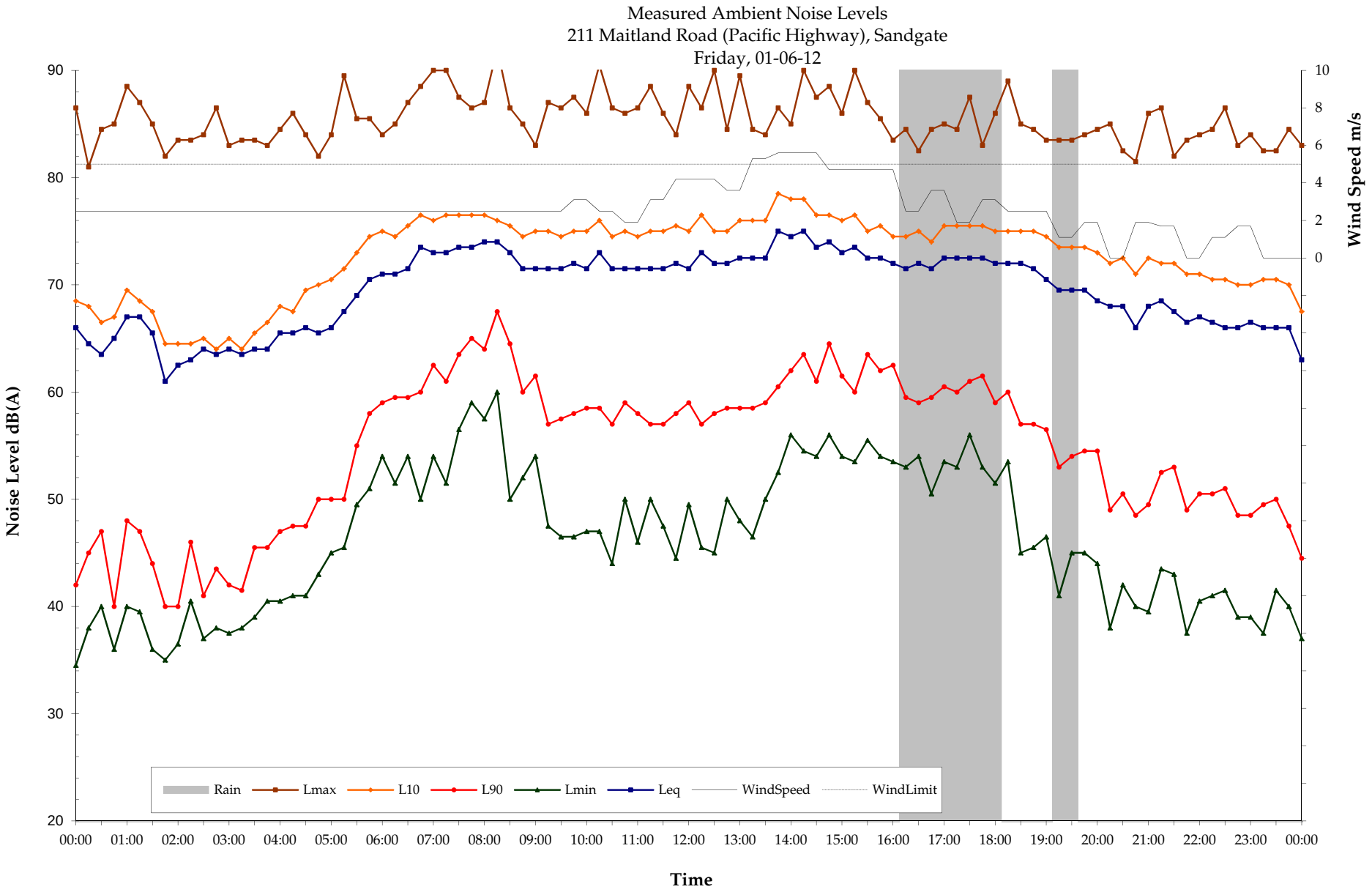
Measured Ambient Noise Levels
211 Maitland Road (Pacific Highway), Sandgate
Thursday, 31-05-12




