Noise Impact Assessment

Commercial Subdivision

1111-1141 Elizabeth Drive, Cecil Park

VMS AUSTRALIA

Report Number 10-1459

ae design partnership

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1 Introduction

It is proposed to develop a commercial subdivision at 1111-1141 Elizabeth Drive, Cecil Park (the Project). The subdivision is likely to be affected by road traffic noise from Cecil Road, Elizabeth Drive and to the lesser extent, Wallgrove Road and the M7 motorway. The is also the potential for the surrounding residences to affected by noise emissions from development.

VMS Australia Pty Ltd has been engaged by ae design partnership to provide a noise and vibration impact assessment for the Project and in support of the Environmental Impact Statement in order to satisfy the requirements of Fairfield City Council and the Department of Planning and Environment (DPE) Secretary's Environmental Assessment Requirements (SEARs).

This report presents the criteria nominated in the Infrastructure SEPP, assesses the Project against the documented design objectives and controls, and where required, provides recommendations ameliorate the acoustical amenity.

2 Project Description

- The Project Site is located at Lot 2, Section 4 DP 2954, 1111-1141 Elizabeth Drive, Cecil Park within Fairfield Local Government Area as presented in **Figure 1**. Residential receivers are located to the north and east of the Project Site.

Figure 1 Project Site Location and Surrounding Residential Receivers

Image Courtesy of Six Maps.

3 Proposed Development

The proposed subdivision will comprise of 14 lots from 2,908 m^2 to 3,610m^2. **Figure 2** represents the lot layout of the proposed subdivision.

Figure 2 Proposed Subdivision Plan

Drawing courtesy of ae design partnership dated 21/3/2018.

3.1 Nearest Noise Sensitive Receivers

An aerial photograph of the site location and the surrounding area, including the location of the nearest noise sensitive receivers, are presented in **Figure 1**. The receivers are detailed in **Table 1**.

Table 1 Nearby Representative Noise Sensitive Receivers

Receiver Number	Address	Description
1	28 Cecil Road	Residential
2	30-36 Cecil Road	Residential
3	38-42 Cecil Road	Residential
4	18 Cecil Road	Residential
5	20-22 Cecil Road	Residential
6	87-95 Wallgrove Road	Residential
7	37-73 Wallgrove Road	Residential

4 Baseline Noise Monitoring

4.1 Unattended Background Noise Monitoring

To characterise the existing ambient acoustical environment of the area unattended noise monitoring was conducted adjacent to the northern boundary of the Project Site between Monday 11 December and Monday 18 December 2017.

The logger location was selected with consideration of other noise sources which may influence readings as well as of security issues for the noise monitoring equipment.

Instrumentation for the survey comprised of a Bruel and Kaer 2250 Environmental Noise Logger (serial number 3008706) fitted with microphone windshields. Calibration of the loggers was checked prior to and following measurements. Drift in calibration did not exceed ±0.5 dBA. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

Charts presenting summaries of the measured daily noise data are attached in **Appendix B**. The charts present each 24-hour period by incorporating the L_{A1}, L_{A10}, L_{Aeq} and L_{A90} noise levels for the corresponding 15-minute periods.

The measured data has been filtered to remove periods affected during adverse weather conditions following consultation of weather reports recorded at the Bureau of Meteorology (BOM) Badgerys Creek weather station. The filtered data is shown in **Appendix B**.

In order to conservatively assess the acoustical implications of the development at nearby sensitive receivers, the measured background noise data from the noise logger was processed in accordance with the Environmental Protection Authority's (EPA's) *Noise Policy for Industry 2017* (NPI).

Table 2 details the Rating Background Level (RBL) and L_{Aeq} noise levels recorded during the daytime, evening and night-time periods. Data affected by adverse meteorological conditions has been excluded from the results, and also excluded from the data used to determine the noise levels presented in **Table 2**.

Table 2 Measured Ambient Noise Levels Corresponding to EPA Noise Policy for Industry Assessment Time Periods – 18 Cecil Road

Daytime1		Evening1		Night-time1	
RBL[2]	LAeq[3]	RBL[2]	LAeq[3]	RBL[2]	LAeq[3]
46	54	46	51	41	52

Note 1: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am.
On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am.

Note 2: The RBL noise level is representative of the "average minimum background sound level" (in the absence of the source under consideration), or simply the background level.

Note 3: The L_{Aeq} is essentially the "average sound level". It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

4.2 Road Traffic Noise Intrusion

In order to assess the road traffic noise impacts on the site, the data was obtained from the noise logging conducted at 1279 Elizabeth Drive, Mount Vernon during the period 27 August to 12 September 2013 has been processed to establish representative ambient noise levels over the time periods defined in the Environment Protection Authority's (EPA's) *Road Noise Policy* (RNP). The results are presented in **Table 3**.

Charts presenting summaries of the measured daily noise data are attached in **Appendix C**. The charts present each 24-hour period by incorporating the LA1, LA10, LAeq and LA90 noise levels for the corresponding 15-minute periods.

The measured data has been filtered to remove periods affected during adverse weather conditions following consultation of weather reports recorded at the Bureau of Meteorology (BOM) Badgerys Creek weather station. The filtered data is presented in **Appendix C**.

Table 4 details the Rating Background Level (RBL) and L_{Aeq} noise levels recorded during the daytime, evening and night-time periods. Data affected by adverse meteorological conditions has been excluded from the results, and also excluded from the data used to determine the noise levels presented in **Table 4**.

Table 3 Measured L_{Aeq} Road Traffic Noise Descriptors

Logger Location	Daytime (7:00am to 10:00 pm	Night-time (10:00 pm to 7:00 am)
	LAeq(15hour)	LAeq(9hour)
1279 Elizabeth Drive	64	61

The $L_{Aeq(15hour)}$ and $L_{Aeq(9hour)}$ descriptors represent the logarithmic average noise energy during the measurement period. The "15 Hour" represents the daytime period between 7:00 am to 10:00 pm and the "9 Hour" represents the night-time period between 10:00 pm to 7:00 am.

Table 4 Measured Ambient Noise Levels Corresponding to EPA Noise Policy for Industry Assessment Time Periods – 1279 Elizabeth Drive

Daytime[1]		Evening[1]		Night-time[1]	
RBL[2]	LAeq[3]	RBL[2]	LAeq[3]	RBL[2]	LAeq[3]
53	64	49	62	37	61

Note 1: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am.
On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am.

Note 2: The RBL noise level is representative of the "average minimum background sound level" (in the absence of the source under consideration), or simply the background level.

Note 3: The LAeq is essentially the "average sound level". It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

4.3 Operator Attended Noise Monitoring

Short-term attended noise monitoring was conducted on Monday 11 December 2017 at the logger location to determine the contribution from typical noise sources in the surrounding environment.

Instrumentation for the attended survey comprised a Bruel & Kaer 2250 sound level meter (serial number 3008618) fitted with a microphone windshield. Calibration of the sound level meter was checked prior to and following measurements. Drift in calibration did not exceed ±0.5 dBA. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

Measurements were conducted in accordance with AS 1055.1-1997: *"Acoustics - Description and measurement of environmental noise - General procedures"*.

The results of the operator attended noise survey are presented in **Table 5**.

Table 5 Operator Attended Noise Survey Results - dBA

Date / Start Time	Primary Noise Descriptor			Typical Maximum Levels dBA
	LAeq	LA1	LA90	
11/12/2017 8.30 am 15 Minute Measurement	64	68	49	Plane – 59-61 Birds – 46-58 Traffic (Elizabeth Drive) – 50-53 Traffic (Cecil Road) – 52-57 Dogs- 87-96

It was noted during the attended measurement that the acoustic environment was observed to be influenced by traffic along Cecil Road the majority of noise emissions from truck passbys and general wildlife.

5 Noise Assessment Criteria

Responsibility for the control of noise emissions in New South Wales is vested in Local Government and the NSW Environment Protection Authority (EPA).

The EPA oversees the NPI which provides a framework and process for deriving noise criteria. The NPI criteria for industrial noise sources have two components:

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

5.1 Project Intrusiveness Noise Level

For assessing intrusiveness, the background noise generally needs to be measured. The Project Intrusiveness Noise Level essentially means that the equivalent continuous noise level (L_{Aeq}) of the source should not be more than 5 dBA above the measured Rated Background Level (RBL), over any 15-minute period.

5.2 Project Amenity Noise Level

The amenity criterion is based on land use and associated activities (and their sensitivity to noise emission). The cumulative effect of noise from industrial sources needs to be considered in assessing the impact. The criteria relate only to industrial-type noise sources and do not include road, rail or community noise. The existing noise level from industry is measured. If it approaches the criterion value, then noise levels from new industrial-type noise sources, (including air-conditioning mechanical plant) need to be designed so that the cumulative effect does not produce total noise levels that would significantly exceed the criterion.

The Project Amenity Noise Level corresponds to the recommended amenity noise level for urban residences presented in Table 2.2 of the NPI minus 5dBA.

The Project will consists of multiple new noise-generating premises, therefore an additional Individual Project Amenity Noise Level is also to be applied to the individual developments on each Project lot. The Project will comprise of 14 commercial lots. Accordingly, in accordance with section 2.4.2 of the NPI, the Individual Project Amenity Noise Level corresponds to the recommended amenity noise level for urban residences presented in Table 2.2 of the NPI minus 16 dBA.

5.3 Receiver Category

The NPI, for the purposes of determining the appropriate Project Amenity Noise Level, characterises an "Urban" noise environment as 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.
- Has any combination of the above.

Where "urban hum" means the aggregate sound of many unidentifiable, mostly traffic-related sound sources.

For the purposes of this assessment, the area surrounding the nearest sensitive receivers falls under the "Urban" category.

5.4 Sleep Disturbance

Intermittent noises, in particular those with short durations, due to activities such as car doors closing are not directly addressed by the NPI. A definitive noise level whereby sleep disturbance is likely to occur is not available and research in the area is ongoing. Notwithstanding, the NPI nominates two trigger levels above which a detailed maximum noise level event assessment is to be undertaken.

The night-time sleep disturbance maximum noise level event assessment is required if either of the following trigger level conditions are met:

- $L_{Aeq(15\ minute)}$ > 40 dBA and RBL plus 5 dBA
- L_{AFmax} > 52 dBA and RBL plus 15 dBA

If required, the detailed maximum noise level event assessment is to include the maximum noise level, the extent to which the maximum noise level exceeds the RBL, and the number of times the event occurs during the night-time period. A summary of research is included in the EPA's Road Noise Policy (RNP) and concludes that:

- Maximum internal noise levels below 50-55 dBA are unlikely to awaken people.
- One or two noise events per night, with maximum internal noise levels of 65-70 dBA, are not likely to affect health and wellbeing significantly.

Subsequently, an external criterion of L_{Amax} 60-65 dBA and 75-80 dBA respectively results, if a 10 dBA loss through open windows is adopted (as suggested in the policy).

The wide discrepancy in sleep disturbance screening criteria reflects the uncertainty regarding definitive noise levels and sleep disturbance. Nonetheless, this assessment considers the NPI sleep disturbance trigger levels.

It is also noted that Elizabeth Drive and Wallgrove Road are arterial road carrying heavy vehicles throughout the night-time period.

5.4.1 Project Noise Trigger Levels

Having defined the area type, the processed results of the unattended noise monitoring have been used to determine Project Noise Trigger Levels. The project intrusive and amenity noise levels for nearby residential premises are presented in **Table 6**. These criteria are nominated for the purpose of assessing potential noise impacts from the Project.

For each assessment period, the more stringent of the project amenity or intrusive noise levels are adopted as the Project Noise Trigger Levels as marked in bold in **Table 6**.

Table 6 Project Noise Trigger Levels

Receiver	Time of Day	Recommended Amenity Noise Level $L_{Aeq(period)}$	Measured RBL [1] $L_{A90(15minute)}$	Measured $L_{Aeq(period)}$	Project Noise Trigger Level $L_{Aeq(15minute)}$		Sleep Disturbance Trigger Level	
					Intrusive	Amenity	$L_{A90(15minute)}$	L_{AFmax}
Residential	Day	60	46	54	**51**	55	-	-
	Evening	50	46	51	51	**45**	-	-
	Night	45	41	52	46	**40**	**46**	**56**

Note 1: RBL = "Rating Background Level".

The Individual Project Amenity Noise Trigger Levels for the developments on each Project lot is presented in **Table 7**.

Table 7 Individual Project Amenity Noise Trigger Levels

Receiver	Time of Day	Recommended Amenity Noise Level $L_{Aeq(period)}$	Measured RBL [2] $L_{A90(15minute)}$	Measured $L_{Aeq(period)}$	Individual Project Amenity Noise Trigger Level $L_{Aeq(15minute)}$
Residential	Day	60	46	54	44
	Evening	50	46	51	34
	Night	45	41	52	29

Note 1: RBL = "Rating Background Level".

6 Vibration Assessment Criteria

6.1 Structural Damage Criteria

Most commonly specified "safe" structural vibration limits are designed to minimise the risk of threshold or cosmetic surface cracks and are set well below the levels that have potential to cause damage to the main structure.

6.1.1 British Standard 7385: Part 2 – 1993

In terms of the most recent relevant vibration damage criteria, Australian Standard AS 2187: Part 2-2006 "Explosives Storage and Use Part 2: Use of Explosives" recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2$1993 "Evaluation and measurement for vibration in buildings Part 2" as they "are applicable to Australian conditions".

The standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

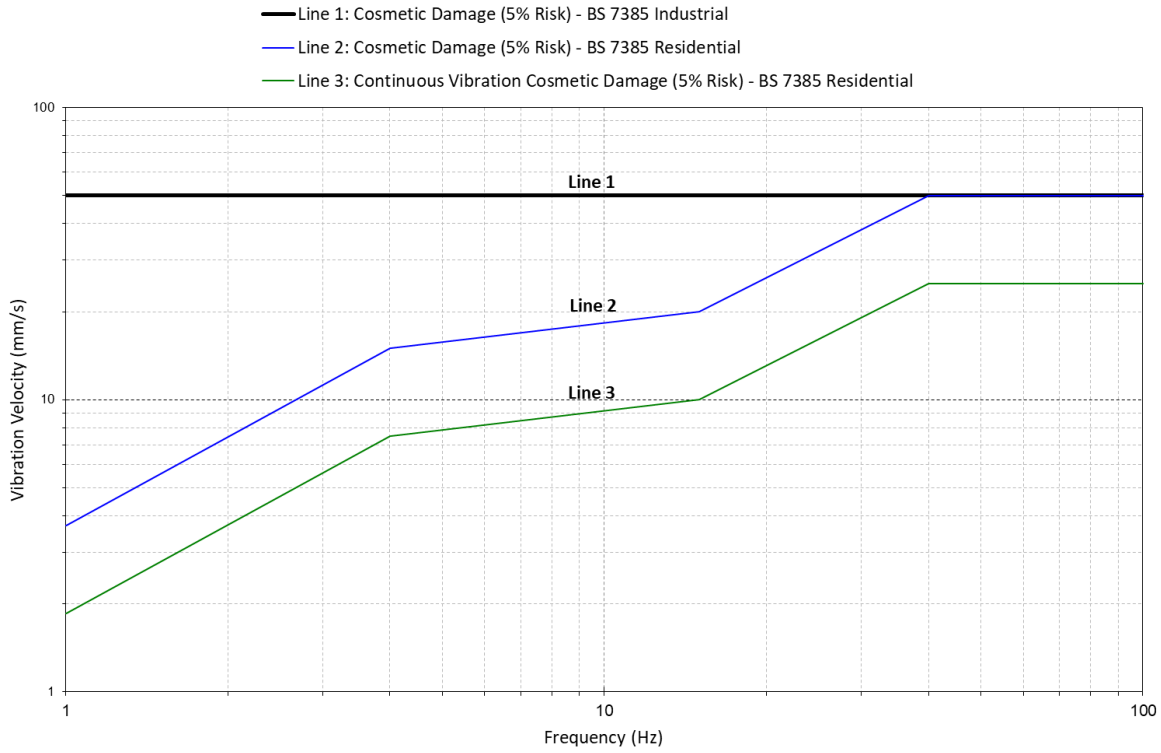
Sources of vibration that are considered in the standard include demolition, blasting (carried out during mineral extraction or construction excavation), piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in **Table 8** and graphically in **Figure 3**.

Table 8 Transient Vibration Guide Values - Minimal Risk of Cosmetic Damage

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Figure 3 Graph of Transient Vibration Guide Values for Cosmetic Damage



In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for building types corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.

The standard goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in **Table 8**, and major damage to a building structure may occur at values greater than four (4) times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in **Table 8** should not be reduced for fatigue considerations.

In order to assess the likelihood of cosmetic damage due to vibration, AS 2187 specifies that vibration measured should be undertaken at the base of the building and the highest of the orthogonal vibration components (transverse, longitudinal and vertical directions) should be compared with the criteria curves presented in **Table 8**.

It is noteworthy that extra to the guide values nominated in **Table 8**, the standard states that:

"Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK."

Also that:

"*A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive*."

6.1.2 German Standard DIN 4150: Part 3-1999

For continuous long-term vibration or repetitive vibration with the potential to cause fatigue effects, DIN 4150 provides the following Peak Particle Velocity (PPV) values as safe limits, below which even superficial cosmetic damage is not to be expected:

- 10 mm/s for commercial buildings and buildings of similar design.
- 5 mm/s for dwellings and buildings or similar design.
- 2.5 mm/s for buildings of great intrinsic value (eg heritage listed buildings).

For short-term vibration events (ie those unlikely to cause resonance or fatigue), DIN 4150 offers the criteria shown in **Table 9**. These are maximum levels measured in any direction at the foundation or in the horizontal axes in the plane of the uppermost floor.

Table 9 DIN 4150 Structural Damage - Safe Limits for Short-term Building Vibration

Group	Type of Structure	Peak Particle Velocity (mm/s)			
		At Foundation			Plane of Floor of Uppermost Storey
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz[1]	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design20	20	20 at 10 Hz increasing to 40 at 50 Hz	40 at 50 Hz increasing to 50 at 100 Hz	40

Group	Type of Structure	Peak Particle Velocity (mm/s)			
		At Foundation			Plane of Floor of Uppermost Storey
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz[1]	All Frequencies
2	Dwellings and buildings of similar design and/or use	5	5 at 10 Hz increasing to 15 at 50 Hz	15 at 50 Hz increasing to 20 at 100 Hz	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 ad have intrinsic value (eg buildings that are under a preservation order	3	3 at 10 Hz increasing to 8 at 50 Hz	8 at 50 Hz increasing to 10 at 100 Hz	8

Note 1: For frequencies above 100 Hz the upper value in this column should be used.

As opposed the "minimal risk of cosmetic damage" approach adopted in BS 7385 (95% probability of no effect), the "safe limits" given in DIN 4150 are the levels up to which no damage due to vibration effects has been observed for the particular class of building. "Damage" is defined by DIN 4150 to include even 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.

6.2 Human Comfort Vibration Criteria

Vibration and its associated effects on people are usually classified as continuous, impulsive or intermittent as follows:

- Continuous vibration: machinery, steady road traffic, continuous construction activity such as underground drilling
- Impulsive vibration: infrequent activities that create up to three distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading
- Intermittent vibration: trains, nearby intermittent demolition activity, rock breakers and jack hammers.

Structural vibration in buildings can be detected by the occupants possibly affecting them in various ways including reducing working efficiency and quality of life. Complaint levels from occupants of the buildings subject to vibration depend on the use of the building and the time of day.

Acceptable levels of continuous vibrations depend on the time of day and the activity being undertaken. The preferred values for continuous and impulsive vibration for office and residential buildings are presented in Table 10 and Table 11 (as nominated in the EPA's *Assessing Vibrations: a technical guideline, Table C1.1*).

Table 10 Criteria for exposure to Continuous Vibration

Space Occupancy	Time of Day	Peak velocity(mm/s)	
		Preferred[1]	Maximum
Residential	Day	0.28	0.56

Space Occupancy	Time of Day	Peak velocity(mm/s)	
		Preferred[1]	Maximum
	Night	0.20	0.4
Offices	Day/Night	0.56	1.1

Note 1: The Preferred Peak Velocity presented represent a "perceptible level of vibration".

Table 11 Criteria for exposure to Impulsive Vibration

Space Occupancy	Time of Day	Peak velocity(mm/s)	
		Preferred[1]	Maximum
Residential	Day	8.6	17.0
	Night	2.8	5.6
Offices	Day/Night	18.0	36.0

Note 1: The Preferred Peak Velocity presented represent a "perceptible level of vibration".

In the case of intermittent vibration, which is caused by plant such as rock breakers, the criteria are expressed as a Vibration Dose Value (VDV). The calculation of a VDV is used to evaluate the cumulative effects of bursts of intermittent vibration. Various studies have shown that VDV assessment methods far more accurately assess the level of disturbance than methods which assess the vibration magnitude only.

The acceptable VDV intermittent vibration for residential and office building uses are presented in Table 12 (as nominated in the *EPA's Assessing Vibrations: a technical guideline, Table 2.4*).

Table 12 Acceptable Vibration Dose Values

Space Occupancy	Time of Day	VDV ($m/s^{1.75}$)	
		Preferred	Maximum
Residential	Day	0.20	0.40
	Night	0.13	0.26
Offices, schools, educational institutions, places of worship	Day/Night	0.40	0.80

7 Noise Assessment

7.1 Road Traffic Noise Intrusion

Road traffic noise intrusion has been assessed based on project drawings provided by ae design partnership, drawing number SK 03 Revision C dated 11 September 2017. Based upon noise logger measurement results in **Table 3**, the noise levels incident upon the proposed future facades are summarised in **Table 13**.

Table 13 Facade Incident Noise Levels

Facade	Daytime (7:00 am - 10:00 pm) LAeq(15 hour) dBA	Night (10:00 pm - 7:00 am) (9 hour) dBA
North	56	53
East	62	59
South	64	61
West	62	59

As a guide, well designed and correctly installed standard 4 mm window glazing will typically attenuate external noise levels by approximately 20 dB with windows closed and approximately 10 dB with windows open (allowing for natural ventilation).

The predicted internal noise levels for standard facade glazing are presented in **Table 14**. For this development, all facades comprise glazing are presented in **Table 14**.

Table 14 Predicted Internal Noise Levels with Standard Glazing - Commercial

Facade	Occupancy Area	Descriptor	Internal Noise Level		Internal Noise Level Criteria[1] (dBA)
			Windows Open (dBA)	Windows Closed (dBA)	
North	Private Office	LAeq(15minute)	46	36	35
	General Office		46	36	40
East	Private Office	LAeq(15minute)	52	42	35
	General Office		52	42	40
South	Private Office	LAeq(15minute)	54	44	35
	General Office		54	44	40
West	Private Office	LAeq(15minute)	52	42	35
	General Office		52	42	40

Note 1: Criteria to be achieved with windows closed as per AS2107.

The predicted internal noise levels indicate that with closed standard-glazed windows, the internal noise level criteria within the offices are unlikely to comply on the east, south and western facades. It is therefore recommended that 10.38mm laminated glass be installed on the east, south and western facades and 8mm laminated glass on the northern façade to achieve satisfactory internal noise levels.

Alternative ventilation should therefore be provided to these rooms to enable the occupants to close windows during noisier periods, or if fixed facades are used. Any such ventilation design must meet the requirements of the National Construction Code.

7.2 Mechanical Plant

Mechanical ventilation / air-conditioning and refrigeration equipment will be provided, and plant selection will take place during the detailed design phase. All equipment would need to be selected and positioned to ensure compliance with the criteria set out in **Table 6** and **Table 7**.

Given the distance to the nearest premises, it is likely that the criteria will be met through the use of conventional noise control methods (eg selection on the basis of quiet operation and, where necessary, providing enclosures or localised barriers).

7.3 Indicative Noise Emission to Surrounding Residential Receivers

Based on the following assumptions, the estimated LAeq(15minute) noise emissions level at the nearest residential receivers has been predicted and presented in the table below.

- Noise emissions from mechanical plant – 100dBA/100m^2 of indicative building GFA (TOTAL GFA 12,324^2) = 120dBA
- 20% vehicle movements per hour of indicative number of car spaces (TOTAL car spaces 409) = 80 movements/hour = 20 light vehicle movements per 15-minute period
- 2 medium vehicle movement per 15-minute period
- 1 heavy vehicle movement per 15-minute period
- Average LAeq(15minute) Sound Power Level (SWL) of one light vehicle = 95 dBA
- Average LAeq(15minute) Sound Power Level (SWL) of one medium vehicle = 100 dBA
- Average LAeq(15minute) Sound Power Level (SWL) of one heavy vehicle = 105 dBA
- Based on the above assumptions the TOTAL site SWL is estimated to be 121dBA
- No noise barriers installed onsite

Table 15 Estimated LAeq(15minute) to Nearest Residential Receivers

Receiver Number	Address	Description	Distance	Estimated LAeq(15minute)
1	28 Cecil Road	Residential	267m	65 dBA
2	30-36 Cecil Road	Residential	328m	63 dBA
3	38-42 Cecil Road	Residential	314m	63 dBA
4	18 Cecil Road	Residential	188m	68 dBA
5	20-22 Cecil Road	Residential	225m	66 dBA
6	87-95 Wallgrove Road	Residential	459m	60 dBA
7	37-73 Wallgrove Road	Residential	368m	62 dBA

8 Vibration Assessment

The main source of vibration emission during the proposed works will occur when rockbreakers are used.

On this site, it is recommended that a smaller hammer be used to ensure that rockbreaking works can safely be undertaken without the risk of damage being sustained to adjacent structures, primarily to the north-west of the site.

Given that the offset distance from nearby occupied dwellings to the proposed works is generally greater than 20 m, vibration levels from light capacity rockbreaking are predicted to comply with the limiting range of human comfort criteria (refer to Section **6.2**).

Vibration emissions may also occur if heavy objects are dropped from a height. The operators of the plant should therefore take care to ensure that this does not occur.

8.1 Safe Working Distances for Vibration Intensive Activities

Safe working distances for typical items of vibration intensive plant are listed in **Table 16**. These distances are indicative only and can vary depending on the particular item of plant and geotechnical conditions.

Vibration monitoring is recommended for site-specific activities and in situations where there is any doubt regarding the suitability of the plant or where there is believed to be a risk of exceeding the applicable vibration criteria.

Table 16 Safe Working Distances for Vibration Intensive Plant Items

Item	Rating	Safe Working Distance	Comments
Rockbreaker	Light - 600 kg	2 m	Based on a 5 mm/s criterion
Rock Saw	-	1 m (nominal)	Based on a 5 mm/s criterion
Excavator Ripping	-	1 m (nominal)	Avoid contact with structure
Vibratory Roller	-	20 m	Based on a 5 mm/s criterion

8.2 Vibration Damage

Disturbance to building occupants can potentially occur at much lower vibration levels than the safe limits relating to building damage.

The risk of exceeding the recommended building damage criteria should be managed by carrying out vibration measurements during excavation and earth works in order to establish satisfactory buffer zones, as outlined in **Section 8.1**.

8.3 Preparatory Works

Prior to the commencement of the works, fencing (typically 2.4 m in height) will be installed around the perimeter of the site by the construction contractor. Fencing which is contiguous and solid would provide some acoustic shielding of noise emissions from the construction works and the loading of trucks.

8.4 Vibration Mitigation Measures

The following vibration mitigation measures will be implemented by the construction contractor:

- Relocate any vibration generating plant and equipment to areas within the site to lower the vibration impacts.
- Investigate the feasibility of rescheduling the hours of operation of major vibration generating plant and equipment.
- Use lower vibration generating items of excavation plant and equipment e.g. smaller capacity rock breaker hammers.
- Minimise consecutive works in the same locality (if applicable).
- Schedule a minimum respite period of at least 30 minutes before activities commence which are to be undertaken for a continuous 4-hour period.
- Use only dampened rock breakers and/or “city” rock breakers to minimise the impacts associated with rock breaking works.

