International Power

APPENDIX D

Noise

URS

PEAKING POWER PLANT, PARKES

NOISE & VIBRATION ASSESSMENT

ACOUSTICS AND AIR

REPORT NO. 06313
VERSION B

WILKINSON MURRAY

PEAKING POWER PLANT, PARKES

NOISE & VIBRATION ASSESSMENT

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VERSION B

OCTOBER 2007

PREPARED FOR

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2 DESCRIPTION OF PROPOSAL, SITE & SURROUNDS

The proposed facility would comprise three gas turbines each nominally rated at 40 to 50MW. Given that the three turbines are proposed to operate as a "peaking plant", there would only be a limited number of hours that any of the turbines would operate. Further it is probable that the turbines would not, under normal circumstances, run after approximately 8.00pm.

It is possible that the turbines could operate during the night time period (i.e. after 10.00pm) during exceptional circumstances. Such circumstances could include emergency generation, or transmission support demands. It is assumed in this assessment that the plant could operate at any time.

The site is located in a rural area west of Parkes. The nearest residential receivers are identified in Table 2-1. The closest existing residence is Location 1, approximately 1km southeast of the site. Closer to the site is a subdivision (Development Application Number S9/92) for three 10-13 ha blocks on Condobolin Road (450m north of the site) that was approved in 1992. Through investigations undertaken for the Environmental Assessment, Parkes Shire Council have confirmed (letter from Council to URS dated 5 October, 2007) that the consent has since lapsed. On this basis this location has not been assessed further.

Table 2-1 Location of the Surrounding Existing Residences

Location No.	Property Name or Description	East (AMG)	North (AMG)	RL
1	Velvedere	601094	6335993	280
2	MillersLookout	603285	6335642	280
3	Hazelwood	602399	6337489	280
4	PineLodge	603491	6337937	295
5	Warawee	599155	6337822	290
6	SW of Site	599190	6335558	280

Refer to Figure 2-1 showing the location of these residences in relation to the plant location.

1 INTRODUCTION

International Power Australia Pty Ltd (IPRA) proposes to construct a gas fired peaking power plant at Parkes, NSW. The location of the site is shown in Figure 1-1.

Upon completion, the facility will comprise of three gas turbines. It will operate as a "peaking plant" which means the turbine(s) only operate during periods of high demand. It is anticipated that the plant will operate at up to 10% of the time.

Each of the turbines is rated nominally at 40 to 50MW. Gas would be provided from an off-take from the existing Central West Pipeline at Parkes.

Wilkinson Murray has been engaged to conduct a noise and vibration assessment forming part of an Environmental Assessment (EA). This assessment covers the environmental noise and vibration aspects relating to the construction and operation of the gas turbine peaking power plant.