Measured Ambient Noise Levels
211 Maitland Road (Pacific Highway), Sandgate
Friday, 01-06-12
Noise Level dB(A)
Wind Speed m/s
Time
Rain
Lmax
L10
L90
Lmin
Leq
WindSpeed
WindLimit
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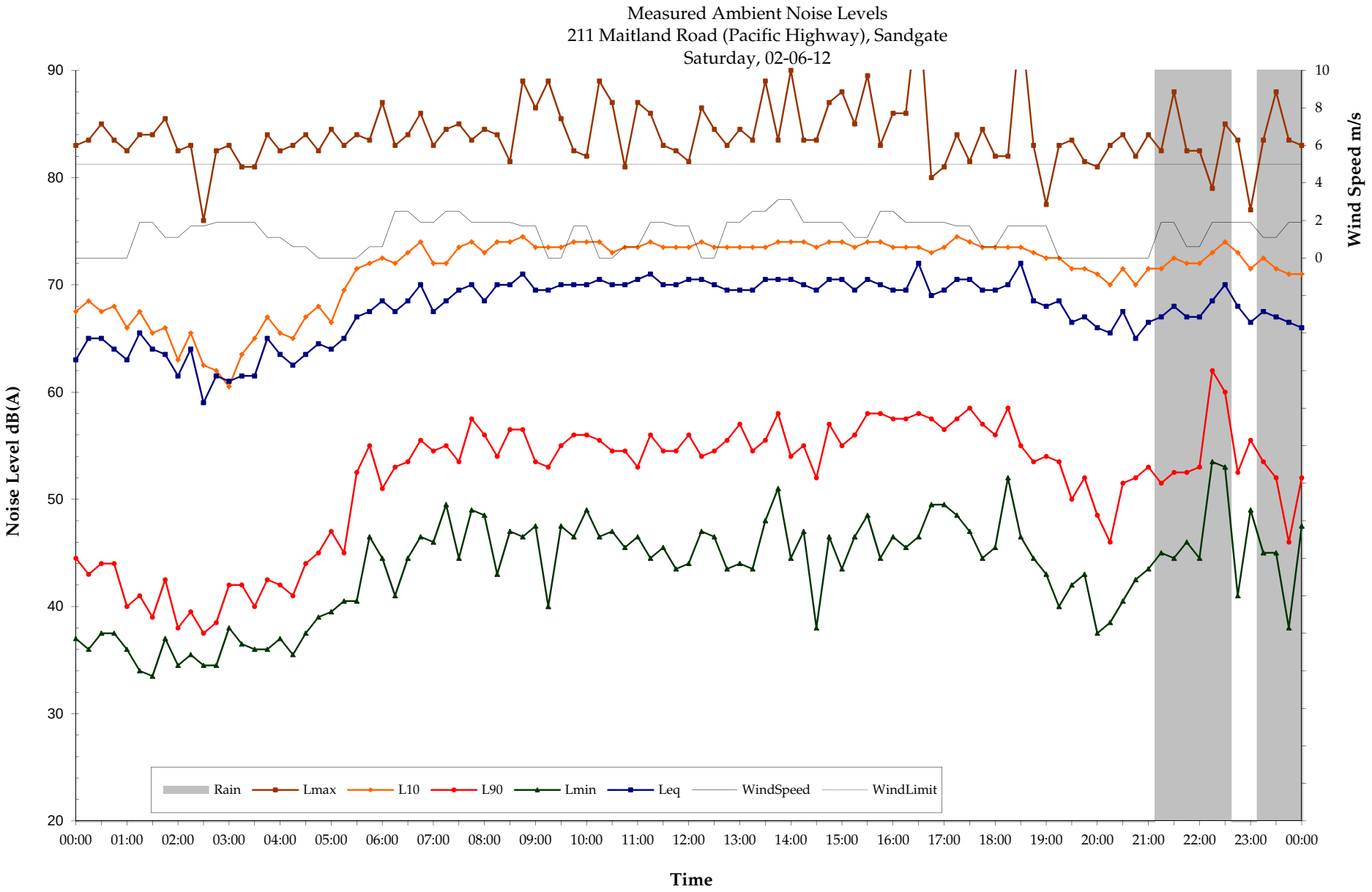
Measured Ambient Noise Levels
211 Maitland Road (Pacific Highway), Sandgate
Saturday, 02-06-12
Noise Level dB(A)
Wind Speed m/s
Time
Rain
Lmax
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WindSpeed
WindLimit
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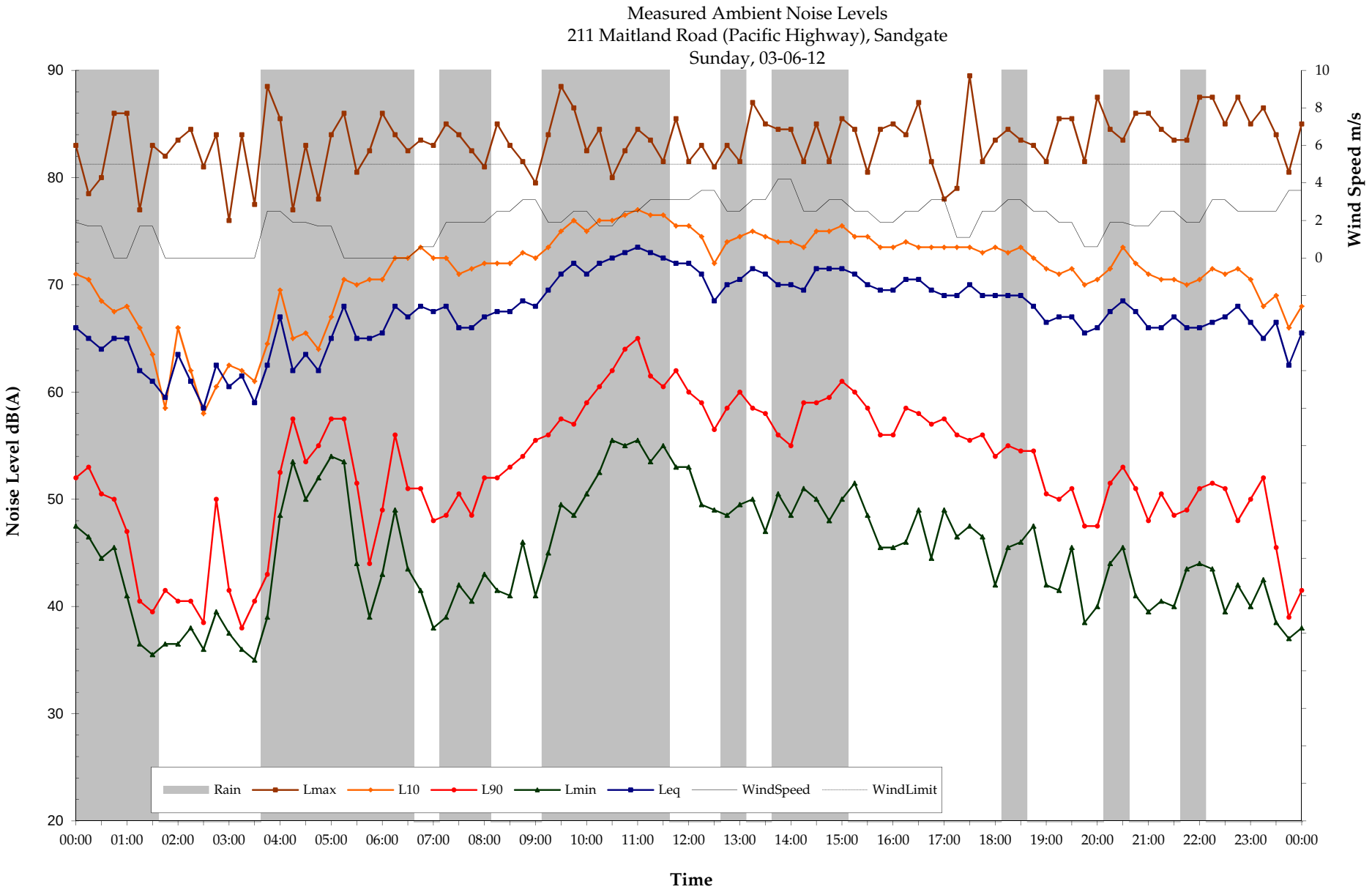
Measured Ambient Noise Levels
211 Maitland Road (Pacific Highway), Sandgate
Sunday, 03-06-12
Noise Level dB(A)
Wind Speed m/s
Time
Rain
Lmax
L10
L90
Lmin
Leq
WindSpeed
WindLimit