9 Conclusion

VMS Australia Pty Ltd has conducted a DA stage noise and vibration impact assessment of the proposed commercial subdivision at 1111-1141 Elizabeth Drive, Cecil Park.

Results of the noise emission to the residential receivers outlined in **Section 7.3** indicate exceedances to various residential developments. However, a comprehensive assessment pertaining to the type of mechanical plant, vehicle class and movements and operational scenarios within the development are required to accurately strategize mitigation methods. Given the topography of the surrounding area, nearest noise sensitive receptors generally overlook the development and are therefore directly exposed to operational noise emissions.

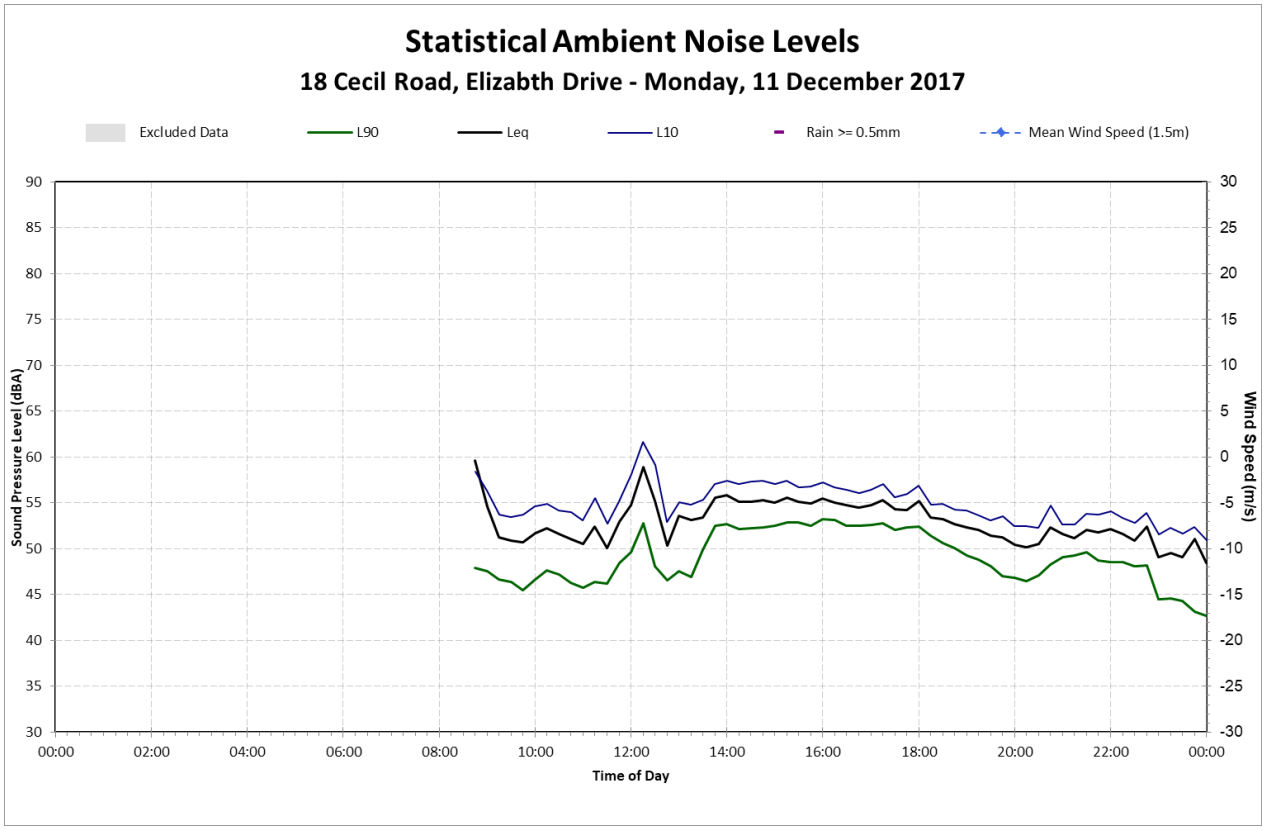
Noise emission affecting general office space from road traffic noise is not expected to be of concern with general construction practices. However, glazing thickness outlined in **Section 7.1** must be observed to achieve internal noise compliance. Acoustic detail design of office fit-outs can be assisted in achieving higher star ratings within the office and general spaces.

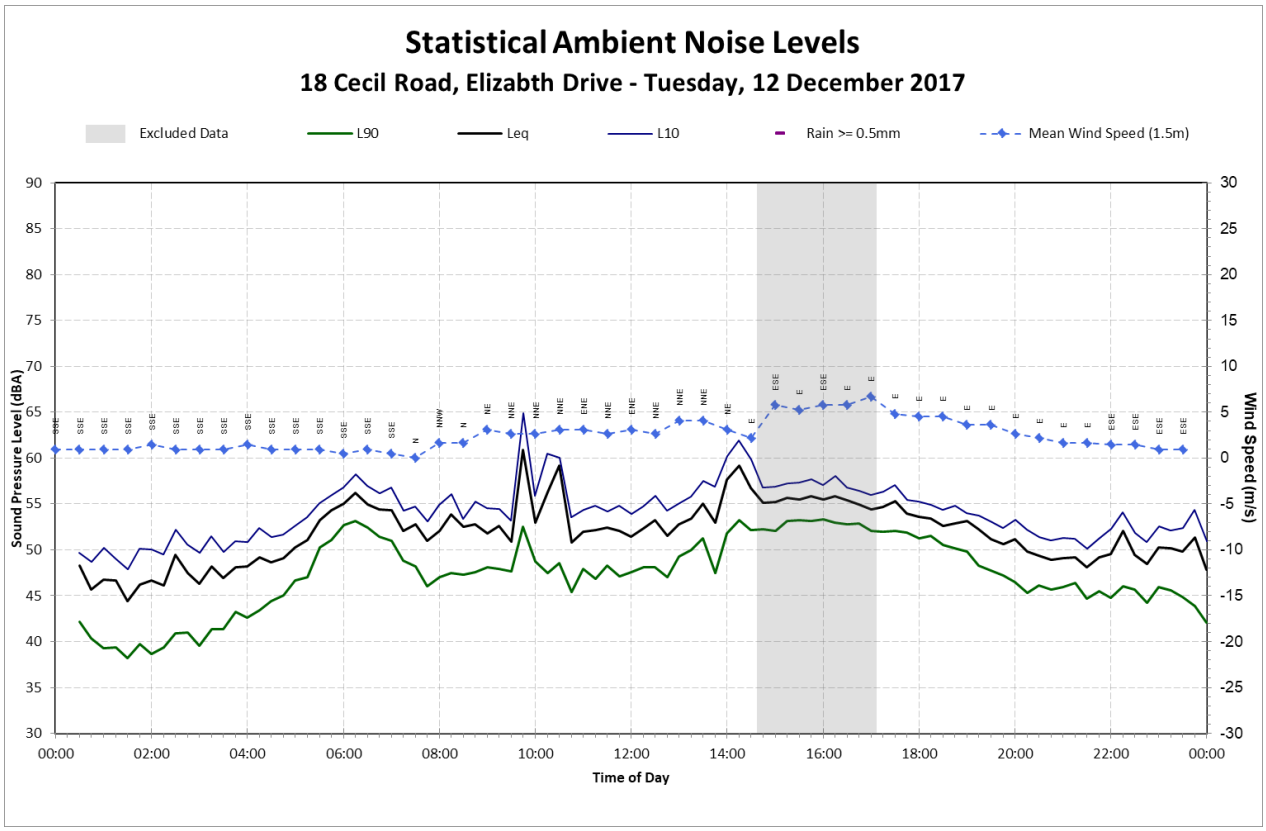
Safe working distances to prevent building damage have been provided in **Section 8.1**. Vibratory roller is predicted to be used for this project and data should be used as a guide when used in close proximity to building structures. Operational vibration is not expected to be of concern to nearby residential receivers.

Based upon the findings of this assessment, the development as proposed appears satisfactory in terms of its general planning arrangement.

Terminology Relating to Noise and Vibration

Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Power	Sound Power is the rate at which sound energy is emitted, reflected, transmitted or received, per unit time. Unlike sound pressure, sound power is neither room-dependent nor distance-dependent.
Sound Pressure Level (SPL)	The sound level is the sound pressure relative to a standard reference pressure of 20µPa ($20x10^{-6}$ Pascals) on a decibel scale.
Sound Power Level (SWL)	The Sound Power Level is the sound power relative to a standard reference pressure of 1pW ($20x10^{-12}$ Watts) on a decibel scale. The SWL of a simple point source may be used to calculate the SPL at a given distance (r) using the following formula: $SPL = SWL - 10 \times Log_{10}(4 \times \pi \times r^2)$ Note that the above formula is only valid for sound propagation in the free-field (see below).
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s1 and s2 is given by 20 log10 (s1 / s2). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20µPa.
A-weighting, dBA	The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
Noise Level Indices	Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
$L_{eq,T}$	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
$L_{max,T}$	A noise level index defined as the maximum noise level during the period T. Lmax is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall Leq noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
$L_{90,T}$	A noise level index. The noise level exceeded for 90% of the time over the period T. L90 can be considered to be the "average minimum" noise level and is often used to describe the background noise.
$L_{10,T}$	A noise level index. The noise level exceeded for 10% of the time over the period T. L10 can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m
Fast/Slow Time Weighting	Averaging times used in sound level meters.
Octave Band	A range of frequencies whose upper limit is twice the frequency of the lower limit.
$D_{nT,w}$	The single number quantity that characterises airborne sound insulation between rooms over a range of frequencies.
Rw	Single number quantity that characterises the airborne sound insulating properties of a material or building element over a range of frequencies.
Reverberation	The persistence of sound in a space after a sound source has been stopped.
PPV	The particles of a medium are displaced from their random motion in the presence of a vibration wave. The greatest instantaneous velocity of a particle during this displacement is called the Peak Particle Velocity (PPV) and is typically measured in the units of mm/s.
Hertz, Hz	The unit of Frequency (or Pitch) of a sound or vibration. One hertz equals one cycle per second. 1 kHz = 1000 Hz, 2 kHz = 2000 Hz, etc.
Acceleration	Acceleration is defined as the rate of change of Velocity of a particle over a period of time and is typically measured in the units of m/sec^2.
Vibration Dose, VDV	When assessing intermittent vibration it is necessary to use the vibration dose value (VDV), a cumulative measurement of the vibration level received over an 8-hour or 16-hour period. The VDV formulae uses the RMS Acceleration raised to the fourth power and is known as the Root-mean-quad method. This technique ensures the VDV is more sensitive to the peaks in the acceleration levels. VDVs are typically measured in the units of $m/s^{1.75}$.


Statistical Ambient Noise Levels
18 Cecil Road, Elizabth Drive - Monday, 11 December 2017
Excluded Data
L90
Leq
L10
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day