Figure 1-1 Locality Map

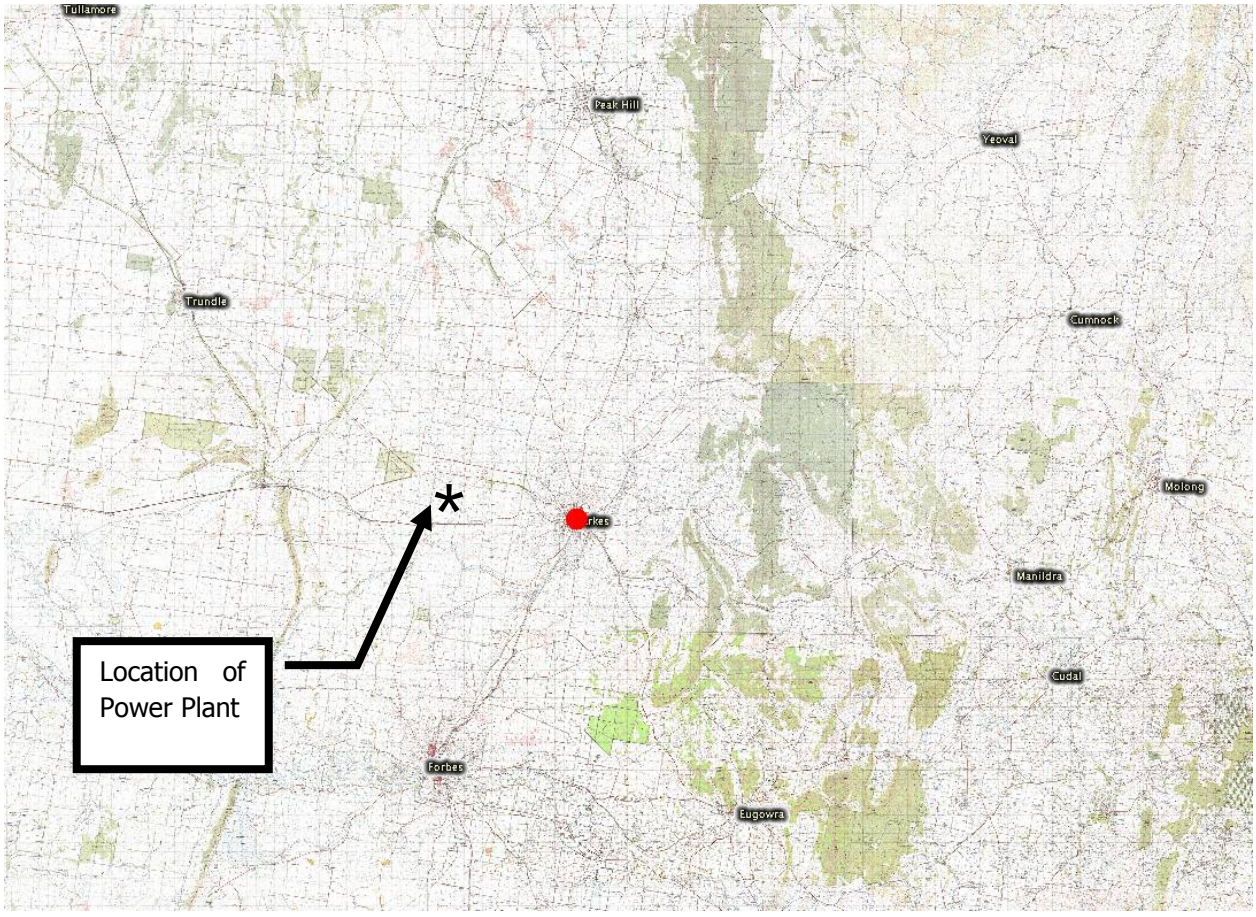
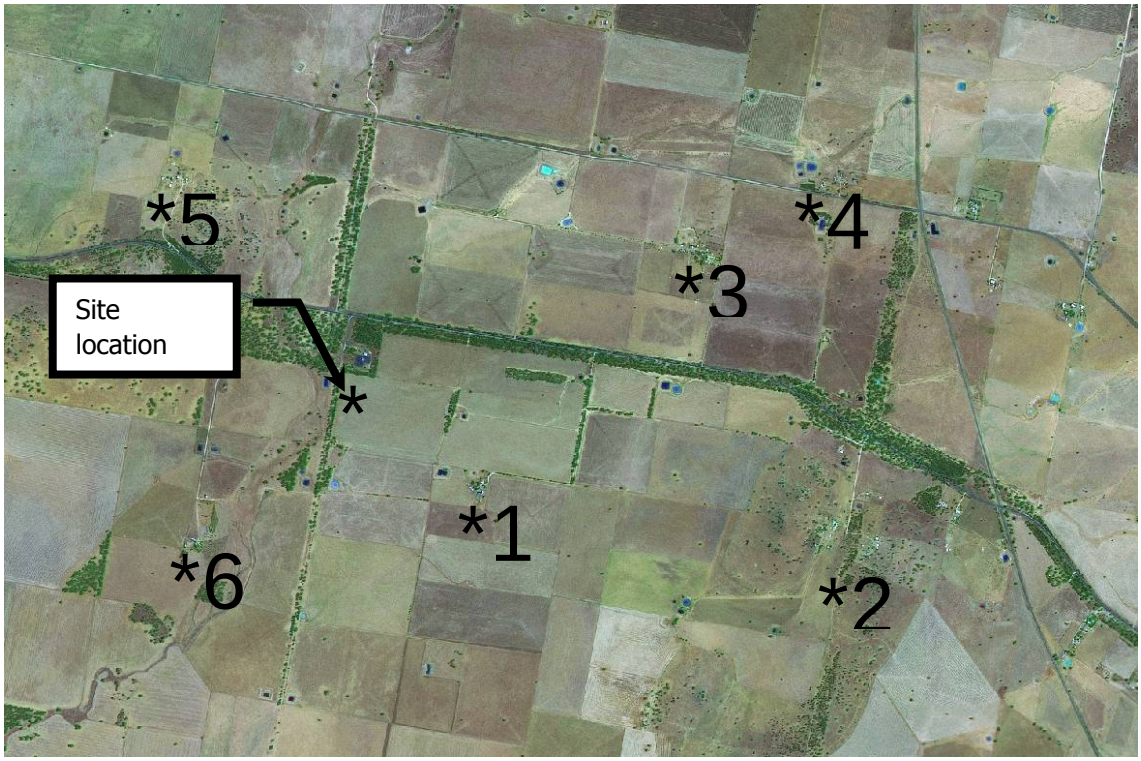


Figure 2-1 Site & Residence Locations



3 EXISTING AMBIENT NOISE LEVELS

3.1 What is the Noise Environment?

In Section 4 of this report noise criteria will be set for this project. Because the noise criteria are set with relation to existing ambient noise levels, the existing environment will be discussed first.