90
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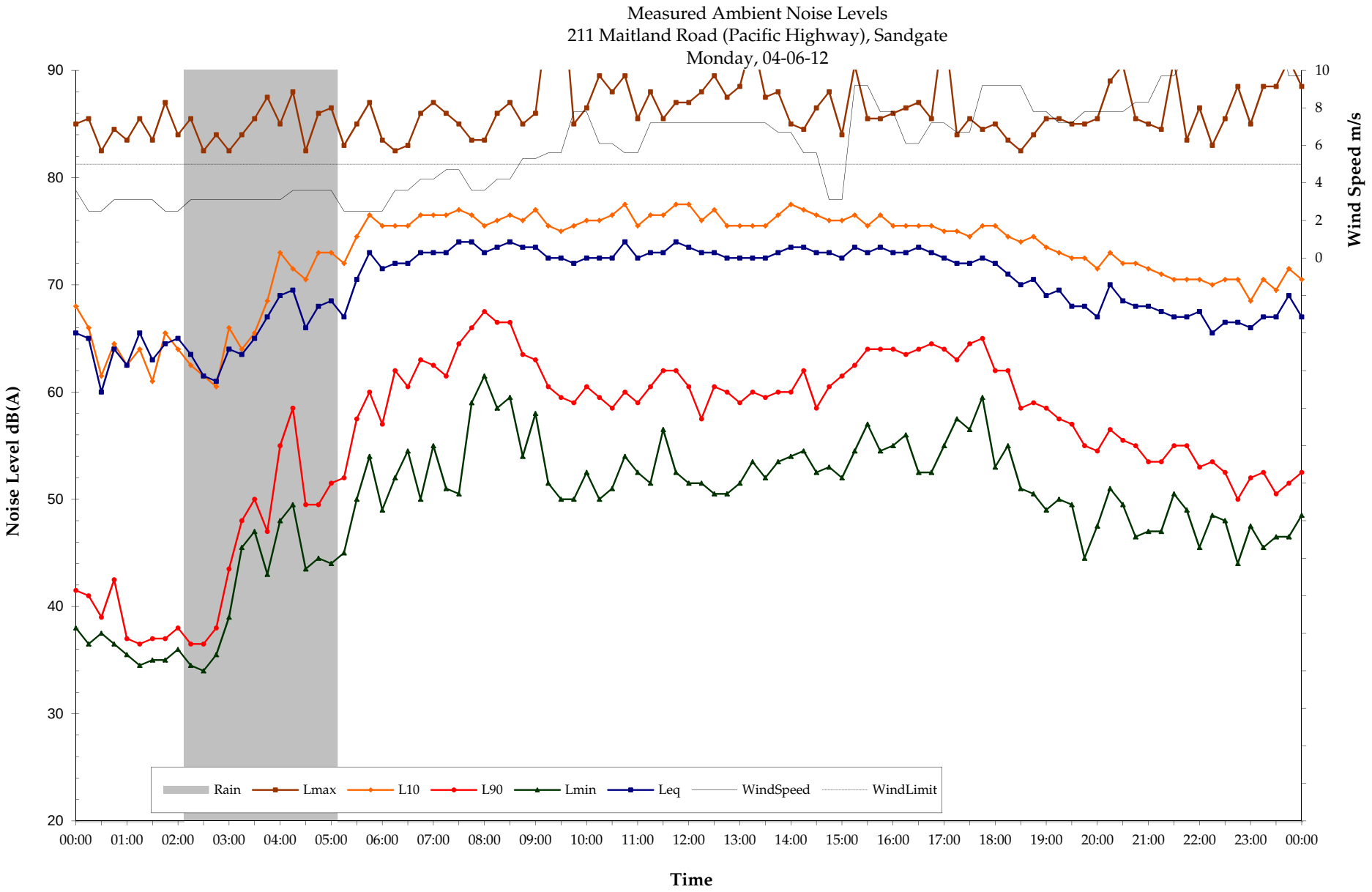
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Monday, 04-06-12
Noise Level dB(A)
Wind Speed m/s
Time
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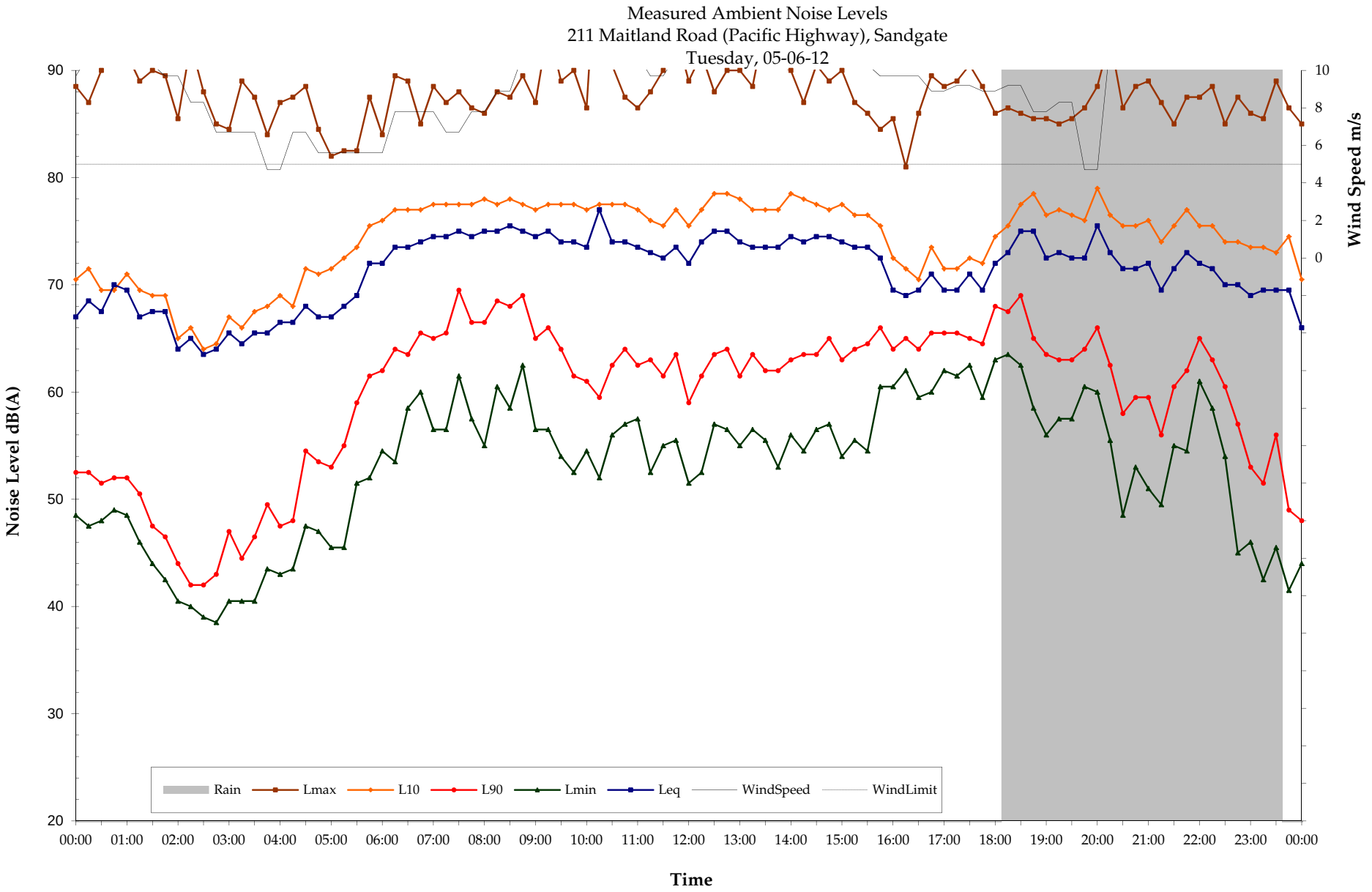
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Time
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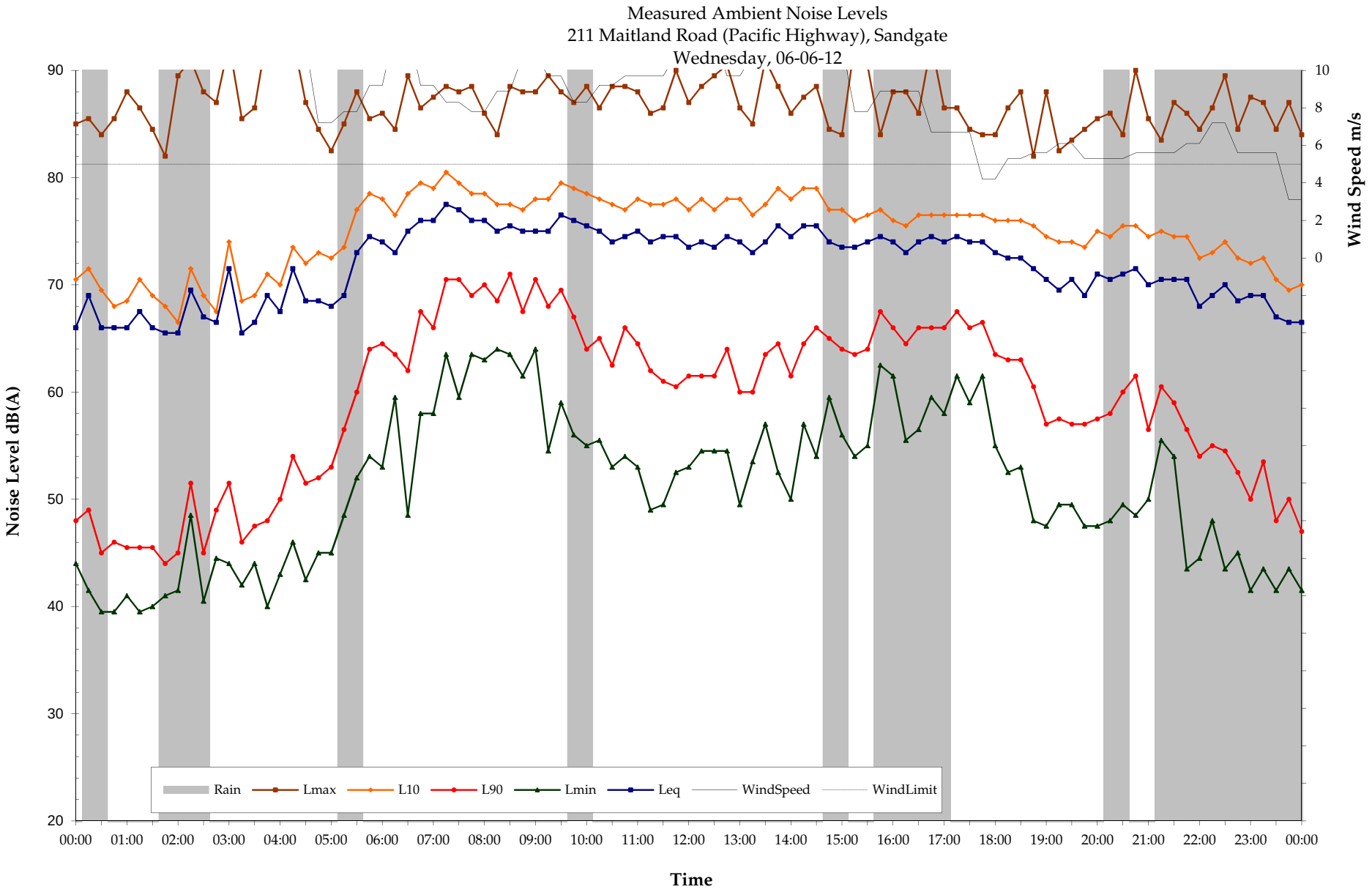
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Wednesday, 06-06-12
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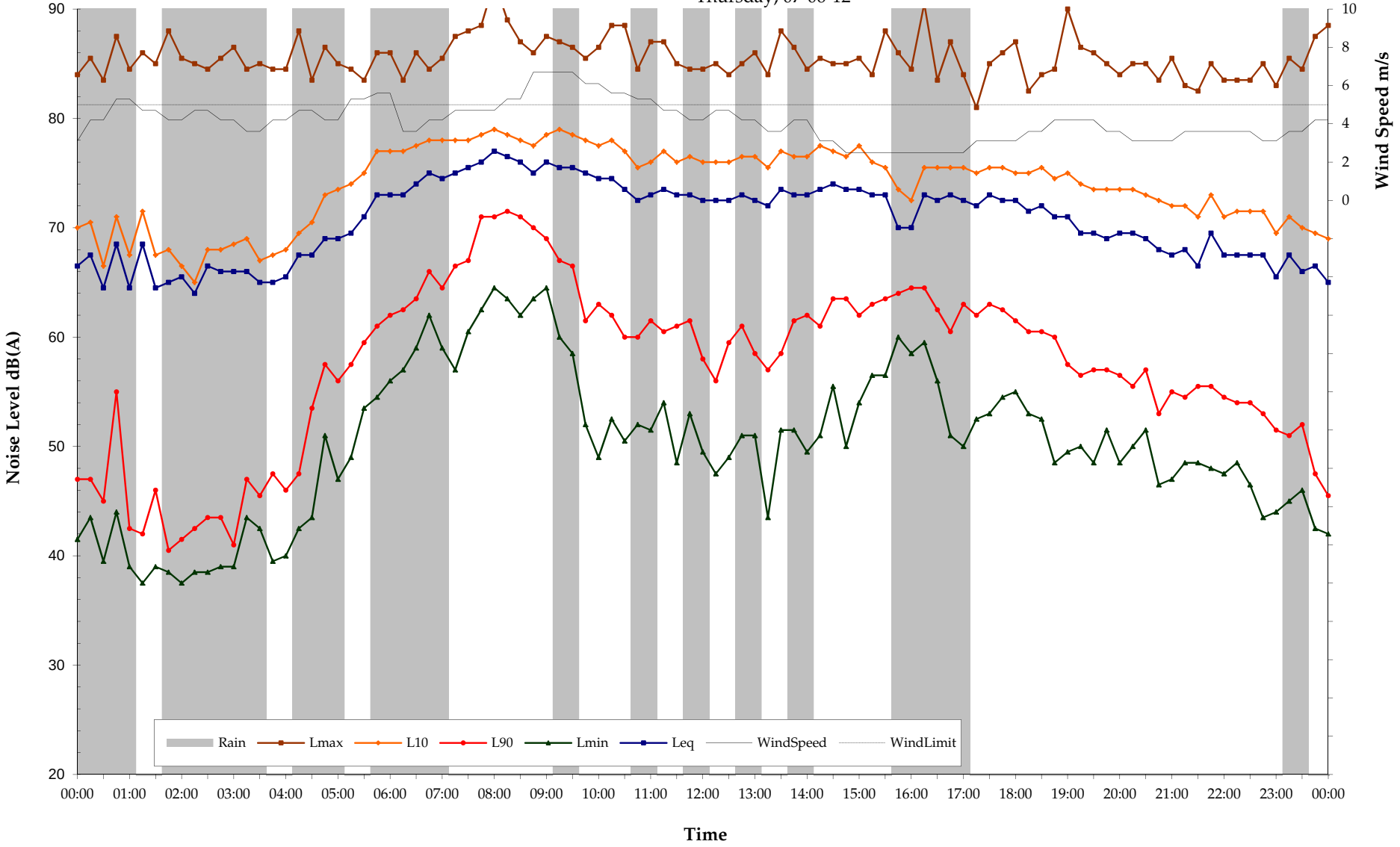
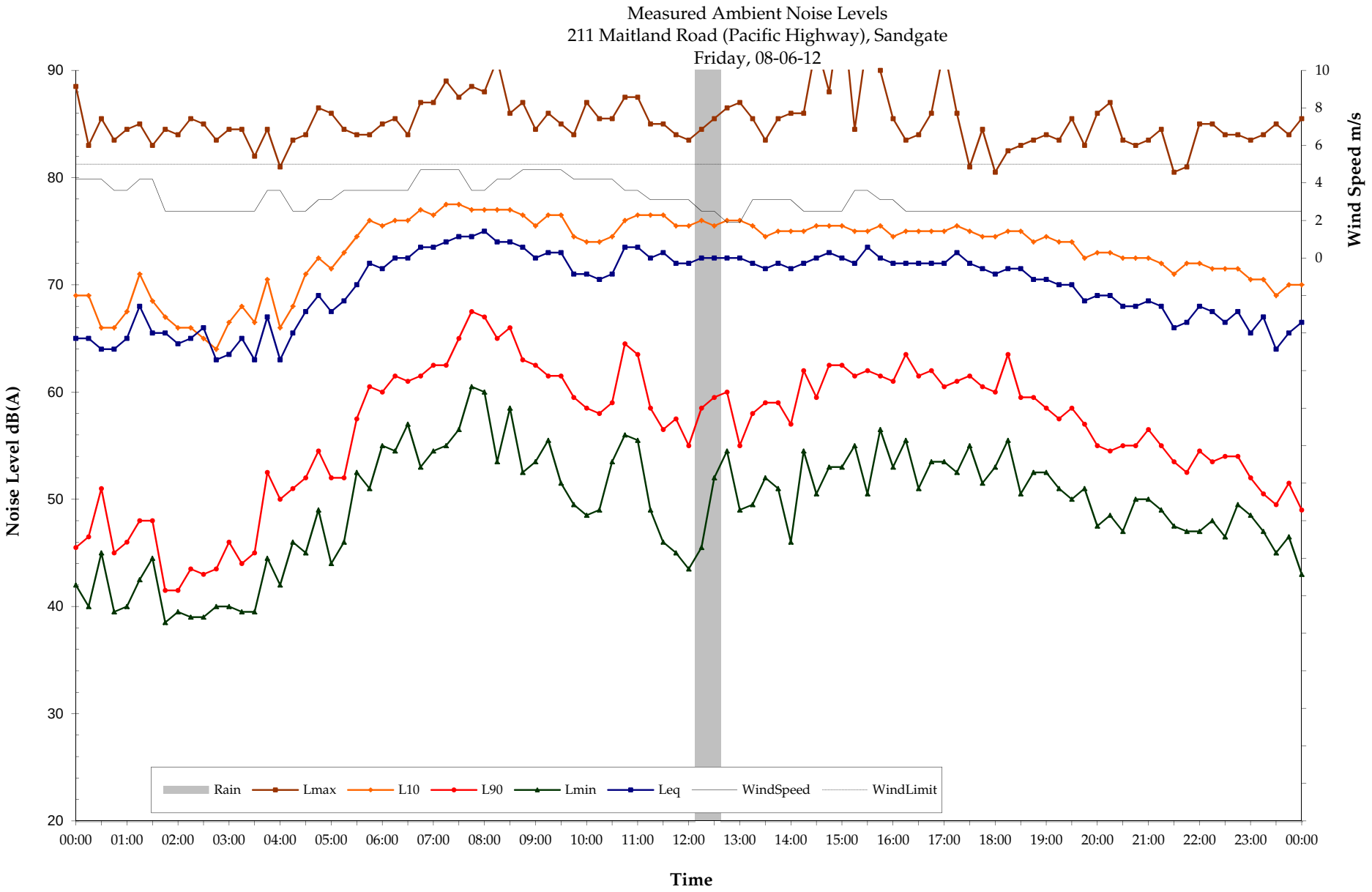
Measured Ambient Noise Levels
211 Maitland Road (Pacific Highway), Sandgate
Thursday, 07-06-12