Statistical Ambient Noise Levels
18 Cecil Road, Elizabth Drive - Tuesday, 12 December 2017
Excluded Data
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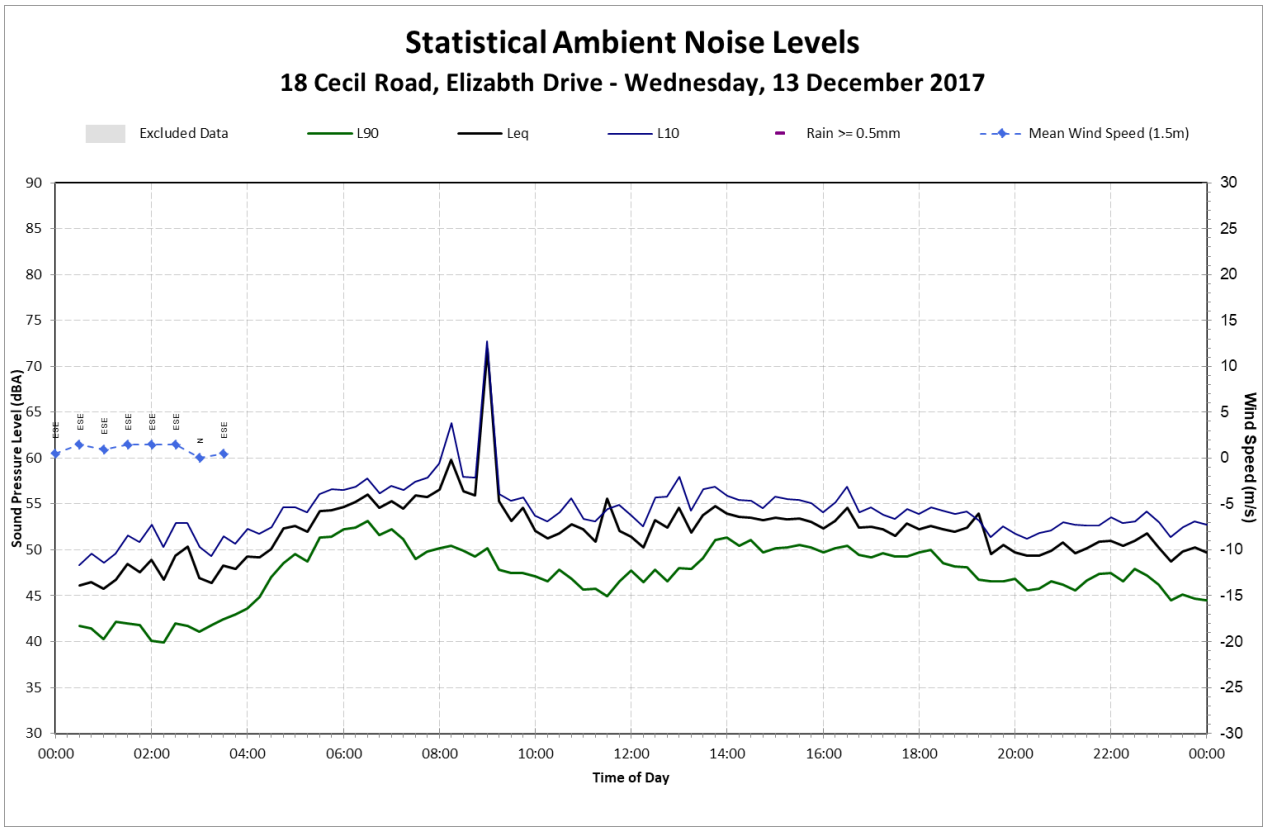
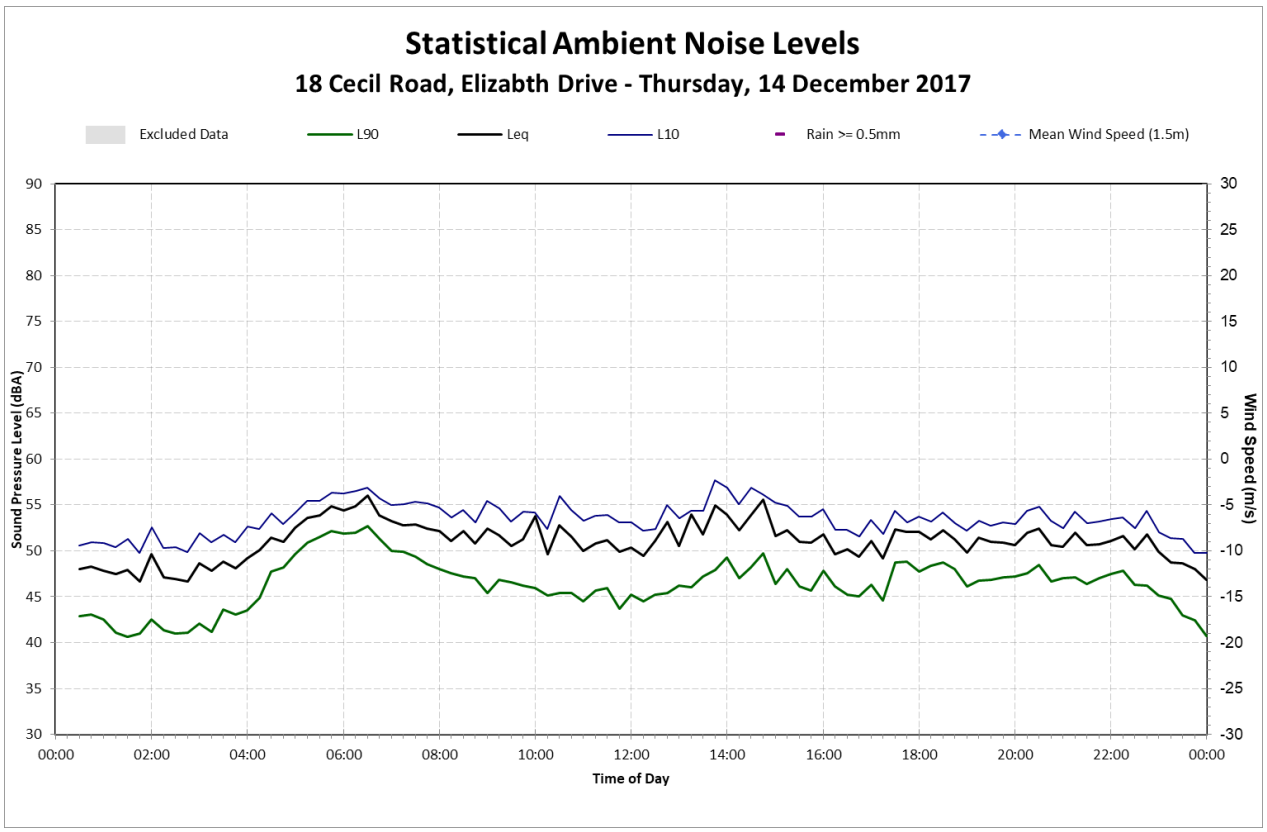
Leq
L10
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day


Statistical Ambient Noise Levels
18 Cecil Road, Elizabth Drive - Wednesday, 13 December 2017
Excluded Data
L90
Leq
L10
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day
ESE
N


Statistical Ambient Noise Levels
18 Cecil Road, Elizabth Drive - Thursday, 14 December 2017
Excluded Data
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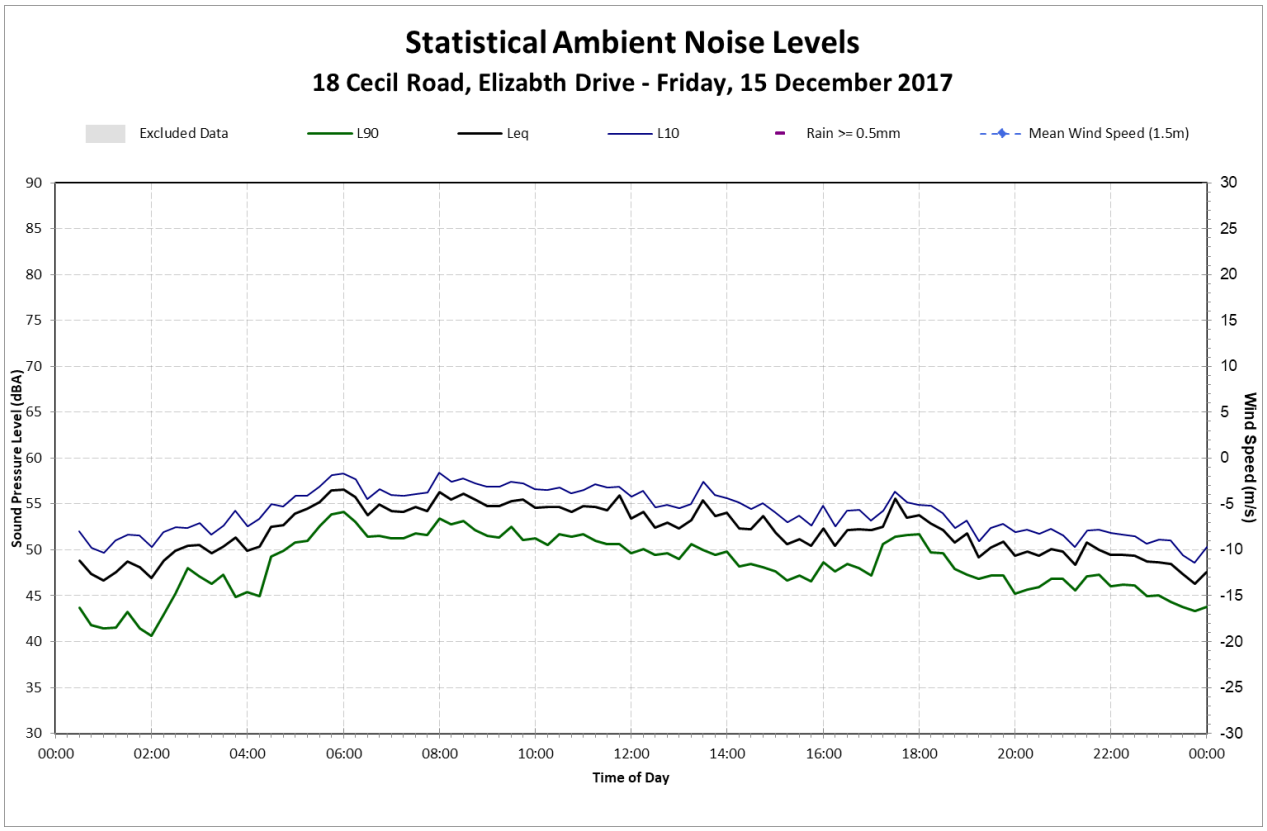
Leq
L10
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day


Statistical Ambient Noise Levels
18 Cecil Road, Elizabth Drive - Friday, 15 December 2017
Excluded Data
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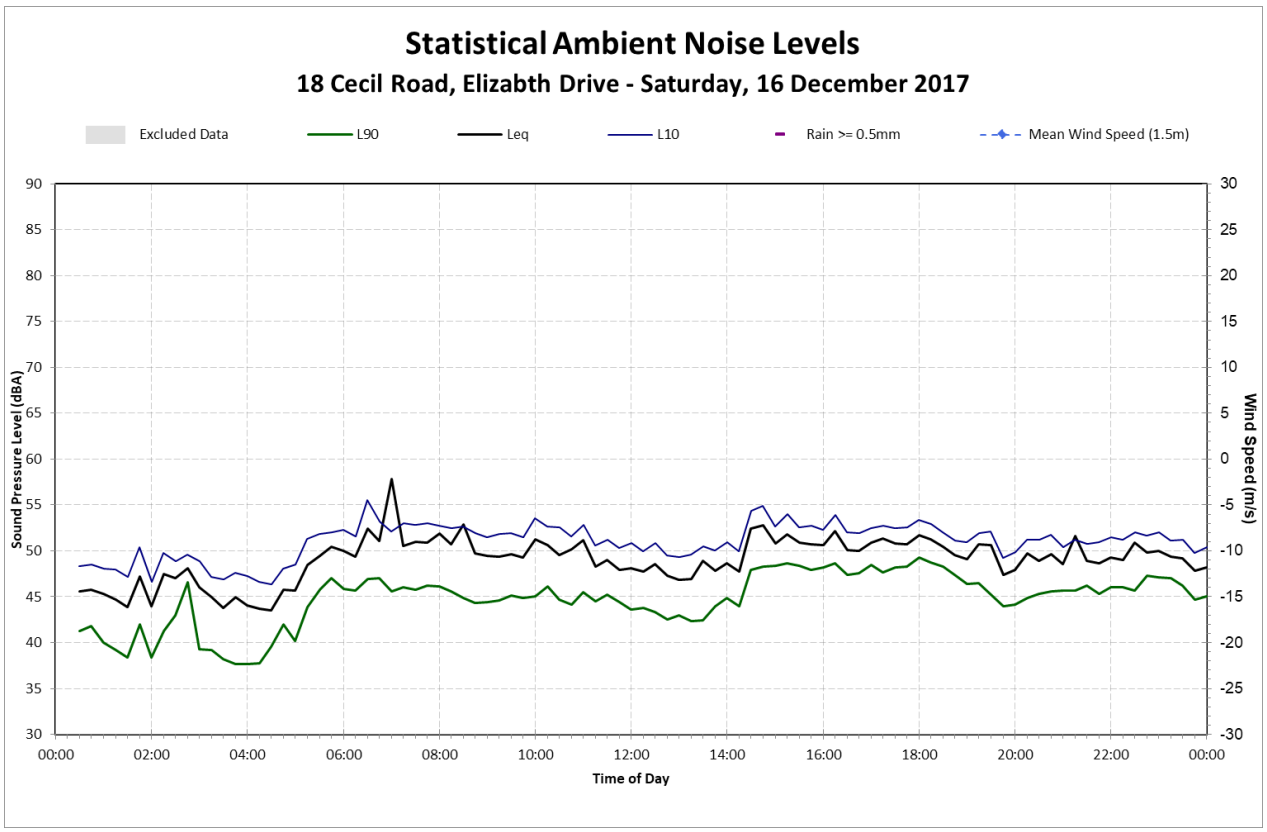
Leq
L10
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day


Statistical Ambient Noise Levels
18 Cecil Road, Elizabth Drive - Saturday, 16 December 2017
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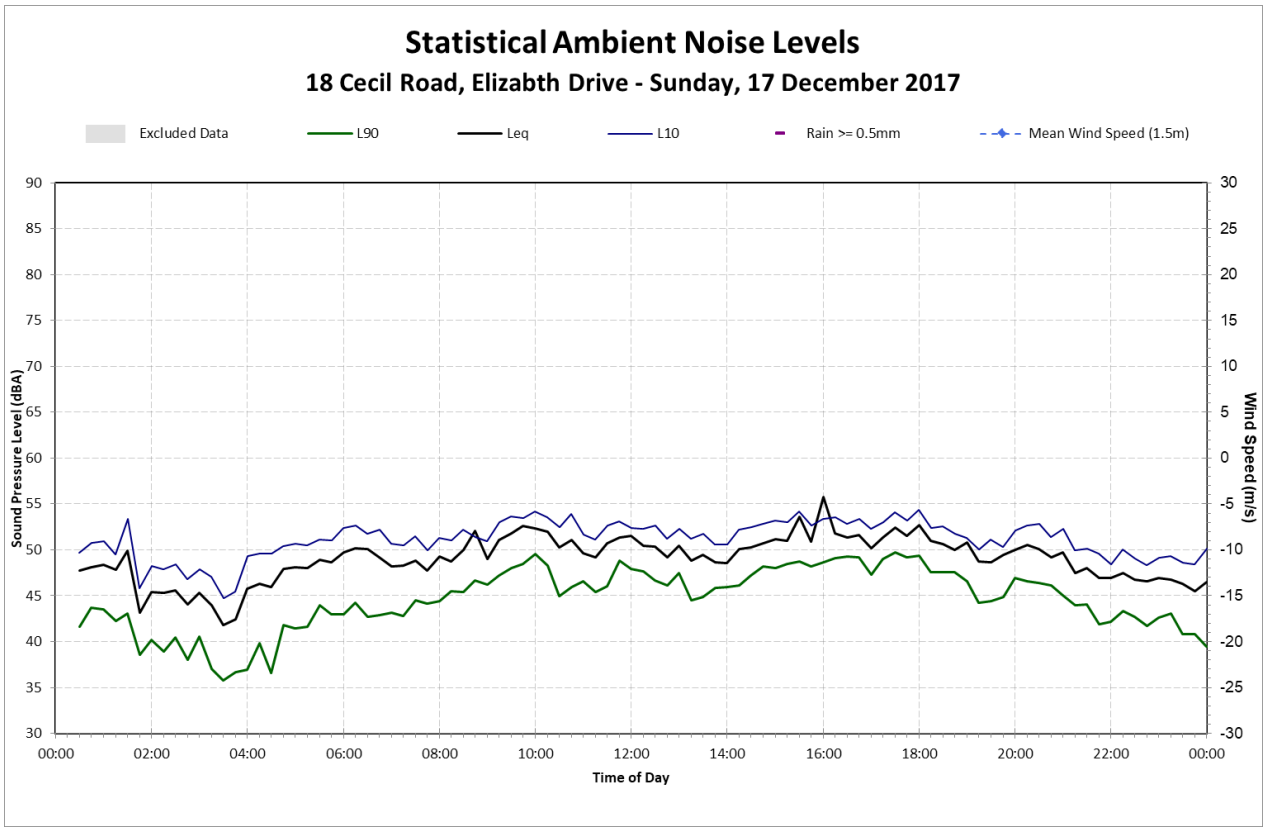
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day