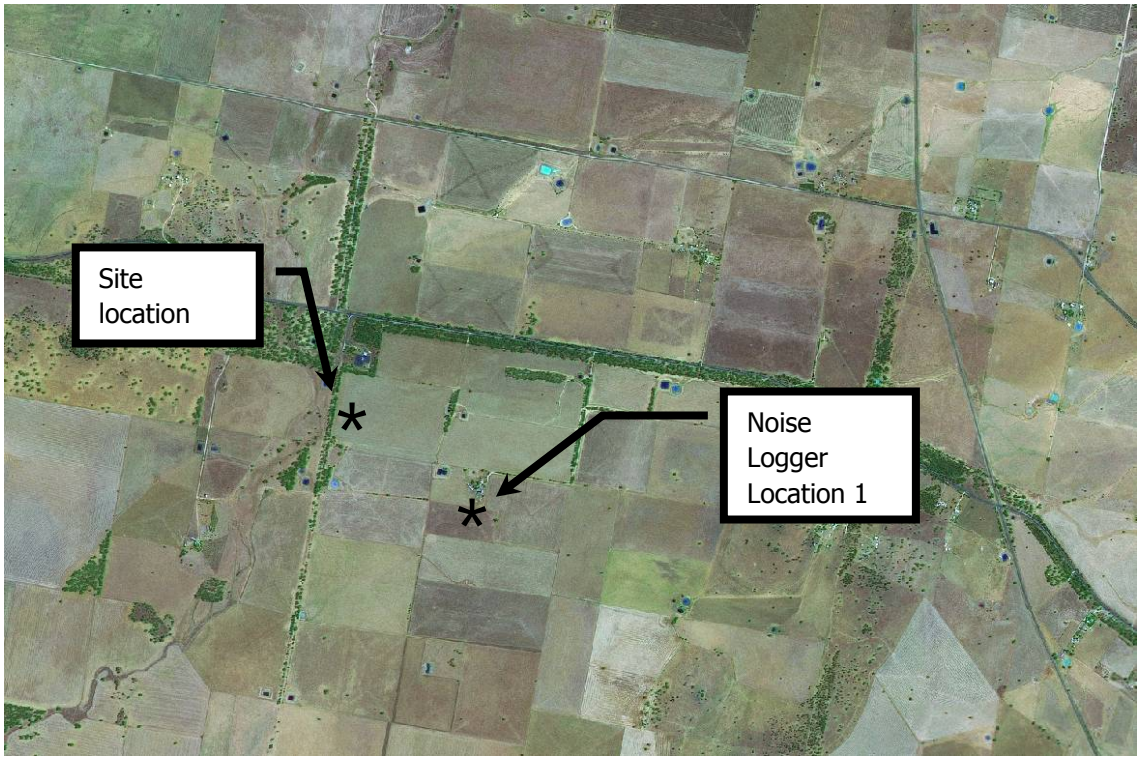
The existing ambient noise levels are the result of all industrial, traffic, and environmental noise at the receiver location.

3.2 Measurement Procedures

The noise monitoring equipment used for the long-term unattended measurements consisted of an Environmental Noise Logger set to A-Weighted, Fast response continuously monitoring over 15-minute sampling periods. This equipment is capable of remotely monitoring and storing noise level descriptors for later detailed analysis. The equipment calibration was checked before and after the survey and no significant drift had occurred.

Monitoring was conducted in free-field conditions (i.e. away from building facades and other reflecting surfaces). Figure 3-1 shows the location of the logger (at Location 1) with respect to the site.

Figure 3-1 Noise Monitoring Location



Noise loggers determine a variety of noise descriptors, including L_{A90} and L_{Aeq} levels (see Appendix A for definitions) of the existing noise environment. From the background noise levels (L_{A90}) the Rating Background Levels (RBLs) were determined using methodology as recommended by the NSW the NSW Department of Environment and Climate Change (DECC) document, the *NSW Industrial Noise Policy (INP)*. The DECC considers the RBL to represent the background noise level.

Table 3-1 summarises the results of the noise monitoring.

Table 3-1 Measured Noise Levels – Unattended

Location	Time Period (1)	Rating Background Level RBL (dBA)
Logger Location A	Daytime	34
	Evening	27
	Night Time	25

Notes: 1) The *INP* considers daytime (7.00am-6.00pm); evening (6.00pm-10.00pm); night time (10.00pm-7.00am). On Sundays and Public Holidays, daytime begins at 8.00am and night time ends at 8.00am.

According to the *INP*, if the RBL derived from measured background levels is less than 30dBA, then it is set to 30dBA for assessment. Hence the RBL for evening and night time is set to 30dBA for this assessment. Further, analysis of the logger data suggests that it was inadvertently located near a pump that operated (at times) during daytime hours. It is probable that the daytime RBL is less than that measured. As it makes no practical difference to this assessment the daytime noise was not remeasured, and the RBL daytime will be set at 30dBA.