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Friday, 08-06-12
Noise Level dB(A)
Wind Speed m/s
Time
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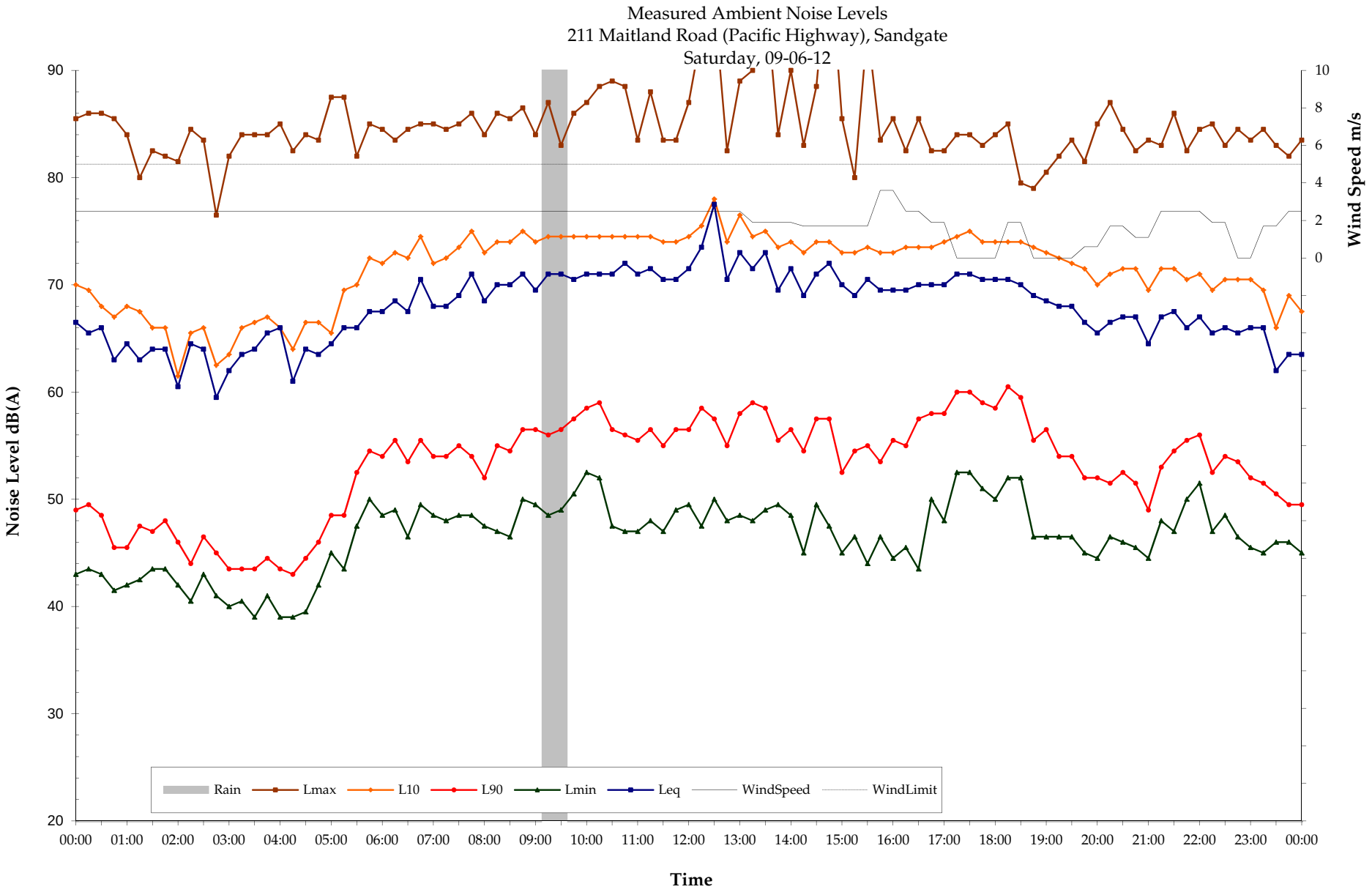
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Saturday, 09-06-12
Noise Level dB(A)
Wind Speed m/s
Time
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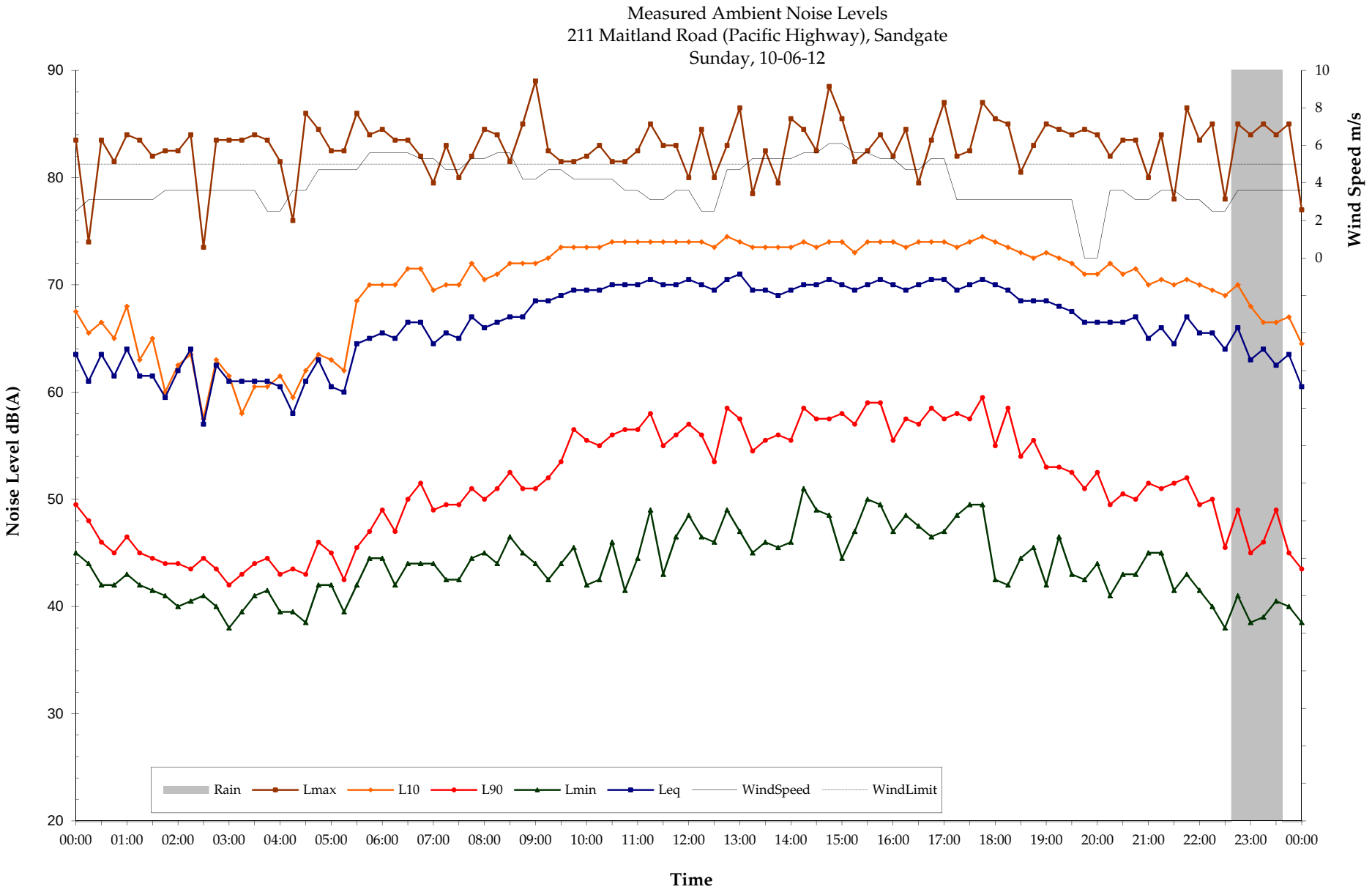
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Sunday, 10-06-12
Noise Level dB(A)
Wind Speed m/s
Time
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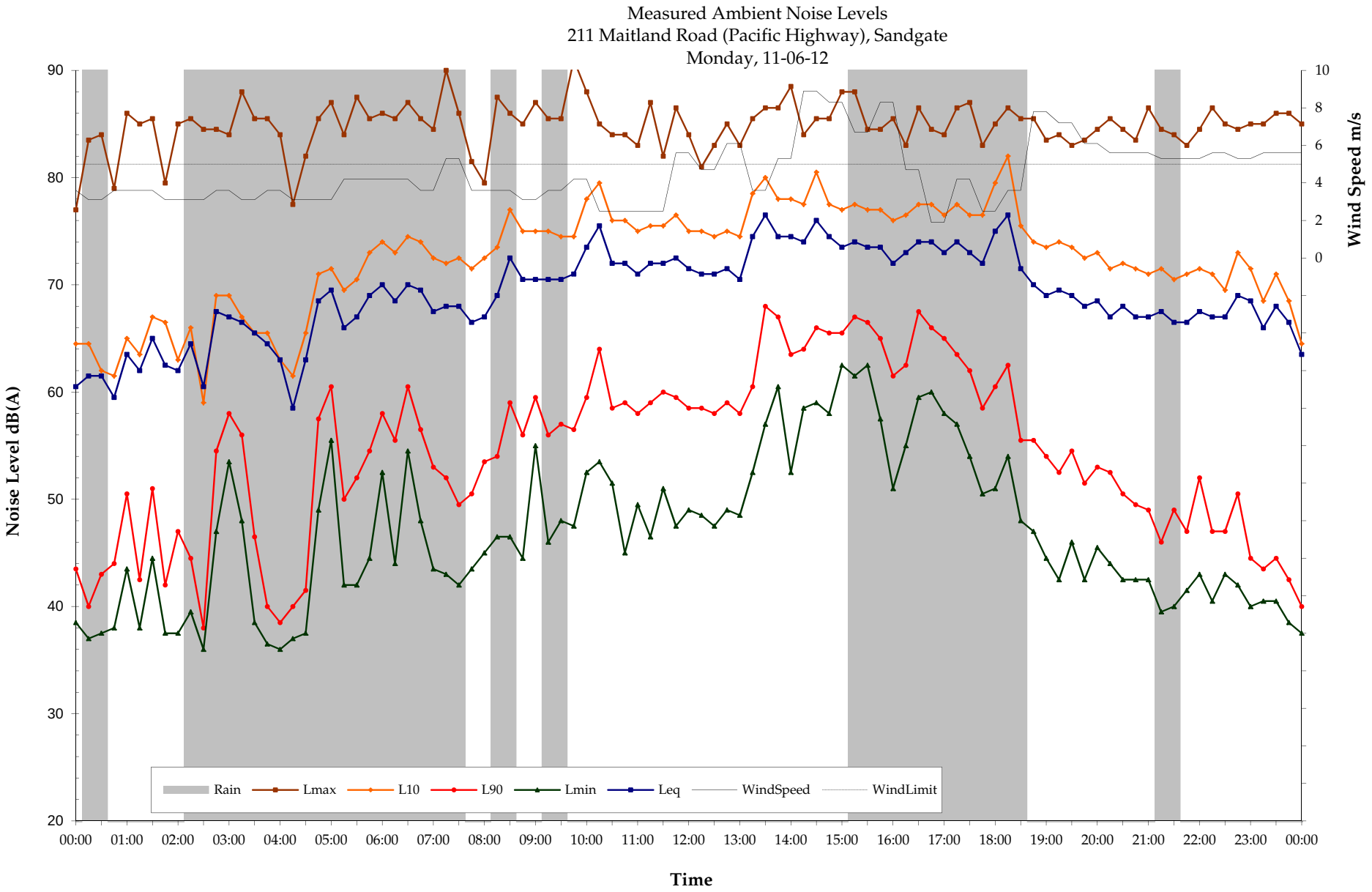
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Monday, 11-06-12
Noise Level dB(A)
Wind Speed m/s
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Measured Ambient Noise Levels
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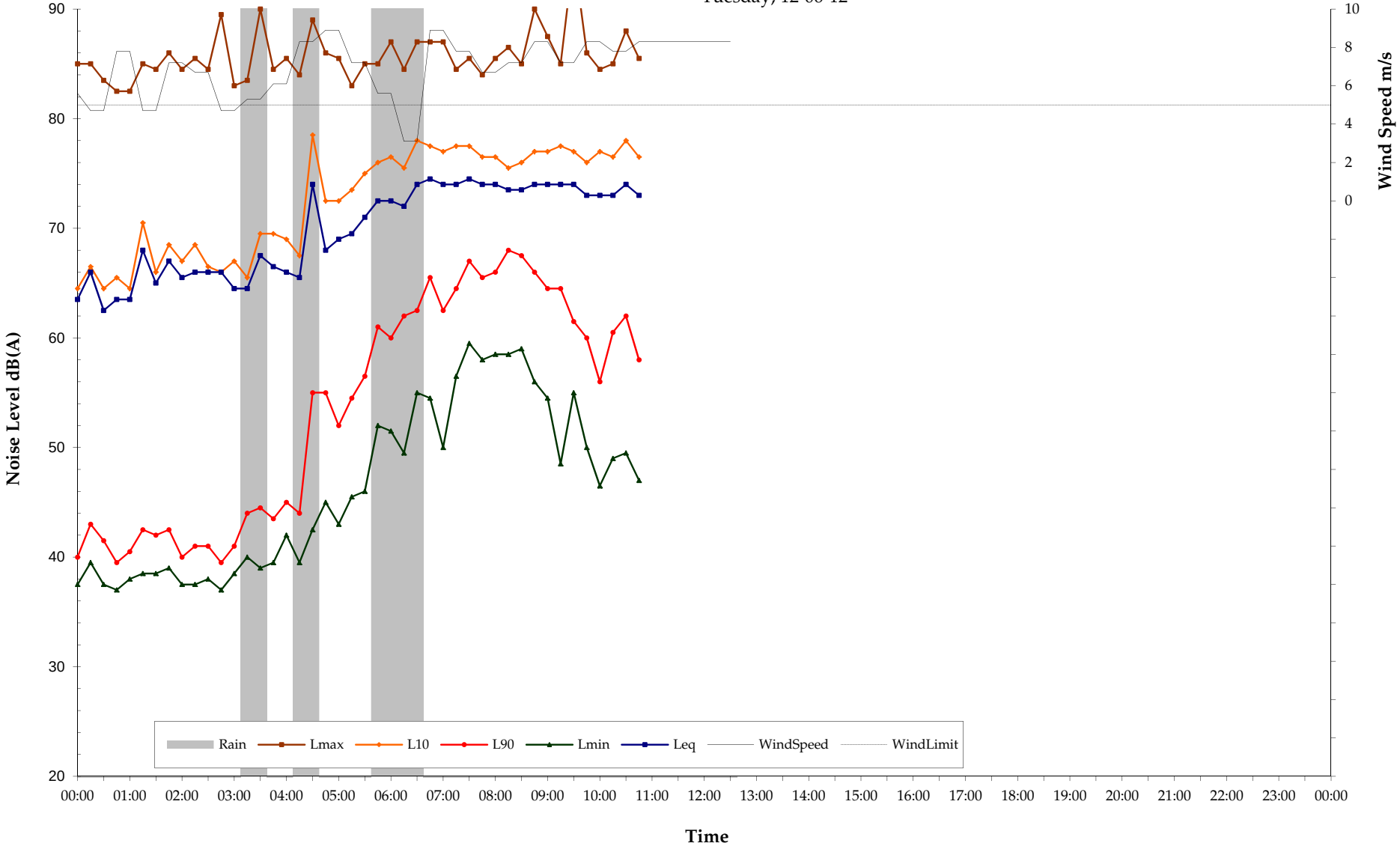
Tuesday, 12-06-12