Statistical Ambient Noise Levels
18 Cecil Road, Elizabth Drive - Sunday, 17 December 2017
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Leq
L10
Rain >= 0.5mm
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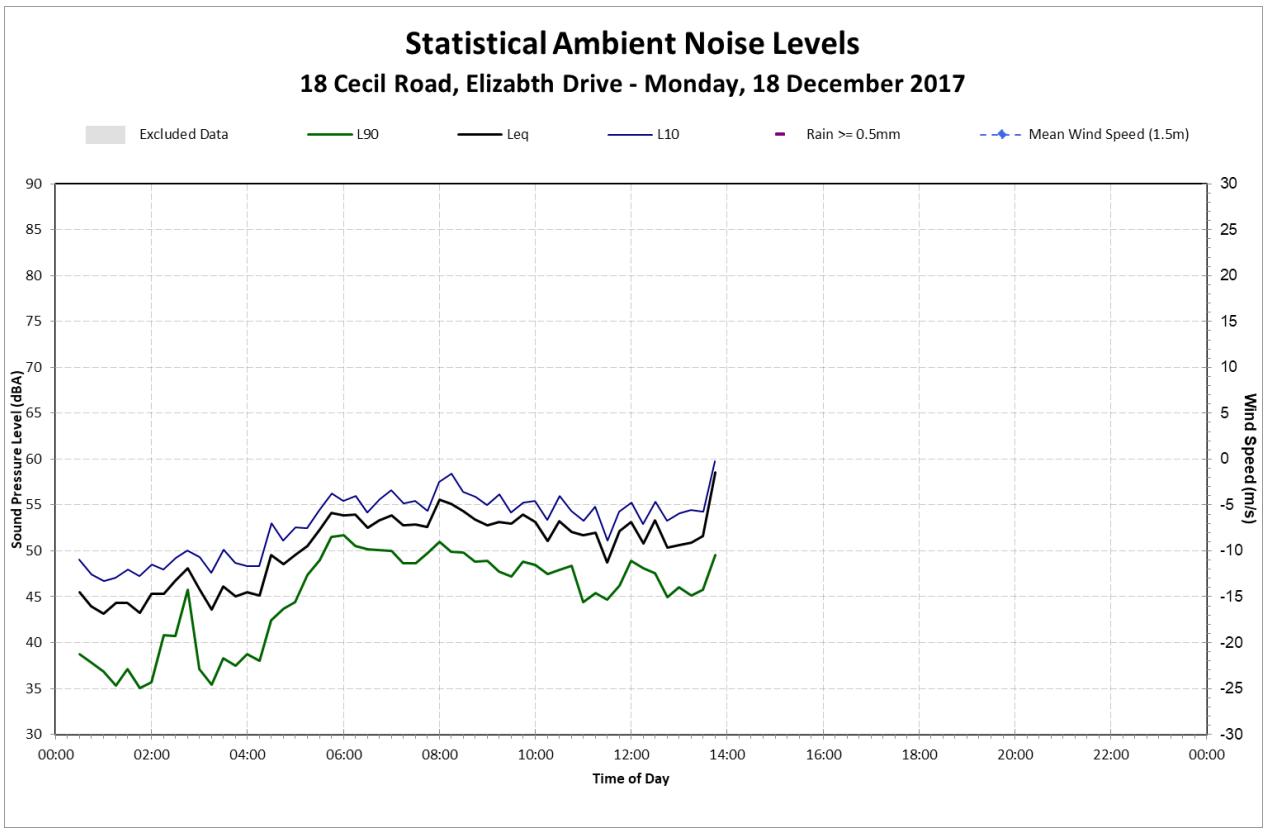
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day


Statistical Ambient Noise Levels
18 Cecil Road, Elizabth Drive - Monday, 18 December 2017
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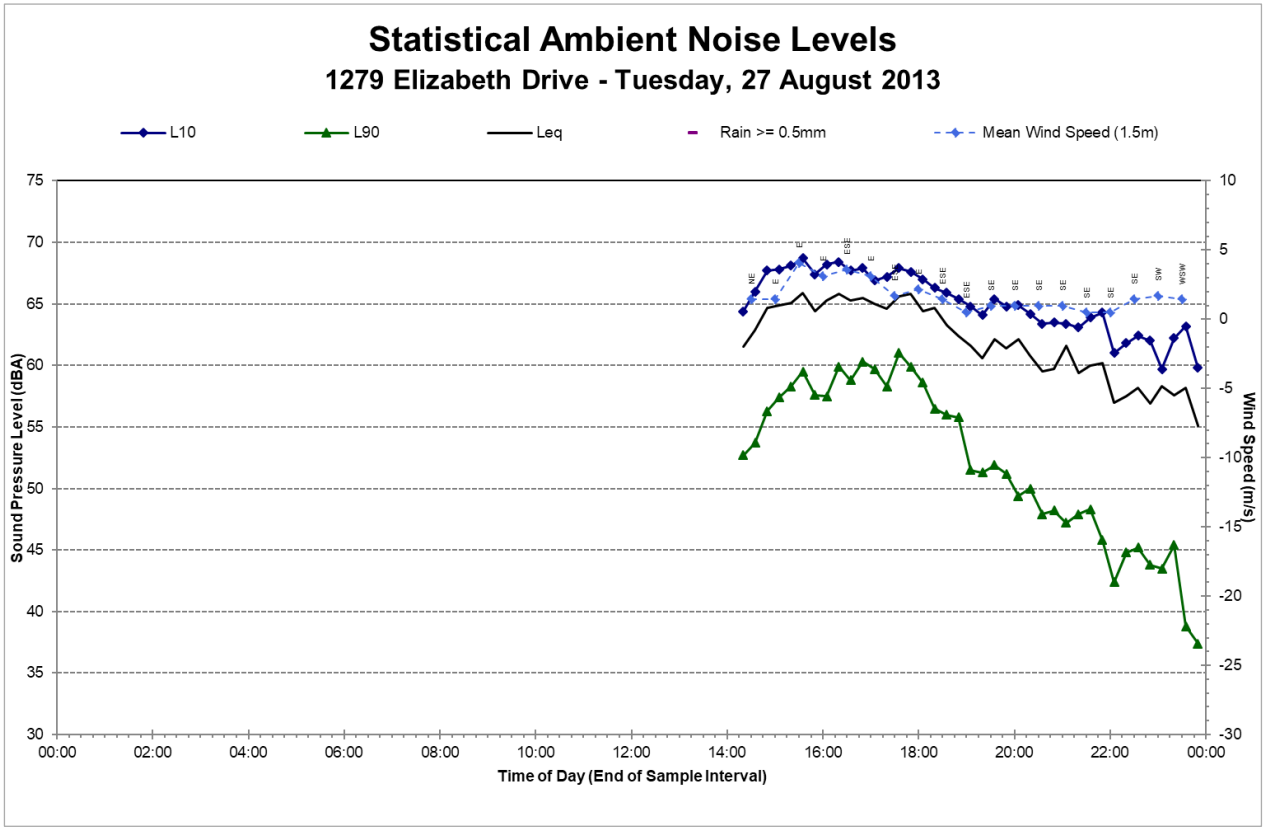
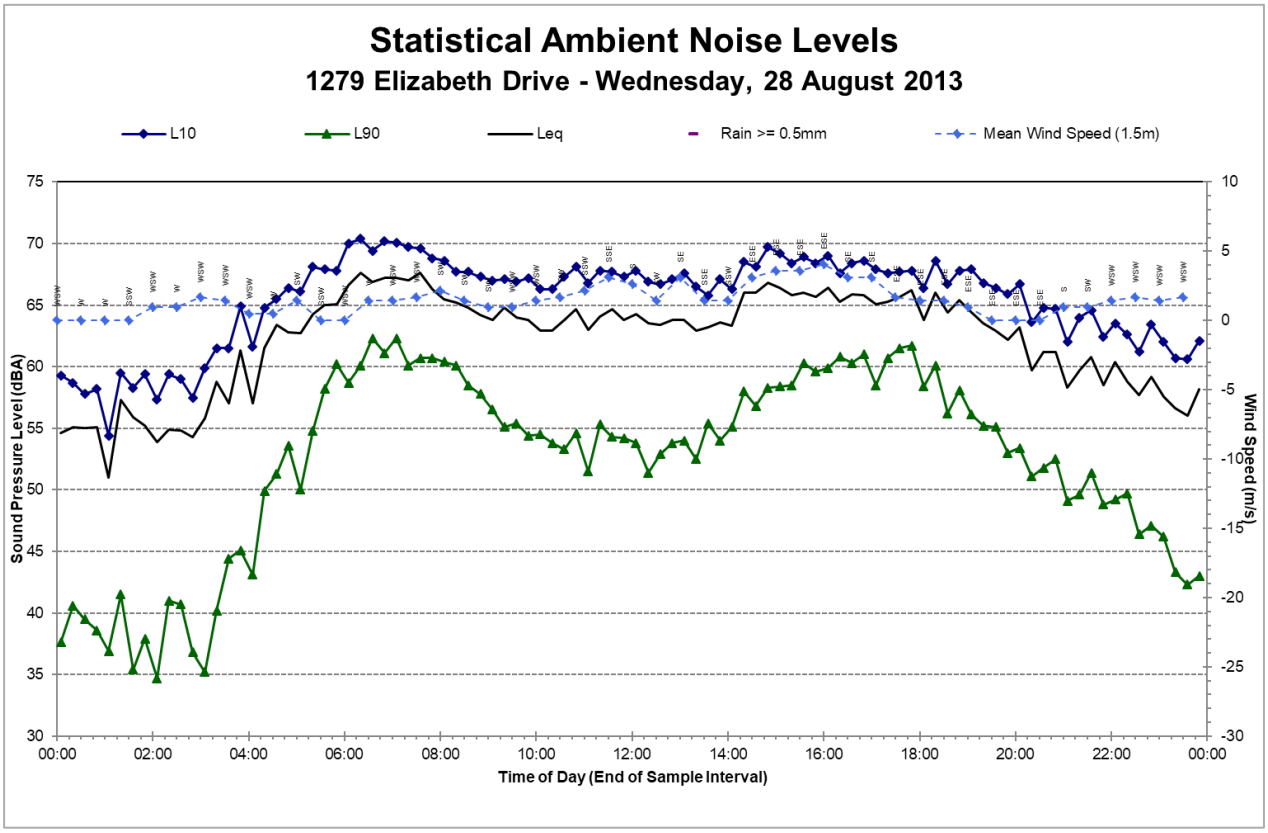
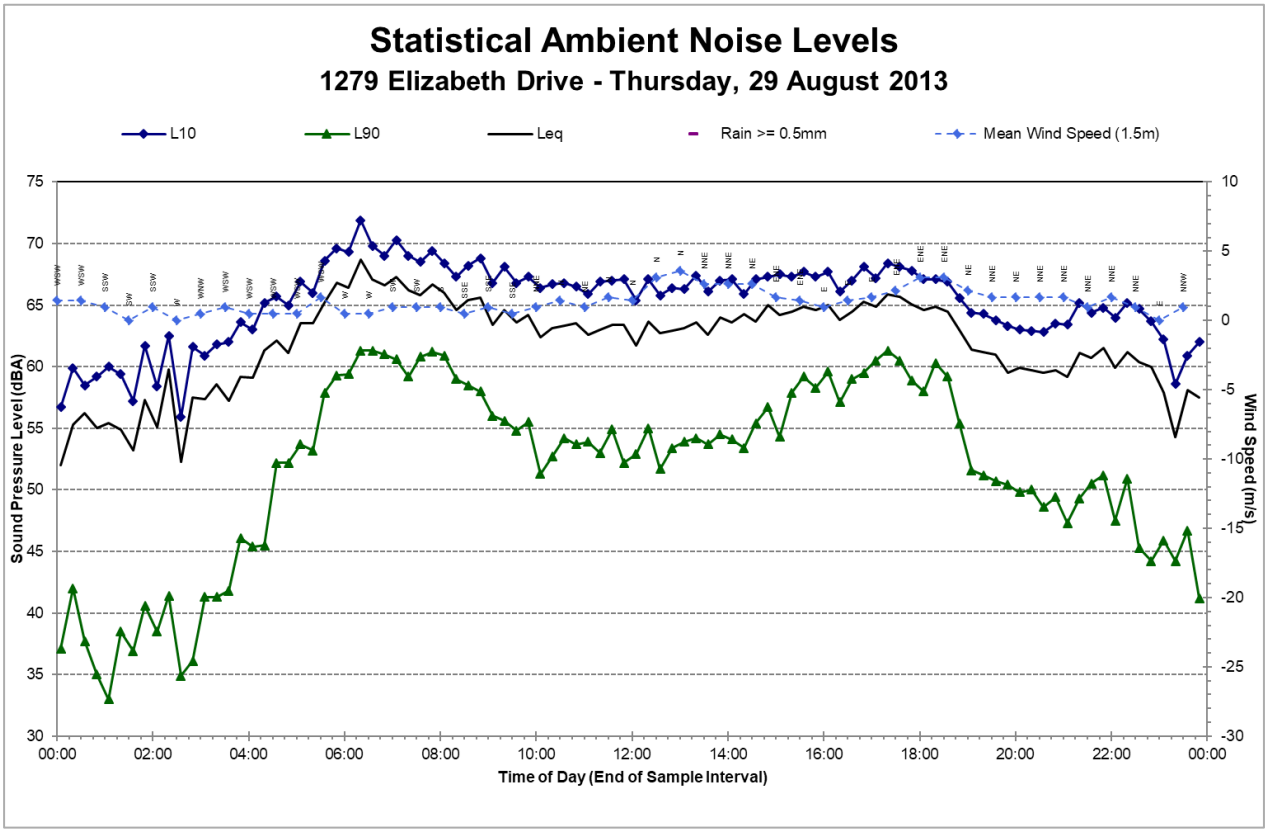
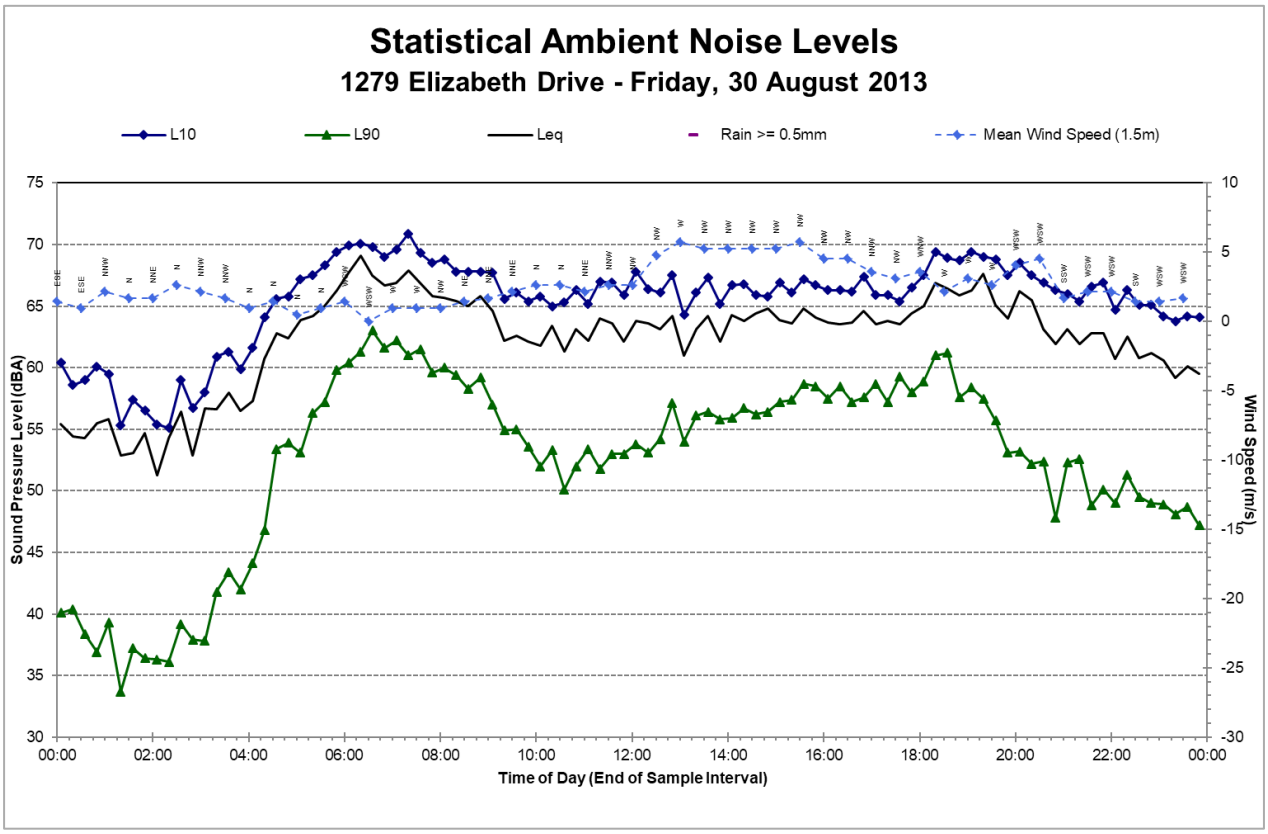
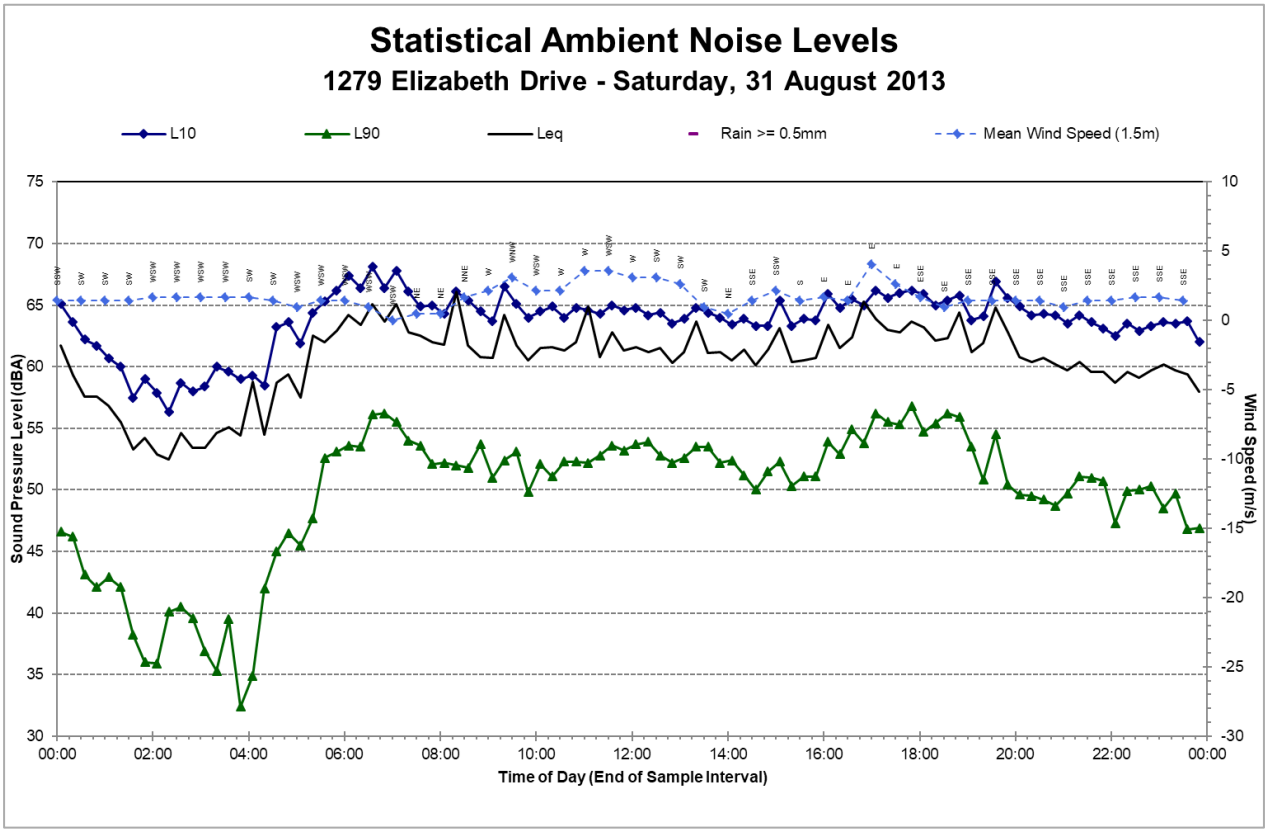
Leq
L10
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day