Annex C

Industrial Noise Policy Methodology

C.1 NSW INDUSTRIAL NOISE POLICY - NOISE IMPACT ASSESSMENT PROCEDURES

Responsibility for the control of noise emissions in NSW is vested in Local Government and the Department of Environment, Climate Change and Water (DECCW, and formerly the EPA – Environment Protection Authority).

The NSW *Industrial Noise Policy* (INP) first published by the EPA in January 2000, provides a framework and methodology for deriving limit conditions for consent and licence conditions. Using this policy the DECCW regulates premises that are scheduled under the *Protection of the Environment Operations Act, 1997* (POEO Act). The specific INP objectives are:

- to establish noise criteria that would protect the community from excessive intrusive noise and preserve amenity for specific land uses;
- to use the criteria as the basis for deriving PSNL;
- to promote uniform methods to estimate and measure noise impacts, including a procedure for evaluating meteorological effects;
- to outline a range of mitigation measures that could be used to minimise noise impacts;
- to provide a formal process to guide the determination of feasible and reasonable noise limits for consent or licence conditions that reconcile noise impacts with the economic, social and environmental considerations of industrial development; and
- to carry out functions relating to the prevention, minimisation and control of noise from premises scheduled under the POEO Act.

The INP is designed for large and complex industrial sources and outlines processes designed to strike a feasible and reasonable balance between the operations of industrial activities and the protection of the community from noise levels that are intrusive or unpleasant. The application of the INP involves the following processes:

- determining the Project-Specific Noise Levels (PSNL) from intrusiveness and amenity based measurement of the existing background and ambient noise levels;
- predicting or measuring the noise levels produced by the development; and
- comparing the predicted noise levels with the PSNL and assessing impacts.

Where the PSNL are predicted to be exceeded the INP provides guidelines on the assessment of feasible and reasonable noise mitigation strategies, including:

- 'weighing up' the benefit of the development against the social and environmental costs resulting from the noise impacts;

- establishment of achievable and agreed noise limits for the development in consultation with the consent authority; and

- undertaking performance monitoring of environmental noise levels to determine compliance with the consent and licence conditions.

C.1.1 NSW INP - Assessment Methodology

There are two criteria to consider when establishing PSNL for the assessment of industrial noise sources. These criteria are as follows:

- the 'Intrusive Noise' criterion, which is based on the background noise level plus 5 dB. The background noise level, or Rating Background Level (RBL), is determined in accordance with Section 3 of the INP and is based on the use of noise monitoring data to establish the assessable background noise levels; and

- the 'Amenity Noise' criterion, which is based on the recommended noise levels in the INP for prescribed land use. The recommended acceptable and maximum ambient noise levels are outlined in *Table 2.1* of the INP. *Table 2.2* of the INP outlines the requirements for developments where the existing noise level from industrial noise sources is close to the acceptable noise level.

The relevant tables in *Section 2* of the INP relating to the amenity criteria relevant to the project are presented in *Table C.1* and *Table C.2*.

Table C.1 Amenity Criteria - Recommended Noise Levels (Industrial Noise Sources)

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended LAeq Noise Level	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50 dB(A)	55 dB(A)
		Evening	45 dB(A)	50 dB(A)
		Night	40 dB(A)	45 dB(A)
	Suburban	Day	55 dB(A)	60 dB(A)
		Evening	45 dB(A)	50 dB(A)
		Night	40 dB(A)	45 dB(A)
	Urban	Day	60 dB(A)	65 dB(A)
		Evening	50 dB(A)	55 dB(A)
		Night	45 dB(A)	50 dB(A)
	Urban/Industrial Interface - for existing situations only	Day	65 dB(A)	70 dB(A)
		Evening	55 dB(A)	60 dB(A)
		Night	50 dB(A)	55 dB(A)
Area specifically reserved for passive recreation	All	When in use	50 dB(A)	55 dB(A)
Active recreation area (School playground, golf course)			55 dB(A)	60 dB(A)
Commercial premises			65 dB(A)	70 dB(A)
Industrial premises			70 dB(A)	75 dB(A)

1. in accordance with the INP the assessment periods are defined as follows: Daytime is the period from 7am to 6pm - Monday to Saturday; or 8am to 6pm on Sundays and Public Holidays, Evening is the period from 6pm to 10pm and Night time is all remaining periods; and
2. the LAeq index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

Table C.2 ***Modification to Acceptable Noise Level (ANL) to Account for Existing Levels of Industrial Noise***

Total Existing LAeq Noise Level from Industrial Noise Sources	Maximum LAeq Noise Level for Noise from New Sources Alone, dB
≥ Acceptable noise level plus 2 dB	If existing noise level is likely to decrease in future acceptable noise level minus 10 dB If existing noise level is unlikely to decrease in future existing noise level minus 10 dB
Acceptable noise level plus 1 dB	Acceptable noise level minus 8 dB
Acceptable noise level	Acceptable noise level minus 8 dB
Acceptable noise level minus 1 dB	Acceptable noise level minus 6 dB
Acceptable noise level minus 2 dB	Acceptable noise level minus 4 dB
Acceptable noise level minus 3 dB	Acceptable noise level minus 3 dB
Acceptable noise level minus 4 dB	Acceptable noise level minus 2 dB
Acceptable noise level minus 5 dB	Acceptable noise level minus 2 dB
Acceptable noise level minus 6 dB	Acceptable noise level minus 1 dB
< Acceptable noise level minus 6 dB	Acceptable noise level

1. ANL = recommended acceptable LAeq noise level for the specific receiver.

In assessing the noise impacts from industrial sources at residential receivers both criteria are considered. For each period (day, evening and night) the most stringent of either the intrusive or amenity criteria becomes the limiting criterion and forms the project-specific noise level for the industrial source.

If the existing ambient noise level is close to the acceptable noise level, a new source must be controlled to preserve the amenity of the surrounding area. If the overall noise level from the industrial source already exceeds the acceptable noise level for the affected area, the L_{Aeq} noise level from a new source should meet the conditions set out in *Table 2.2* of the INP.

C.1.2 INP - Project Specific Noise Levels

The INP states that the criteria outlined in *Table C.1* and *Table C.2* have been selected to protect at least 90 per cent of the population living in the vicinity of industrial noise sources from the adverse effects of noise for at least 90 per cent of the time. Provided the criteria in the INP are achieved, it is unlikely that most people would consider the resultant noise levels excessive.

Table C.3 presents the methodology for assessing noise levels which may exceed the INP PSNL.

Table C.3 Noise Impact Assessment Methodology

Assessment Criterion	Project Specific Noise Level	Noise Management Zone	Noise Affectation Zone
Intrusive	Rating background level plus 5 dB	≤ 5 dB above project-specific criteria	≥ 5 dB above project-specific criteria
Amenity	INP based on existing industrial level	≤ 5 dB above project-specific criteria	≥ 5 dB above project-specific criteria

For the purposes of assessing the potential noise impacts the project-specific, management and affectation criteria are further defined in the following sections.

Project Specific Noise Level

Most people in the broader community would generally consider exposure to noise levels that achieve the project-specific criteria acceptable.

Noise Management Zone

Depending on the degree of exceedance of the project-specific noise level (1 dB to 5 dB) noise impacts in this zone could range from negligible to moderate. It is recommended that management procedures be implemented including:

- prompt response to any issues of concern raised by community;
- noise monitoring on-site and within the community;
- refinement of on-site noise mitigation measures and plant operating procedures where practical;
- consideration of acoustical mitigation at receivers; and
- consideration of negotiated agreements with property holders.

Noise Affectation Zone

Exposure to noise levels corresponding to this zone (more than 5 dB above project-specific criteria) may be considered unacceptable by some property holders and implementation of the following measures may be required:

- discussions with relevant property holders to assess concerns and provide solutions;
- implementation of acoustical mitigation at receivers; and
- negotiated agreements with property holders.

C.1.3 Sleep Disturbance

Refer INP Application Note *C.2.17*

NSW Environmental Criteria for Road Traffic Noise - Guidance

Further guidance on potential sleep disturbance impacts is provided in the Department of Environment, Climate Change and Water (formerly the EPA – Environment Protection Authority) NSW *Environmental Criteria for Road Traffic Noise* (ECRTN), May 1999, which states that:

- sleep disturbance occurs through two mechanisms: changes in sleep state and awakenings;
- awakenings are better correlated to subjective assessments of sleep quality than are changes in sleep state;
- factors (other than noise) that contribute significantly to awakening reactions include sleep state and subject age; and
- the maximum noise level, the extent that noise exceeds the ambient noise level and the number of noise events that contribute to sleep disturbance.

The ECRTN recommends that the assessment should include a calculation of the maximum noise levels, the extent to which the maximum noise levels for individual vehicle pass-bys exceed the L_{eq} for each hour of the night, and the number of maximum noise events. A substantial portion of the ECRTN provides a review of international sleep disturbance research, indicating that:

- maximum internal noise levels below 50–55 dB(A) are unlikely to cause awakening reactions; and
- one or two noise events per night with maximum internal noise levels of 65–70 dB(A) are not likely to significantly affect health and wellbeing.

Internal To External Correction Factors

Modelled noise levels (for operational and sleep disturbance aspects of a project) are typically calculated at the property boundary or external building façade, however the ECRTN specifies and internal noise level criteria for assessing maximum noise level events, as such an internal noise level equivalent must be determined, or the criteria adapted to assess a calculated external noise level.

In determining an external criteria equivalent for maximum noise level assessment, ERM conservatively applies a 20 dB noise level correction factor to the relevant internal criteria described in the ECRTN. This 20 dB correction factor is approximately equivalent to the acoustic performance of an outer building envelope with windows closed (light frame and single glazed window, refer Roads and Traffic Authority (RTA) – *Environmental Noise Management Manual* (ENMM), December 2001). This is considered reasonable as the maximum noise level assessment only applies at night, when windows would typically remain closed.

C.2 INP - APPLICATION NOTES

These application notes are provided to assist industry and acoustical consultants develop noise impact assessments and apply the provisions of the INP with the aim of reducing processing time. The DECCW require noise impact assessments to apply the provisions of the INP; alternative approaches are not acceptable. The process for identifying PSNL in *Section 2* of the INP must be followed.

The level of mitigation that can be applied to a project is based on what is feasible and reasonable within the circumstances of that project. Valid factors include costs, aesthetics, community preferences, noise reduction achieved, etc. Noise level requirements in a licence are based on what the project can achieve using feasible and reasonable mitigation.

C.2.1 Identifying the Existing Level of Noise from Industry

(See INP *Section 2.2* and *Section 3.2*)

Table 2.1 of the INP (Amenity Criteria p.16) sets out recommended cumulative noise levels for industry. In assessment of the amenity effects of noise from a new development it is essential that the level of noise already present be determined.

Where the ambient noise levels are below the Acceptable Noise Level (ANL), then ideally the measurement of the existing level of noise should include only noise from industrial sources. In these situations, however, it may be acceptable to include noise from other sources (for example, roads or neighbourhood). The reasons for this are that:

- including noise from other sources typically results in assessing the worst case for impacts on amenity; and
- strictly excluding noise from sources other than industry can be difficult and costly and may not be necessary if the development meets the criteria.

However, where ambient noise levels are above the ANL then noise from other sources should be excluded in establishing existing levels of industrial noise. Where the level of road traffic noise is high enough to make noise from an industrial source inaudible for the majority of the time or difficult to measure directly, it may be necessary to consider applying the assessment for areas of high traffic noise. (Application Note: '*Amenity criteria in high traffic noise areas*', provides further guidance on this).

C.2.2 Assessing Noise at Industrial/Commercial Receivers

(See INP *Section 2.2*)

The INP does not require that intrusive noise be assessed at industrial or commercial premises. For industrial/commercial receivers, only the amenity criteria apply. Amenity noise levels should be assessed at the most affected point on or within the property boundary. This approach also applies to other non-residential receivers, such as educational facilities, hospitals and places of worship.

C.2.3 When to Apply the Urban/Industrial Interface Amenity Category

(See INP *Section 2.2.1*)

The urban/industrial interface category in the INP recognises that the availability of noise mitigation measures might be limited for existing premises where residences are close to existing industries.

The urban/industrial interface amenity category applies only for existing situations (that is, an existing receiver near an existing industry) and only for those receivers in the immediate area surrounding the existing industry, that is, the region that extends from the boundary of the existing industry to the point where the noise level of the existing industry (measured at its boundary) has fallen by 5 decibels.

Beyond the interface region (that is, beyond the point where noise has fallen by 5 decibels) the receiver category that most describes the area (rural, suburban or urban) would apply[4].

[4] The wording on pages 18 and 67 of the INP does not fully clarify this and the word 'urban' should be deleted and replaced with the word 'applicable' on page 18 at line 6 of the 'Urban/industrial interface' category and on page 67 at line 9 of the first paragraph

For new developments of a limited nature (such as an extension to existing process or plant or when replacing part of an existing process or plant with new technology) on existing sites (where the urban/industrial amenity category applies) then the urban/industrial amenity category is the appropriate amenity category for the new development. However, where a new development on an existing site is of a substantial nature (such as demolition of the existing plant and replacement with current technology or different type of plant) and where replacement of the existing plant has a realistic potential to significantly reduce receiver noise levels through using feasible and reasonable noise mitigation (i.e. where the existing plant is the dominant or a significant contributor to receiver noise levels) then the applicable noise criteria for the new development is the appropriate (rural, suburban or urban) amenity criteria for the location.

In most cases the situation will be apparent but in some cases careful judgement will be required to determine whether the new development is of sufficient magnitude to effectively replace the existing plant. In situations where no clear conclusion on the magnitude of change created by the new development is possible then the urban/industrial amenity category should apply.

C.2.4 Identifying the Appropriate Receiver Amenity Category

(See INP *Section 2.2.2*)

Amenity criteria in *Table 2.1* of the INP vary depending on the type of receiver. INP *Section 2.2.2* provides guidance on identifying the appropriate receiver type. Where there is doubt or debate over which receiver category is appropriate, the proponent needs to seek the views of the relevant land use manager (for example, Council or Department of Planning). Once the land use manager has identified the land use (eg zone, allowable density of development and land use patterns), the appropriate amenity criteria can be assigned.

C.2.5 Amenity Criteria in High Traffic Noise Areas

(See INP *Section 2.2.3*)

In areas where traffic flow is continuous and noise from industrial sources is inaudible or difficult to measure due to a high level of road traffic noise, and where the $L_{Aeq\ (period,\ traffic)}$ noise level is more than 10 dB above the ANL presented in *Table 2.1*, the ANL is replaced by $L_{Aeq\ (period,\ traffic)}$ minus 10 dB and this becomes the new ANL for the receiver area. Once the new ANL is determined, the project-specific amenity criterion can be determined by following the modification process given in *Table 2.2* of the INP[5].

C.2.6 Identifying Which of the Amenity or Intrusive Criteria Apply

(See INP *Section 2.4*)

The INP notes that the PSNL is the more stringent of either the amenity or intrusive criteria. This is not necessarily just a matter of comparing the magnitude of the amenity criteria to the intrusive criteria because different time periods apply (intrusive criteria uses 15 minutes while the amenity criteria are over the day, evening or night period).

For example, where the same number applies to both of the amenity and intrusive criteria, the intrusive criteria would typically be more stringent because it is determined over a much shorter period.

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[5] **Example:** An industrial development is proposed adjacent to several existing industrial facilities. The measured ambient night-time LAeq noise level is 60 dB(A) at a receiver potentially affected by noise from the proposed industrial development. The residential receiving area of the assessment location has been identified as 'urban'. A nearby road dominates the night-time acoustic environment at the receiver and there are no other environmental or extraneous local noise sources. In these circumstances, the measured ambient LAeq noise level of 60 dB(A) can be taken to represent the LAeq (period, traffic). The night-time noise contribution from existing industry is estimated to be 46 dB(A). What is the project-specific amenity (night-time) noise criterion for the proposed industrial development?

Solution: The LAeq (period, traffic) minus 10 dB is greater than the night time ANL of 45 dB(A) as determined from Table 2.1 for urban areas not significantly affected by traffic noise. Therefore, the approach described in Section 2.2.3 of the INP can be applied and the new ANL becomes LAeq (period, traffic) minus 10 dB. As the LAeq (period, traffic) is 60 dB(A), then the new ANL becomes 50 dB(A). This is the amenity noise criterion for the total industry LAeq noise in the area. The project-specific amenity (night-time) noise criterion for the proposed industrial development is then determined by comparing the existing industry LAeq of 46 dB(A) to the new ANL of 50 dB(A) with respect to the modification process given in Table 2.2. This gives the project-specific amenity (night-time) noise criterion of 48 dB(A), that is, new ANL minus 2 dB(A).

Where the predicted amenity noise level is lower than the intrusive level for the proposed development, the proponent needs to ensure that both levels will be satisfied. In this situation, noise limits specified in the licence conditions will include both the intrusive and amenity noise levels predicted to be achieved by the proposal to ensure that the community is protected from intrusive noise impacts at all times.

C.2.7 Assessing Background Noise Levels

(See INP *Section 3.1*)

To determine the Rating Background Level (RBL) and existing industry-contributed L_{Aeq}, the measurement of ambient noise levels should be undertaken in the absence of noise from the development under consideration.

C.2.8 When the RBL for Evening or Night Is Higher Than the RBL for Daytime

(See INP *Section 3.1*)

The results of long term unattended background noise monitoring can sometimes determine that the calculated Rating Background Level (RBL) for the evening or night period is higher than the RBL for the daytime period. These situations can often arise due to increased noise from, for example, insects or frogs during the evening and night in the warmer months or due to temperature inversion conditions during winter. The objective of carrying out long-term background noise monitoring is to determine existing background noise levels at a location that are indicative of the entire year.

In determining PSNL from the RBL's, the community's expectations also need to be considered. The community generally expects greater control of noise during the more sensitive evening and night-time periods than the less sensitive daytime period. Therefore, in determining PSNL for a particular development, it is generally recommended that the intrusive noise level for evening be set at no greater than the intrusive noise level for daytime. The intrusive noise level for night-time should be no greater than the intrusive noise level for day or evening. Alternative approaches to these recommendations may be adopted if appropriately justified.

C.2.9 Maximum Noise Levels during Shoulder Periods

(See INP *Section 3.3*)

Noise levels in limit conditions for sleep disturbance would typically be set as a maximum noise level. The approach noted in the INP for developing intrusive criteria for the shoulder period is not appropriate for determining maximum noise levels for the shoulder period. That is, assigning a background noise level based on averaging daytime and night-time RBL's may be appropriate for determining intrusive criteria but it is not appropriate

for assigning maximum noise levels. The reason for this is that the day or night RBL is based around the 90th percentile of LA90's, which is quite different to an RBL based on an average. (Additionally, setting maximum noise levels for the shoulder period based on the lowest LA90 during the period is not practical as it can result in the maximum noise limit being set lower than the intrusive noise limit).

In order to generate a statistically valid data set to derive the 90th percentile of LA90's for the shoulder period, a much larger sampling time (than the one week typically applied) would be required, with associated cost and practicality implications. Therefore, a statistical approach to calculating the RBL for shoulder periods is not required by the INP.

It is the intention of the INP that appropriate noise targets for the shoulder period be negotiated with the regulatory/consent authority on a case-by-case basis. The focus of the INP is on avoiding or minimising noise of a high level and/or with intrusive characteristics, during the shoulder period, through the use of best practice.

Options available to the proponent for managing maximum noise levels during the shoulder period are to:

- avoid noise events during the shoulder period (or at least during the first half and then to meet RBL (shoulder period) +15 dB(A) during the second half of the shoulder period);

- collect sufficient data to calculate a statistically robust 90th percentile-based RBL for the shoulder period and use this to determine RBL+15 dB(A) as the maximum noise level limit; and

- conduct a detailed analysis of the number and noise level of noise events, and the exceedance of the background noise level, then, present a case comparing the results of the analysis and the research results contained in Appendix B of the ECRTN.

C.2.10 Tonality - Sliding Scale Test

(See INP *Section 4.2*)

The sliding scale test for tonality outlined in *Section 4* of the INP uses a linear (z-weighted) spectrum (that is, no frequency weighting on each of the octave or third octave bands).

C.2.11 Duration Correction

(See INP *Section 4.2*)

Section 4 of the INP provides guidance on the use of modifying factors to account for certain characteristics of a noise source. The duration factors in *Table 4.2* are intended to increase the criterion that is acceptable, whereas the modifying factor corrections in *Table 4.1* are intended to increase the measured or predicted level.

C.2.12 Determining What Weather Conditions Should Be Used When Predicting Noise

Background

(See INP *Section 5*)

The INP intends that the noise levels used in assessing noise impacts at the consent stage include the effects of any weather conditions that are a feature of the area when the development operates. This means that the effects of weather conditions such as temperature inversions and wind on the noise level experienced at sensitive receivers should be adequately assessed at the consent stage.

Wind can enhance noise propagation compared with calm conditions (where there is no wind). When a wind blows, friction causes the air to move more slowly close to the ground than at higher altitudes. This phenomenon of wind speed increasing with height is termed 'wind shear'. The increase in noise occurs because sound waves from the source are bent through this 'wind shear' back towards the ground.

Unlike temperature inversions, wind can enhance propagation during any time of the day, evening or night. Wind does not increase noise in all directions and can also reduce noise. For example, wind blowing from the south to the north (termed a 'southerly' wind) increases noise to the north of an industrial premise and also reduces noise to the south of that premises.

In some instances, where one or more significant weather conditions have been identified as part of a noise assessment, noise levels from the industrial premises under only these significant weather conditions have been assessed, but noise levels under calm conditions have not.

The INP describes in *Section 5* when weather is "significant" (i.e. it occurs more than 30% of the relevant time period) and how to apply this in the noise assessment. This approach may result in noise levels at some receivers being underestimated, as in the southerly prevailing wind scenario described above.

Recommended Approach

This application note clarifies that in all cases at each receiver:

- noise levels from the premises under calm conditions as well as any significant weather conditions as defined in the INP should be predicted or measured; and

- the highest of the noise levels from Step 1 (above) is to be used in the assessment for that receiver.

The intent of the INP is not to require that these conditions should be applied exclusively where the significant weather conditions act to reduce noise at a sensitive receiver.

For example, where a significant prevailing wind of speed less than three metres per second increases noise levels at a receiver to the north of a development (compared with those predicted under calm conditions), the noise levels predicted under that prevailing wind should be used at that receiver. For receiver(s) to the south of the same development, if the noise levels predicted under calm wind conditions are higher than those predicted under the significant prevailing wind, the noise levels predicted under calm wind conditions should be used at the southern receiver(s).

The DECCW has previously accepted (and will accept) noise predictions based on modelling noise emissions using long term weather data, as it can present a higher level of analysis than that required under the INP.

C.2.13 How Calm Is Defined

(See INP *Section 5.1*)

In the assessment of wind effects, the INP requires the assessment of wind speeds of up to 3 metres per second where these speeds are a feature of the area (they occur for 30% of the time or more) but does not specify the minimum wind speed that needs to be assessed. The calm condition is typically represented by wind speeds less than or equal to 0.5 metres per second as this is likely to be the lower limit of measurement.