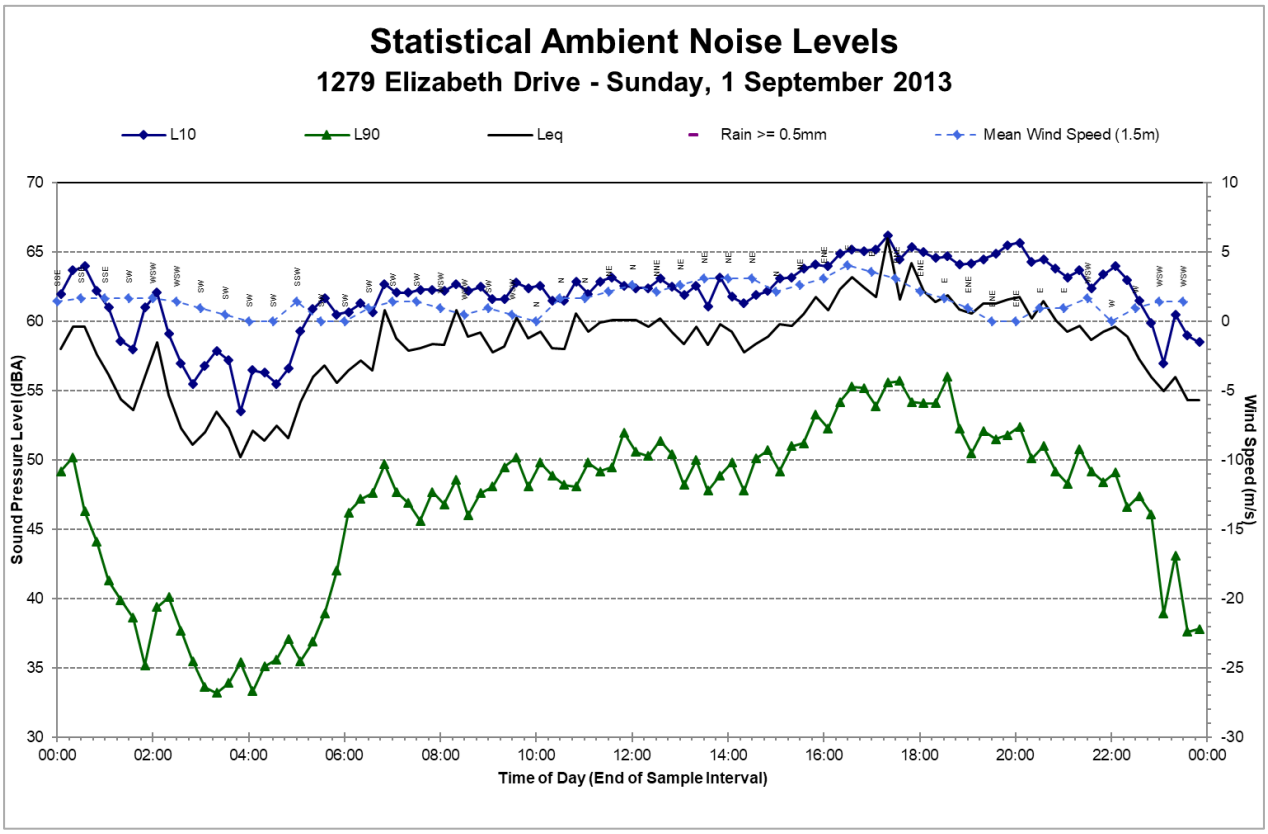

Statistical Ambient Noise Levels
1279 Elizabeth Drive - Tuesday, 27 August 2013
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
1279 Elizabeth Drive - Wednesday, 28 August 2013
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
1279 Elizabeth Drive - Thursday, 29 August 2013
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
1279 Elizabeth Drive - Friday, 30 August 2013
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
1279 Elizabeth Drive - Saturday, 31 August 2013
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
1279 Elizabeth Drive - Sunday, 1 September 2013
L10
L90
Leq
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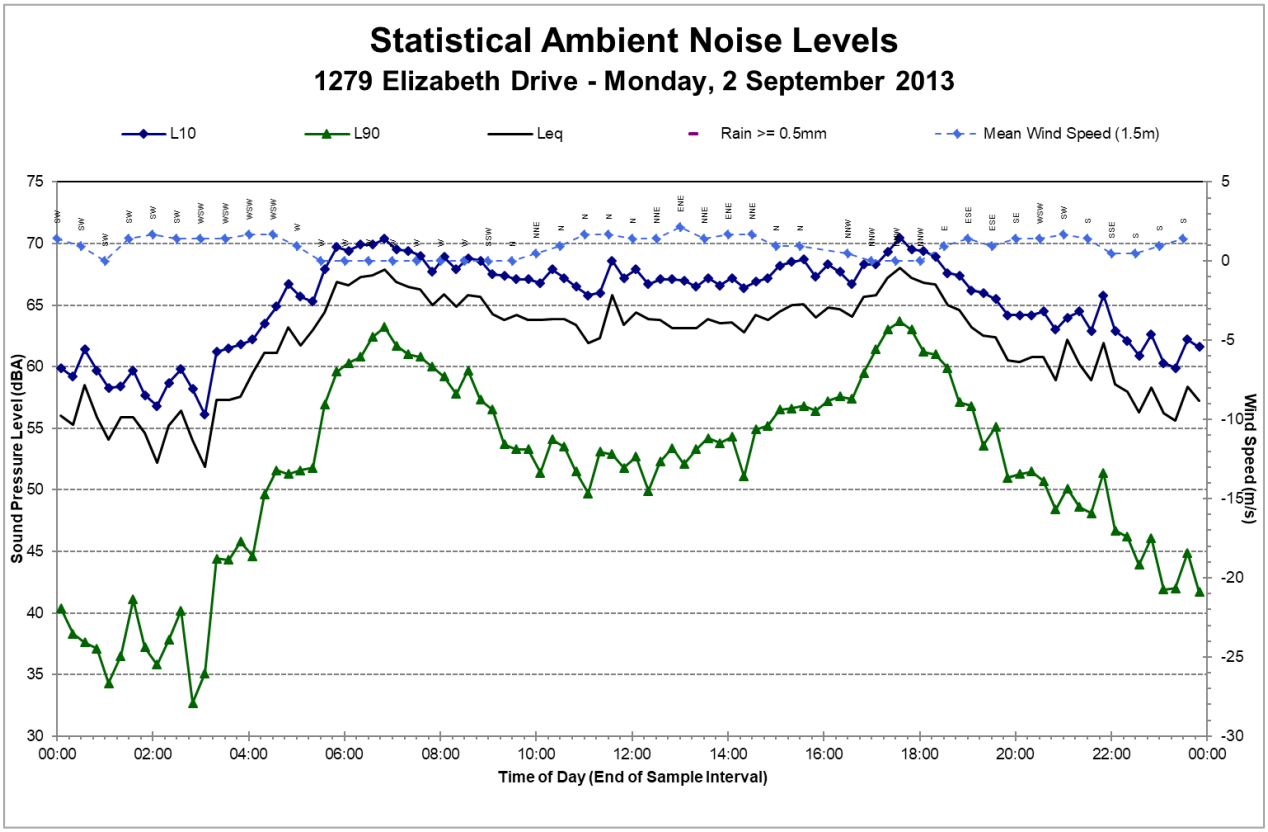
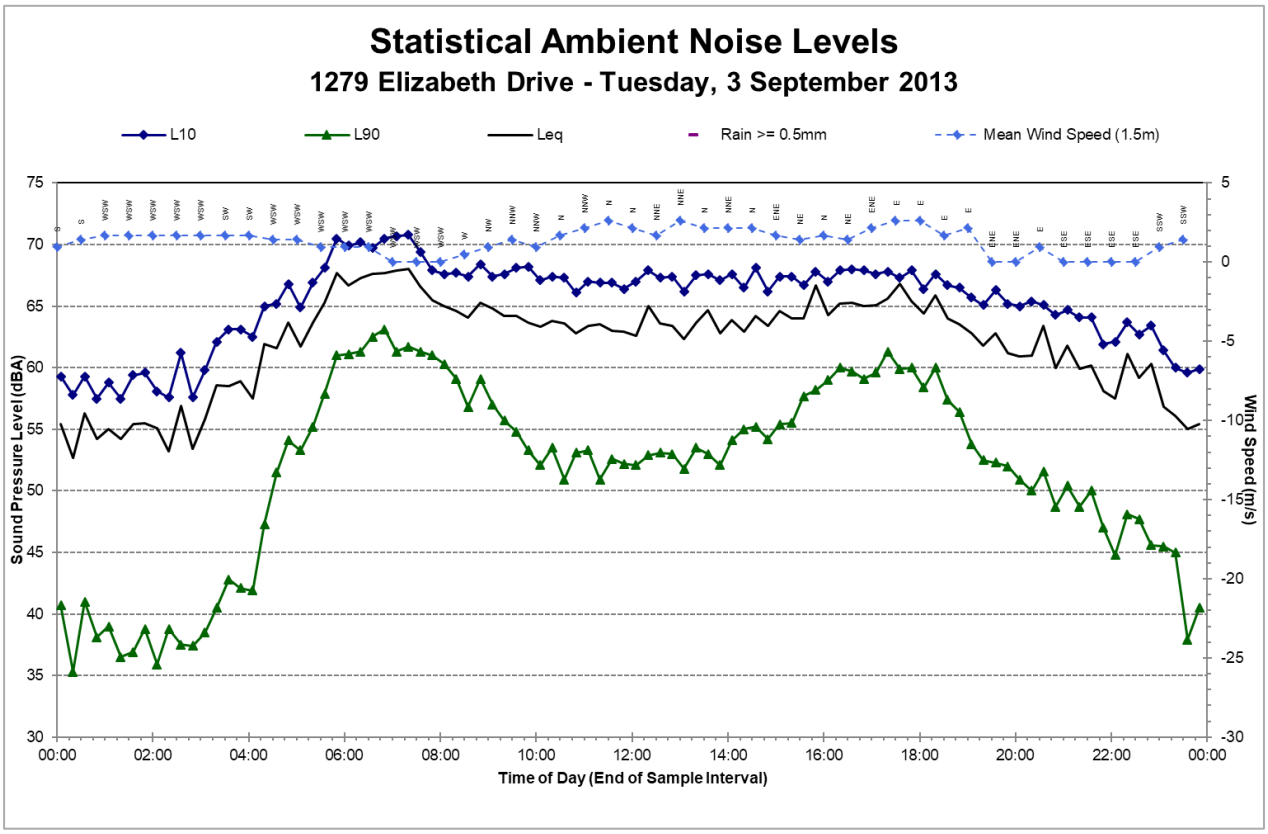
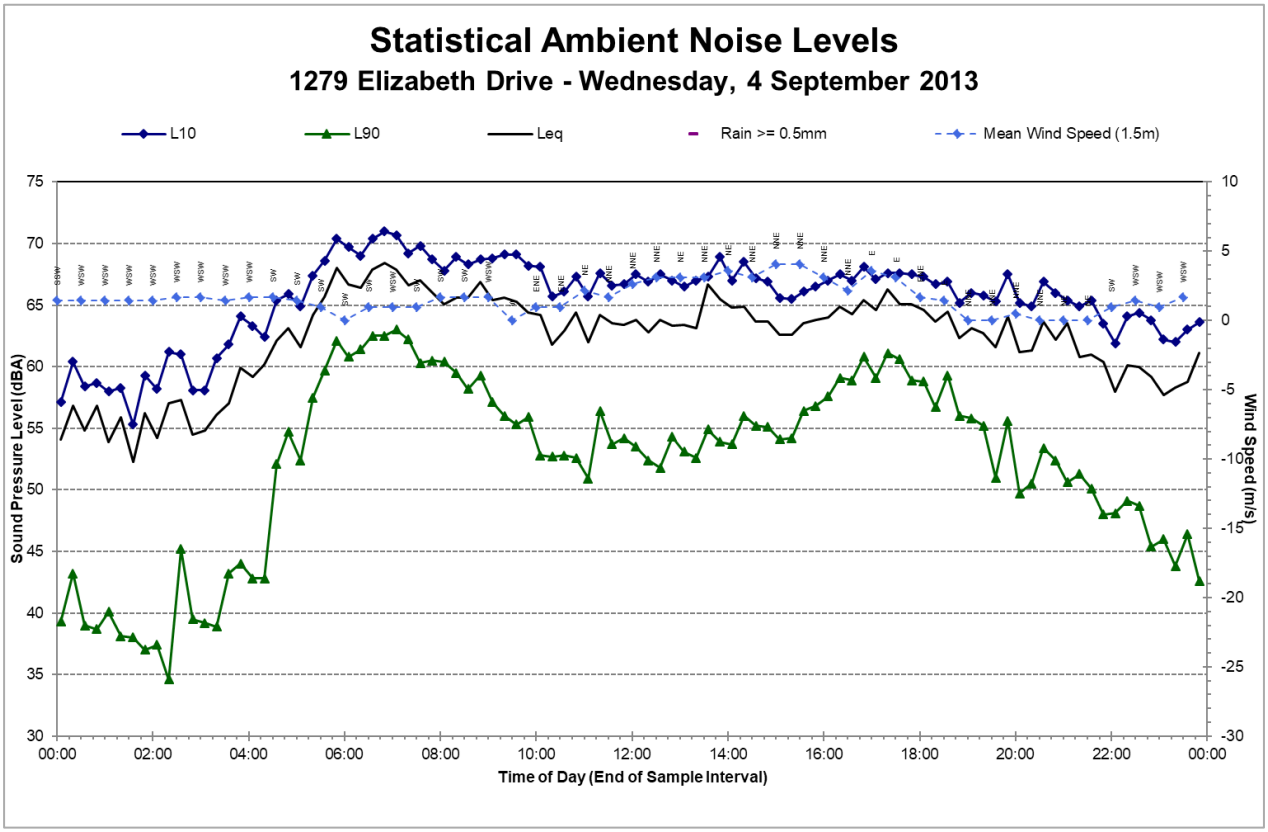
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
1279 Elizabeth Drive - Monday, 2 September 2013
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
1279 Elizabeth Drive - Tuesday, 3 September 2013
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
1279 Elizabeth Drive - Wednesday, 4 September 2013
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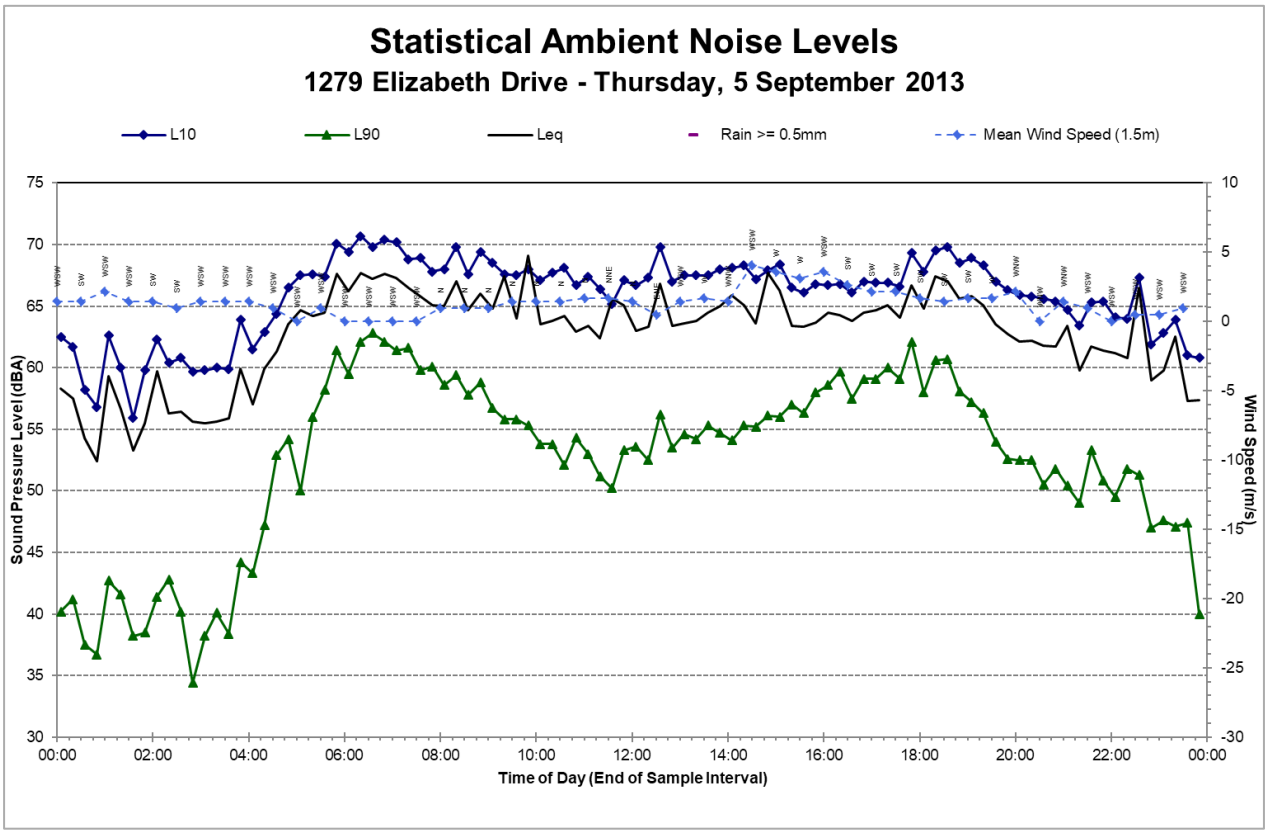
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
1279 Elizabeth Drive - Thursday, 5 September 2013
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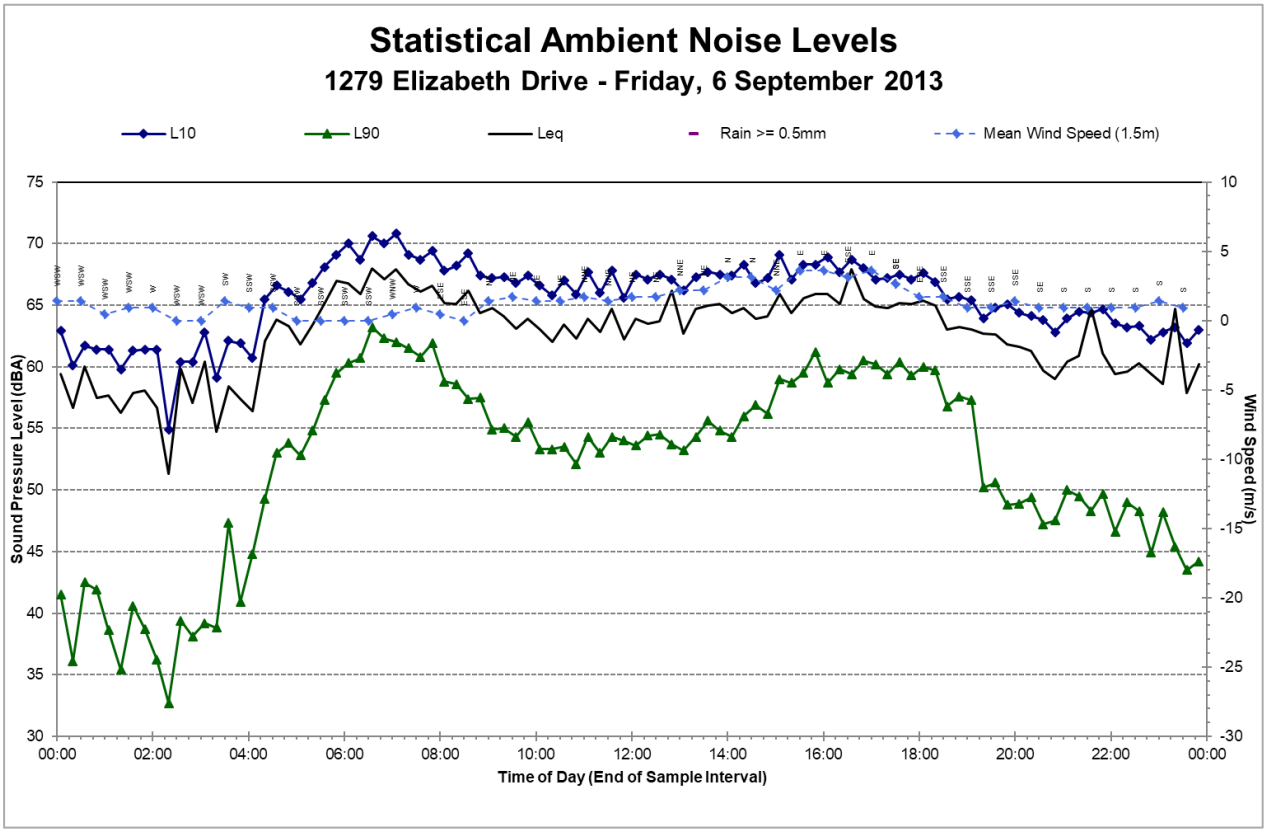
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
1279 Elizabeth Drive - Friday, 6 September 2013
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Leq
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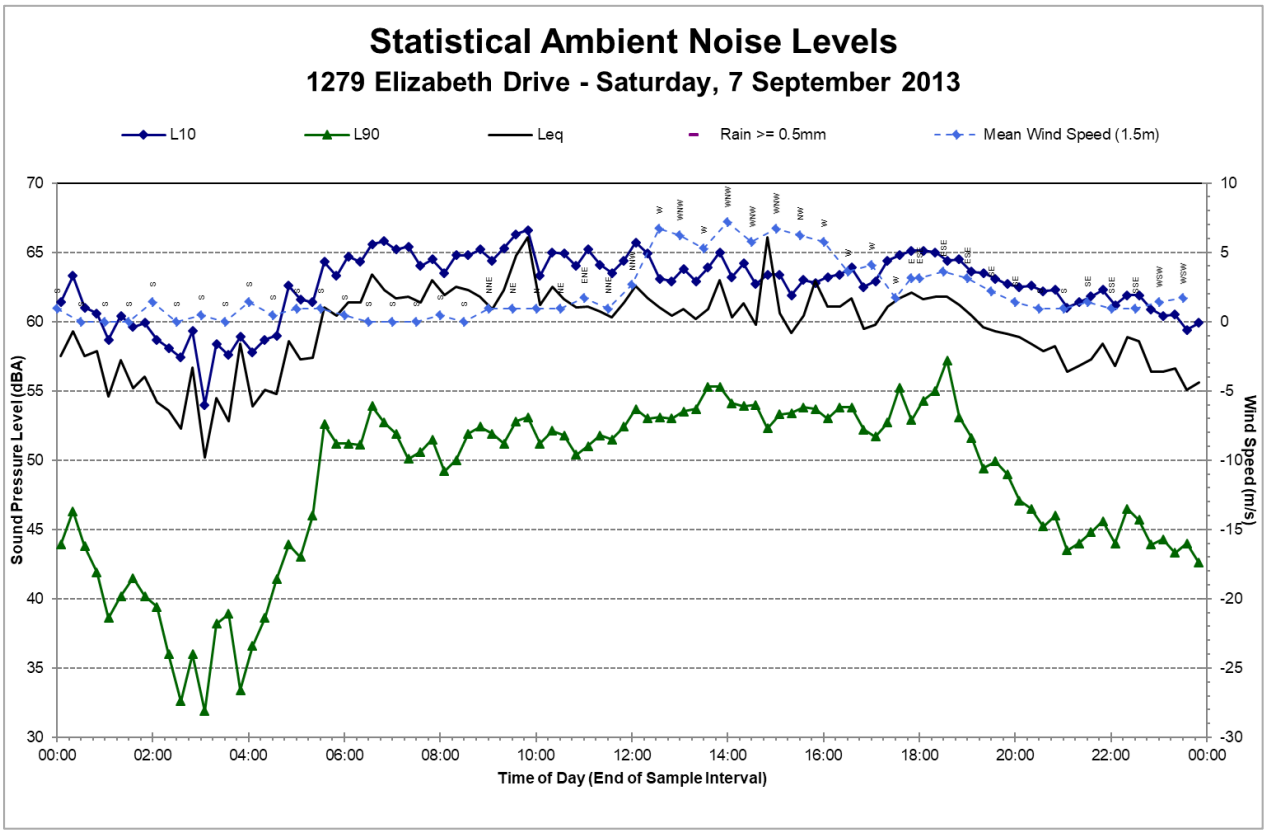