C.2.14 Presenting Predicted Noise Impacts

(See INP *Section 6.3*)

In carrying out noise impact predictions for a particular development, predicted noise levels for calm conditions as well as any significant adverse weather conditions should generally be provided. It is particularly useful to provide predicted noise impacts for calm weather conditions where predicted noise impacts under adverse weather conditions exceed the PSNL. This allows for a better understanding of potential noise impacts from the development.

C.2.15 Prosecution Guidelines

(See INP *Section 11.1*)

The DECCW's approach to prosecuting offences is described in EPA prosecution guidelines, 2001, particularly *Sections 3.2* to *Section 3.6* under 'Discretion' which states that "*not every breach of the criminal law is automatically prosecuted*", "*The EPA has a discretion as to how to proceed in relation to environmental breaches*" and "*Each case will be assessed to determine whether prosecution is the appropriate strategic response*". *Sections 3.7* to *Section 3.8* under '*Factors to be considered*' in the Guidelines describe factors that are considered when determining whether prosecution is required, such as "*whether the breach is a continuing or second offence*", "*the availability and efficacy of any alternatives to prosecution"* and "*the prevalence of the alleged offence and the need for deterrence, both specific and general*".

C.2.16 Using Appendix D

Appendix D of the INP provides a rough guide for predicting the increase in noise due to inversion effects. The data provided is based on simple calculations performed using the Environmental Noise Model (ENM), assuming flat ground and no barriers.

The use of this Appendix may underestimate the effects of temperature inversions where a barrier or intervening topography is present. For detailed noise impact assessments, a more thorough analysis of noise impacts under temperature inversions is expected. Where a noise model such as SoundPlan or ENM is used to determine noise impacts from a development under calm conditions or during wind conditions, the model should also be used to determine potential noise impacts under inversion conditions, rather than using Appendix D of the INP.

C.2.17 Sleep Disturbance

Peak noise level events, such as reversing beepers, noise from heavy items being dropped or other high noise level events, have the potential to cause sleep disturbance. The potential for high noise level events at night and effects on sleep should be addressed in noise assessments for both the construction and operational phases of a development. The INP does not specifically address sleep disturbance from high noise level events.

DECCW reviewed research on sleep disturbance in the ECRTN. This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.

From the research, DECCW recognised that current sleep disturbance criterion of an $L_{A1\ (1\ minute)}$ not exceeding the $L_{A90\ (15\ minute)}$ by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, DECCW will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.

The detailed analysis should cover the maximum noise level or $L_{A1\ (1\ minute)}$ that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the appendices to the ECRTN. Other factors that may be important in assessing the extent of impacts on sleep include:

- how often high noise events will occur;
- time of day (normally between 10pm and 7am); and
- whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).

The $L_{A1\ (1\ minute)}$ descriptor is meant to represent a maximum noise level measured under 'fast' time response. DECCW will accept analysis based on either $L_{A1\ (1\ minute)}$ or L_{AMax}.

C.2.18 Addressing Privately Owned Haul Roads

Noise from privately owned haul roads is to be assessed as an industrial noise source according to the INP. The practice of treating access roads as part of the industrial premises with which they are associated is a long established part of noise management in NSW, which the INP has not changed. The basis for treating vehicles on private access roads as part of an industrial noise source lies in the relationship between the enterprise and the noise, and the community's response to noise from vehicles operating on private roads.

The character of the noise is different to general road traffic noise: Traffic on access roads is solely related to the operation of the site served by the access road and is usually composed almost entirely of heavy vehicles, producing noise of a different character to the typical public roadway where smaller vehicles typically predominate.

Factors that influence community response are different compared to public roads: The distribution of benefits from the operation of a private access road is typically perceived to be different than from a public road. Affected members of the public have been reported as questioning the equity of truck noise degrading their amenity for the benefit of others.

The degree of control possible for traffic on a private access road is typically perceived as greater than for a public road. The result is a higher level of expectations that more can and should be done to reduce noise from the private road (than from a public one).

C.2.19 Determining Noise Limits for Licence Conditions

Where the proponent predicts that noise levels from the industrial development would be below the PSNL, then the noise limits specified in the licence/consent conditions should reflect the noise levels that the proponent states would be achieved (that is, the predicted noise levels, however a minimum intrusive criterion of 35 dB(A) still applies). This is for a number of reasons:

- to ensure that the best-management practices and best available technology described in the noise impact assessment report are actually adopted by the proponent;
- to ensure that the level of achievable performance presented by the proponent to the public, though public documentation such as Environmental Impact Statements, is achieved;
- to optimise the opportunity for further industrial development in the area without an unacceptable degradation of the acoustic amenity of the area; and
- to fulfil a general aim of the environmental assessment process to minimise environmental impacts.

It should be noted that noise limits would apply to the contributed noise levels from only the premises or site of concern. In setting noise limits, judgement needs to be made as to whether the predicted noise levels warrant noise limits on the licence/consent. Where the predicted noise levels from the premises of concern are well below the PSNL, there may be no need for noise limit conditions.

Any tolerances to the predicted noise levels should be addressed in the proponent's assessment of impacts so that the predicted noise levels can be applied in conditions.

Annex D

ICNG and Road Noise Policy Assessment Approach

D.1 ICNG ASSESSMENT METHODOLOGY

The project-specific construction noise assessment criteria have been developed with due regard to and in accordance with the NSW Department of Environment and Climate Change – NSW *Interim Construction Noise Guideline* (ICNG), July 2009. The ICNG presents a detailed approach and methodology to qualitatively and/or quantitatively assess potential noise and vibration impacts associated with construction works. Importantly this document outlines the recommended standard hours for normal construction works, these are:

- Monday to Friday, 7am to 6pm;
- Saturday, 8am to 1pm; and
- No work on Sundays or public holidays.

ERM understands that the proposed construction works are to be limited to the standard hours for normal construction, as such ICNG Noise Management Levels for ground borne noise (regenerated noise) at residences (evening and night only) and sleep disturbance at residences (night only) do not apply.

In this case, noise management levels for construction are then relevant to the following types of noise emission:

- airborne noise at residences;
- airborne noise at sensitive land uses; and
- airborne noise at commercial and industrial premises.

The ICNG Noise Management Levels for each applicable type of noise emission are summarised in *Table D.1* to *Table D.3*; those relevant to this assessment are highlighted in green.

Table D.1 Construction Noise at Residences

Time of day	Management level LAeq, 15 minute[1]	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm, Saturday 8 am to 1 pm and no work on Sundays or public holidays	Noise Affected RBL + 10 dB	The noise affected level represents the point above which, there may be some community reaction to noise. • where the predicted or measured LAeq (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level; and • the proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.

	Highly Noise Affected **≤ 75**	The highly noise affected level represents the point above which there may be strong community reaction to noise.
		• where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account:
		  • times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences; and
		  • if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

1. dB re: 2 x 10^{-5} Pa.

Table D.2 Sensitive Land Uses

Land use	Management Level[1] [2]
Classrooms at schools and other educational institutions	Internal noise level ≤ 45
Hospital wards and operating theatres	
Places of worship	
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level ≤ 65
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level ≤ 60
Community centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS2107 for specific uses

1. dB(A) re 2 x 10-5 Pa; and
2. Leq, 15 minute dB(A) - applies only when properties are being used.

Table D.3 Commercial and Industrial Premises

Land use	Management Level[1] [2]
Industrial premises	External noise level ≤ 75
Offices, retail outlets	External noise level ≤ 70

1. dB(A) re 2 x 10-5 Pa;
2. Leq, 15 minute dB(A) - applies only when properties are being used; and
3. other businesses that may be very sensitive to noise, where the noise level is project specific.

D.2 ROAD NOISE POLICY ASSESSMENT METHODOLOGY

The project-specific road traffic noise assessment criteria have been developed with due regard to and in accordance with the NSW Department of Environment, Climate Change and Water – NSW *Road Noise Policy* (the road noise policy), March 2011. This policy presents a detailed approach and methodology to quantitatively assess potential noise impacts associated with road traffic noise on public roads and aims to identify the strategies which may be applied to address potential issues from a range of project type, in this case new traffic-generating developments.

Section 2.3 and 2.4 of the road noise policy present noise assessment criteria and relative increase criteria which can be applied to assess road traffic noise, these are reproduced below; those relevant to the assessment are highlighted green. The criteria aim to provide protection primarily inside and immediately around permanent residences, and at schools, hospitals and other sensitive land uses, rather than at all points in a given locality, which would not be practical or possible.

Table D.4 Road Traffic Noise Assessment Criteria for Residential Land Uses

		Assessment Criteria – dB(A)	
		Day	Night
Road Category	**Type of Project/Land Use**	**(7 a.m.–10 p.m.)**	**(10 p.m.–7 a.m.)**
Freeway/ arterial/ sub-arterial roads	1. Existing residences affected by noise from new freeway/arterial/sub arterial road corridors	LAeq, (15 hour) 55 (external)	LAeq, (9 hour) 50 (external)
	2. Existing residences affected by noise from redevelopment of existing freeway/arterial/sub arterial roads	LAeq, (15 hour) 60 (external)	LAeq, (9 hour) 55 (external)
	3. Existing residences affected by additional traffic on existing freeways/arterial/sub arterial roads generated by land use developments		
Local roads	4. Existing residences affected by noise from new local road corridors	LAeq, (1 hour) 55 (external)	LAeq, (1 hour) 50 (external)
	5. Existing residences affected by noise from redevelopment of existing local roads		
	6. Existing residences affected by additional traffic on existing local roads generated by land use developments		

Table D.5 Road Traffic Noise Assessment Criteria for Non-Residential Land Uses

Sensitive Land Use	Assessment Criteria – dB(A) Day (7 a.m.–10 p.m.)	Assessment Criteria – dB(A) Night (10 p.m.–7 a.m.)	Additional Considerations
1 School classrooms	LAeq, (1 hour) 40 (internal) when in use	-	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the maximum levels shown in Australian Standard 2107:2000 (Standards Australia 2000).
2 Hospital Wards	LAeq, (1 hour) 35 (internal)	LAeq, (1 hour) 35 (internal)	
3 Places of worship	LAeq, (1 hour) 40 (internal)	LAeq, (1 hour) 40 (internal)	The criteria are internal, i.e. the inside of a church. Areas outside the place of worship, such as a churchyard or cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for such external areas, it should be established what in these areas may be affected by road traffic noise. For example, if there is a church car park between a church and the road, compliance with the internal criteria inside the church may be sufficient. If, however, there are areas between the church and the road where outdoor services may take place such as weddings and funerals, external criteria for these areas are appropriate. As issues such as speech intelligibility may be a consideration in these cases, the passive recreation criteria (see point 5) may be applied.
4 Open space (active use)	LAeq, (15 hour) 60 (external) when in use	-	Active recreation is characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion. Passive recreation is characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, eg playing chess, reading. In determining whether areas are used for active or passive recreation, the type of activity that occurs in that area and its sensitivity to noise intrusion should be established. For areas where there may be a mix of passive and active recreation, eg school playgrounds, the more stringent criteria apply. Open space may also be used as a buffer zone for more sensitive land uses.
5 Open space (passive use)	LAeq, (15 hour) 55 (external) when in use	-	

Sensitive Land Use	Assessment Criteria – dB(A)		Additional Considerations
6 Isolated residences in commercial or industrial zones	-	-	For isolated residences in industrial or commercial zones, the external ambient noise levels can be higher than those in residential areas. Internal noise levels in such residences are likely to be more appropriate in assessing any road traffic noise impacts, and the proponent should determine suitable internal noise level targets, taking guidance from Australian Standard 2107:2000 (Standards Australia 2000).
7 Mixed use development	-	-	Each component of use in a mixed use development should be considered separately. For example, in a mixed use development containing residences and a childcare facility, the residential component should be assessed against the appropriate criteria for residences and the childcare component should be assessed against point 8 below.
8 Childcare facilities	Sleeping rooms LAeq, (1 hour) 35 (internal) Indoor play areas LAeq, (1 hour) 40 internal) Outdoor play areas LAeq, (1 hour) 55 (external)	-	Multi-purpose spaces, eg shared indoor play/sleeping rooms should meet the lower of the respective criteria. Measurements for sleeping rooms should be taken during designated sleeping times for the facility, or if these are not known, during the highest hourly traffic noise level during the opening hours of the facility.
9 Aged care facilities	-	-	Residential land use noise assessment criteria should be applied to these facilities

Table D.6 Relative Increase Criteria for Residential Land Uses

		Total traffic noise level increase – dB(A)	
Road category	**Type of project/development**	**Day (7 a.m.–10 p.m.)**	**Night (10 p.m.–7 a.m.)**
Freeway/arterial/ sub-arterial roads and transit-ways	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road	Existing traffic LAeq, (15 hour) + 12 dB (external)	Existing traffic LAeq, (9 hour) + 12 dB (external)

It should be noted that the 'existing' traffic noise level refers to the level from all road traffic noise sources which occur. Where the existing $L_{Aeq, (period)}$ road traffic noise level is found to be less than 30 dB(A), it is deemed to be 30 dB(A). A relative increase of 12 dB represents slightly more than an approximate doubling of perceived loudness and is likely to trigger community reaction, particularly in environments where there is a low existing level of traffic noise.