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
1279 Elizabeth Drive - Saturday, 7 September 2013
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Leq
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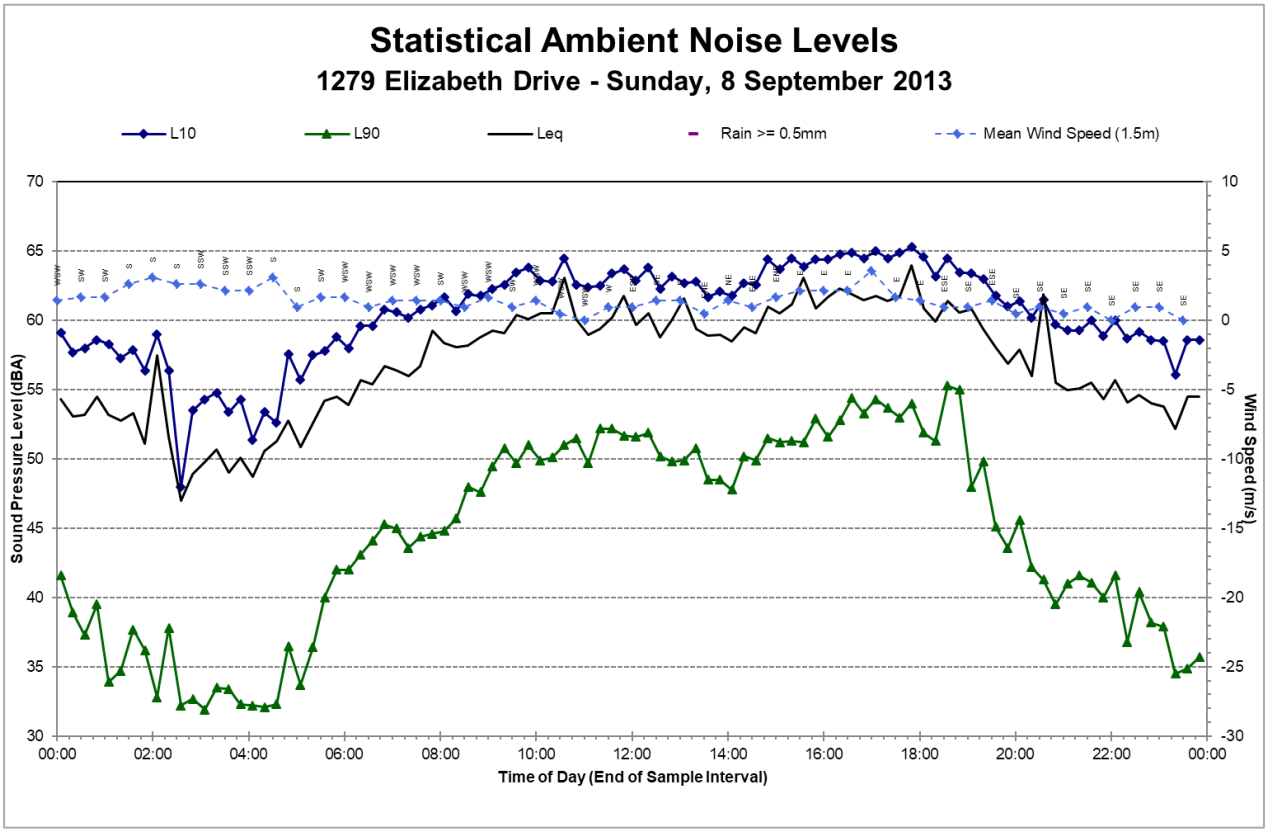
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
1279 Elizabeth Drive - Sunday, 8 September 2013
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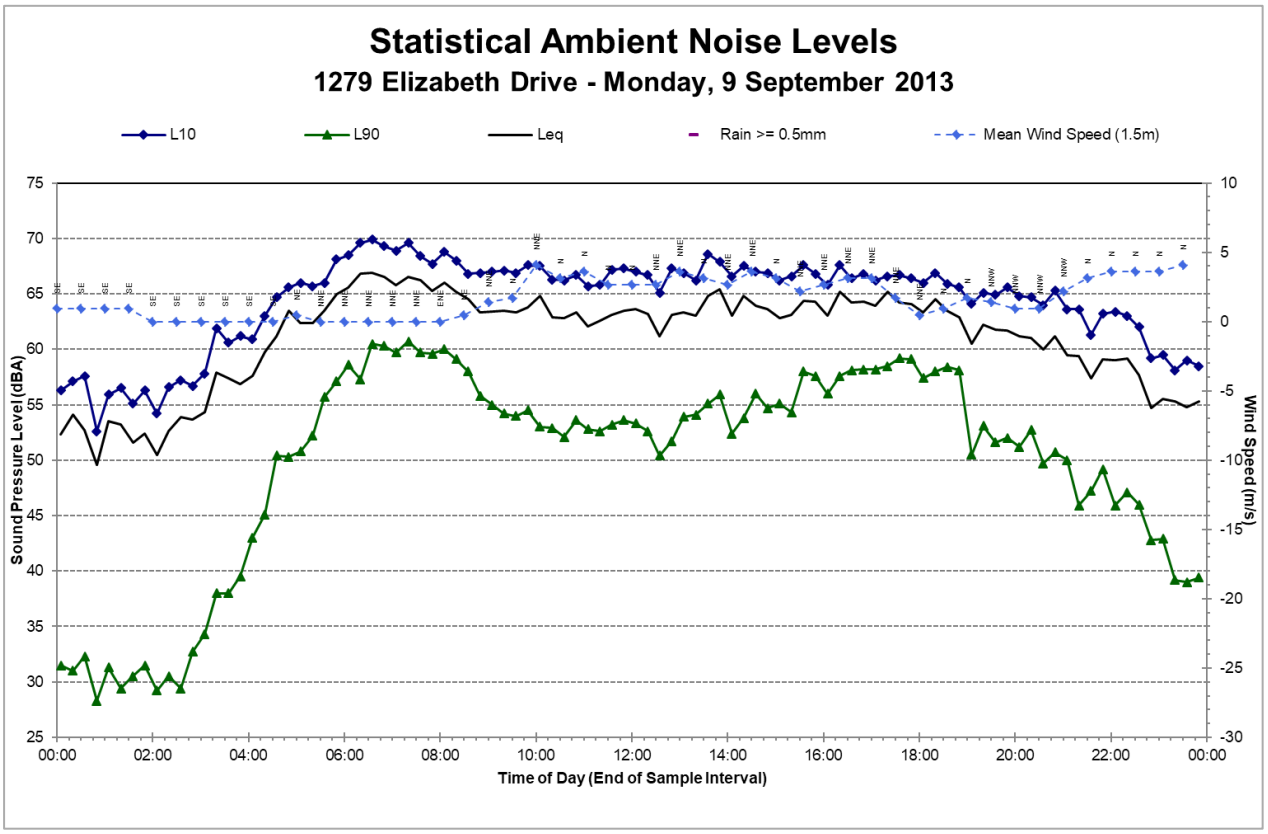
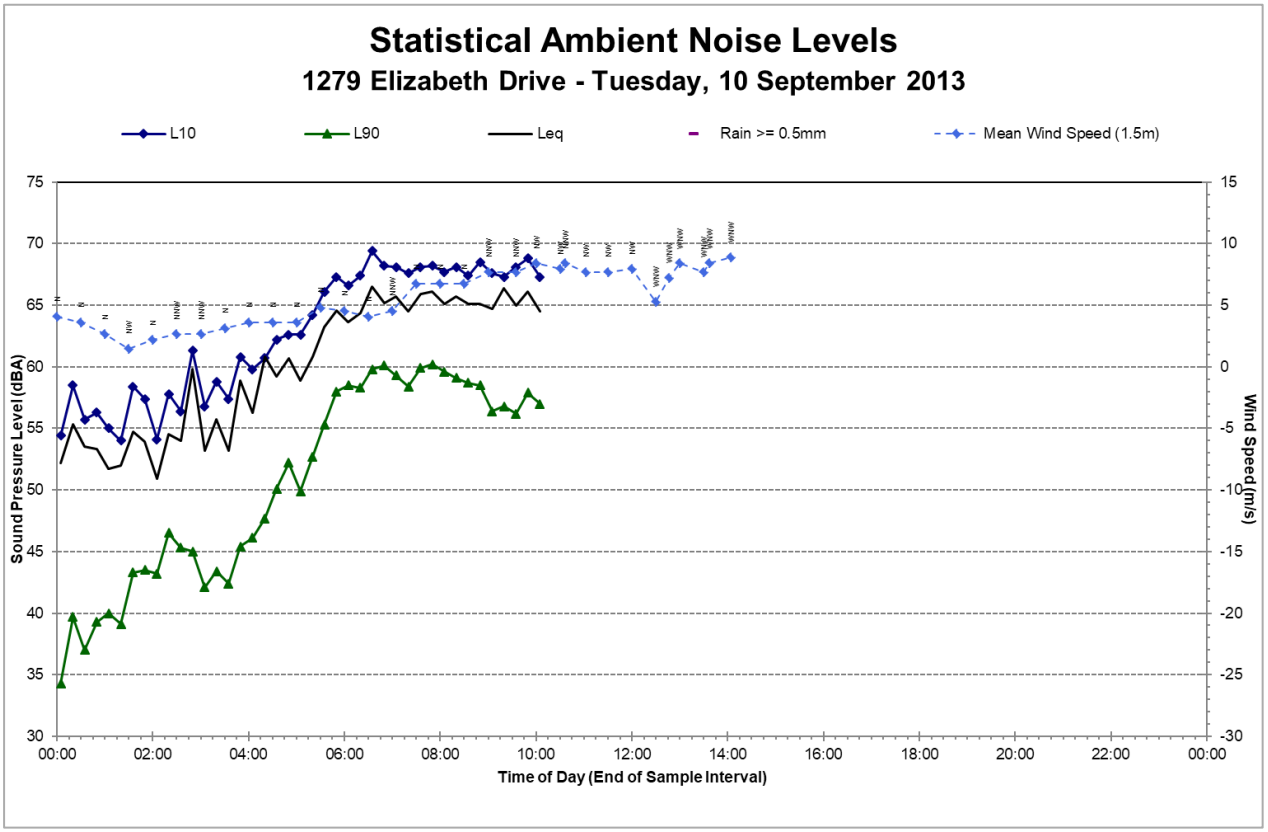
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
1279 Elizabeth Drive - Monday, 9 September 2013
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
1279 Elizabeth Drive - Tuesday, 10 September 2013
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)
75
70
65
60
55
50
45
40
35
30
15
10
5
0
-5
-10
-15
-20
-25
-30
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