Annex E

Vibration Assessment Methodology

E.1 VIBRATION ASSESSMENT METHODOLOGY

The project-specific vibration assessment criteria have been developed with due regard to and in accordance with the following local and international structural damage and human annoyance guidelines.

- NSW Department of Environment and Conservation – NSW *Environmental Noise Management – Assessing Vibration: a Technical Guideline* (the vibration guideline), February 2006; and
- German Institute for Standardisation – DIN 4150 (1999-02) Part 3 (DIN4150-3) – *Structural Vibration - Effects of Vibration on Structures*.

Values relevant to this assessment are highlighted in green below.

Guidance Note

It should be noted that in this case, actual vibration impacts are negligible. Additional analysis would only be deemed necessary where exceedances of the relevant vibration guidelines are predicted. When required the following may be included to assess vibration:

- Presentation of predicted weekly and/or daily vibration levels;
- Analysis and assessment of potential event waveform and FFT (Fast Fourier Transform) analysis of frequency components; and
- Analysis and assessment of event duration and frequency occurrence (i.e. number of events) of vibration levels.

E.1.1 Structural Damage Criteria

In the absence of an Australian Standard, German Standard DIN41510-3 provides the most stringent criteria for evaluating the effects of vibration on structures, as a vibration velocity (mm/s).

When assessing potential structural damage impacts, vibration should be predicted at the foundation of a building or structure. The limits presented in this standard are generally recognised to be conservative.

The DIN4150-3 values (maximum levels measured in any direction at the foundation, or maximum levels measured in (x) or (y) horizontal directions, in the plane of the uppermost floor), are summarised in *Table E.1* and shown graphically in *Figure E.1* in the case of foundation levels.

For residential and commercial type structures, the standard recommends safe limits which increase with frequency values above 10Hz as shown.

Table E.1 Structural Damage Guideline Values

		Vibration Velocity in mm/s			
		At Foundation at a Frequency of:			Plane of Floor of Uppermost Storey
Line	Type of Structure	Less than 10Hz	10Hz to 50Hz	50Hz to 100Hz [1]	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	5 to 20	15
3	Structures that because of their particular sensitivity to vibration do not correspond to those listed in Lines 1 or 2 and have intrinsic value (eg buildings that are under a preservation order)	3	3 to 8	8 to 10	8

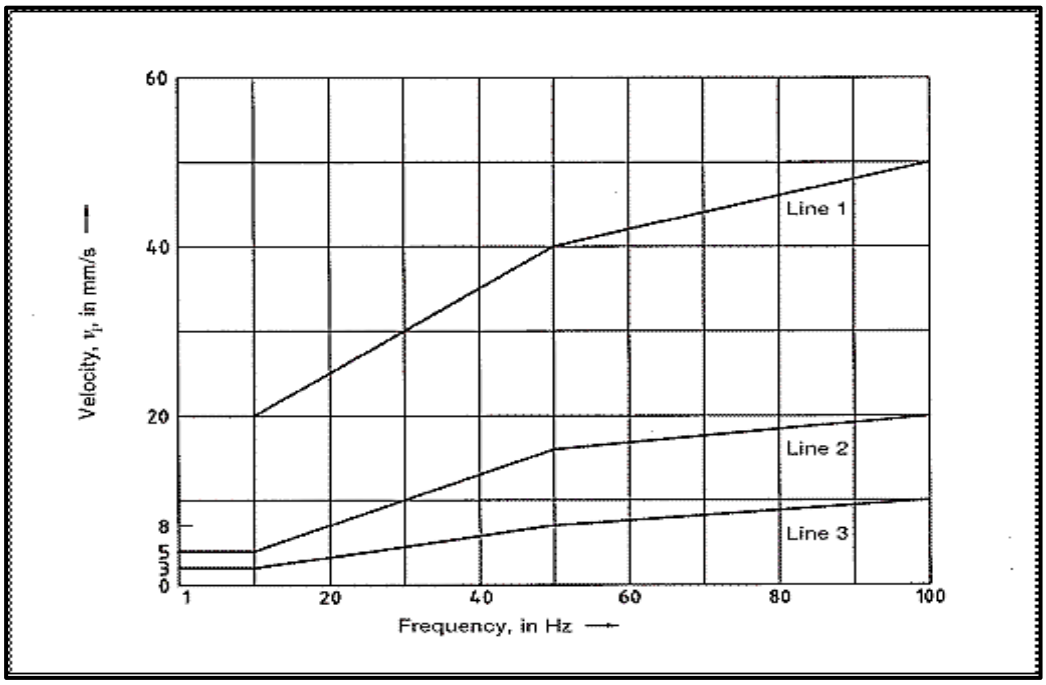
1. at frequencies above 100Hz, the values given in this column may be used as a minimum.

These levels are safe limits, for which damage due to vibration effects is unlikely to occur. Damage is defined in DIN4150-3 to include minor non-structural effects such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls.

Should such damage be observed without vibration levels exceeding the safe limits then it is likely to be attributable to other causes. DIN4150-3 also states that when vibration levels higher than the safe limits are present, it does not necessarily follow that damage will occur.

As indicated by the criteria from DIN4150-3 in *Table E.1* high frequency vibration has less potential to cause damage than that from lower frequencies. Furthermore, the point source nature of vibration from typical sources cause the vibratory disturbances to arrive at different parts of nearby large structures in an out-of-phase manner, thereby reducing its potential to excite in-phase motion and hence reducing the potential for damage.

Figure E.1 DIN4150-3 Structural Damage Guideline Values



E.1.2 Human Exposure and Annoyance Guidelines

The vibration guideline was published in February of 2006 by the DEC (now the Office of Environment and Heritage (OEH) and Environmental Protection Authority (EPA)) and is based on guidelines contained in *BS 6472 – 1992, Evaluation of human exposure to vibration in buildings (1-80Hz).*

The guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. At vibration values below the preferred values, there is a low probability of adverse comment or disturbance to building occupants. Where all feasible and reasonable mitigation measures have been applied and vibration values are still beyond the maximum value, it is recommended the operator negotiate directly with the affected community.

The guideline defines three vibration types and provides direction for assessing and evaluating the applicable criteria. Table 2.1 of the guideline provides examples of the three vibration types and has been reproduced in *Table E.2* below.

Table E.2 Examples of Types of Vibration

Continuous Vibration	Impulsive Vibration	Intermittent Vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery)	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, eg occasional dropping of heavy equipment, occasional loading and unloading. Blasting is assessed using ANZECC (1990)	Trains, intermittent nearby construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer these would be assessed against impulsive vibration criteria.

E.1.3 Continuous and Impulsive Vibration

Appendix C of the vibration guideline outlines acceptable criteria for human exposure to continuous and impulsive vibration (1-80Hz), these criteria are dependent on both the time of activity (usually daytime or night-time) and the occupied place being assessed.

Table E.3 reproduces the preferred and maximum criteria for continuous vibration relating to measured peak velocity.

Table E.3 Criteria for Exposure to Continuous Vibration

		Assessment Criteria	
		Peak Velocity (mm/s)	
Place	Time	Preferred	Maximum
Critical working Areas (eg hospital operating theatres, precision laboratories)	Day or Night-time	0.14	0.28
Residences	Daytime	0.28	0.56
	Night-time	0.20	0.40
Offices	Day or Night-time	0.56	1.10
Workshops	Day or Night-time	1.10	2.20

1. rms velocity (mm/s) and vibration velocity value (dB re 10^{-9} mm/s); and
2. values given for most critical frequency >8Hz assuming sinusoidal motion.

Table E.4 reproduces the preferred and maximum criteria for continuous vibration relating to measured peak velocity.

Table E.4 Criteria for Exposure to Impulsive Vibration

Place	Time	Assessment Criteria: Peak Velocity (mm/s) Preferred	Assessment Criteria: Peak Velocity (mm/s) Maximum
Critical working Areas (eg hospital operating theatres, precision laboratories)	Day or Night-time	0.14	0.28
Residences	Daytime	8.60	17.0
	Night-time	2.80	5.60
Offices	Day or Night-time	18.0	36.0
Workshops	Day or Night-time	18.0	36.0

1. rms velocity (mm/s) and vibration velocity value (dB re 10^{-9} mm/s); and
2. values given for most critical frequency >8Hz assuming sinusoidal motion.

E.1.4 Intermittent Vibration

Intermittent vibration (as defined in Section 2.1 of the guideline) is assessed using the vibration dose concept which relates to vibration magnitude and exposure time.

Intermittent vibration is representative of activities such as sheet piling, rolling or general excavation work (such as an excavator tracking).

Section 2.4 of the guideline provides acceptable values for intermittent vibration in terms of Vibration Dose Values (VDV) which requires the measurement of the overall weighted RMS (Root Mean Square) acceleration levels over the frequency range 1Hz to 80Hz. To calculate VDV the following formula (refer section 2.4.1 of the guideline) was used:

$$VDV = \left[\int_0^T a^4(t)dt\right]^{0.25}$$

Where VDV is the vibration dose value in $m/s^{1.75}$, *a (t)* is the frequency-weighted RMS of acceleration in m/s^2 and *T* is the total period of the day (in seconds) during which vibration may occur.

The acceptable VDV's for Intermittent Vibration is reproduced in *Table E.5*.

Table E.5 Acceptable Vibration Dose Values (VDV) for Intermittent Vibration

Location	Daytime		Night-time	
	Preferred Value, $m/s^{1.75}$	**Maximum Value, $m/s^{1.75}$**	**Preferred Value, $m/s^{1.75}$**	**Maximum Value, $m/s^{1.75}$**
Critical Areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and placed of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

1. daytime is 7am to 10pm and Night-time is 10pm to 7am; and
2. these criterions are indicative only, and there may be a need to assess intermittent values against continuous or impulsive criteria for critical areas.

There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Adverse comment or complaints may be expected if vibration values approach the maximum values. The guideline states that activities should be designed to meet the preferred values where an area is not already exposed to vibration.

E.1.5 Management, Control Short Term Works

It should be noted that *Section 2.5* of the vibration guideline provides information pertaining to 'short-term' construction works. This includes sheet piling, demolition and construction works that are of approximately one-week duration. For such short-term works it is suggested that higher vibration values (above the maximum) may apply, especially if a project has a demonstrated high level of social worth and provides broad community benefits. Additionally, the guideline suggests that for cases where higher levels are adopted, then best management practices should be implemented to reduce impacts along with a comprehensive community consultation program.

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