4 NOISE CRITERIA

With respect to noise criteria, the NSW Department of Planning (DoP) has provided the environmental assessment requirements under Part 3(A) of the *Environmental Planning & Assessment Act* 1979 to be compliant with the *NSW Industrial Noise Policy (INP)* and Chapter 171 of the *Environmental Noise Control Manual (ENCM)*. Similarly, the DECC requires that impacts of noise and vibration be assessed in accordance with the *INP*.

In considering the DoP and DECC requirements, together with previous experience on similar projects and expectations, this development has been assessed primarily in accordance with the following policy guidelines published by the DECC:

- *NSW Industrial Noise Policy (INP)*, dated January 2000;
- *Environmental Criteria for Road Traffic Noise (ECRTN),* dated May 1999;
- *Environmental Noise Control Manual (ENCM*). dated May 1999;
- *Noise Guide for Local Government (NGLG).* dated June 2004 and,
- *Assessing Vibration: A Technical Guideline (AVATG).* dated February 2006.

The following Standards have also been referenced:

- *British Standard 6472, 1992 – Guide to Evaluation of human exposure to vibration in buildings (1Hz to 80Hz), (BS6472, 1992)*
- *German Standard 4150, 1999 - Structural Vibration Part 3: Effects of vibration on structures, (DIN 4150, 1999, Part 3)*

4.1 Operational Noise Criteria

4.1.1 Continuous & Semi-Continuous Plant Noise

The *INP* is designed to assess "industrial noise", as is the case with this development using the more stringent of the following two approaches:

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

The intrusive goal is set 5dBA above the Rating Background Level (RBL) for each time period (daytime, evening or night time) of interest. The RBL's are derived from the measured L_{A90} noise levels as per the DECC guidelines.

The amenity goal sets an upper limit to the total noise level (L_{Aeq}) in an area from all industrial noise. The criterion depends on the time of day, area classifications and the relationship of the total measured L_{Aeq} (and contribution from existing industrial noise) to determine the Acceptable Noise Level (ANL) for the development.

The potentially affected area is classified as "Rural" by the *INP*. Given this, the "acceptable" amenity levels (L_{Aeq} dBA) which apply over the whole day, evening or night period are as follows and are applicable as there are no other significant "industrial" noise sources:

- Daytime 50dBA
- Evening 45dBA
- Night time 40dBA

The "maximum" amenity levels are 5dBA higher.

Where the noise source contains annoying characteristics, such as dominant low frequency content, adjustment factors as per the *INP* apply. This is further detailed in Section 4.1.3.

4.1.2 Sleep Disturbance

The assessment of the disturbance of sleep is complicated and primarily due the following factors:

- Absolute level (usually presented as the L_{Amax} or $L_{A1(1minute)}$);
- The amount the absolute level "emerges" above the general background noise at the time of the event; and
- Number of events.

Where there exists the possibility that instantaneous, short-duration, high-level noise events may occur during night time hours, the DECC requires that consideration be given to the potential for disturbance of sleep within residences.

With reference to the *NGLG,* the primary assessment for whether or not ones' sleep will be disturbed by activities related to the operation of the Peaking Power Plant is based on whether the $L_{A1(1minute)}$ noise level (often approximated as the L_{Amax} noise level) from any instantaneous night time noise event (related to the operational activities of the facility) will exceed the background noise level by more than 15dBA when measured external to a bedroom window.

This is a simple approach and the *NGLG* acknowledges that further research is needed to define a better relationship between noise levels and sleep disturbance and refers to the *ECRTN* which provides a summary of research on sleep disturbance.

4.1.3 Summary of Operational Noise Criteria

Table 4-1 provides a summary of the operational noise criteria applicable to this project.

Table 4-1 Operational Noise Criteria

Residence	Time Period	Criteria (dBA)	
		Continuous Noise	Intermittent Noise
		Intrusive $L_{Aeq,15min}$	Sleep Disturbance $L_{A1,1min}$
All Nearby Residential Receivers	Daytime	35	n/a
	Evening		n/a
	Night Time		45

Further to this, the *INP* requires where noise sources contain certain characteristics, such as tonality, impulsiveness, intermittency or dominate low frequency content, a modifying factor of +5dBA (to a maximum of +10dBA) should be applied because these type of noises typically cause greater annoyance to the community.

These modification factors take effect at the residential receiver and would typically be judged by measurement at the residential receiver where the measurement would be made up of both

the plant noise and existing ambient noise environment as currently experienced by the residential receiver.

With regard to gas turbine power plants and the residences at Parkes, there is a risk (considered by WM to be medium due to the limited existing low frequency noise) that low frequency noise correction could apply if the noise mitigation is not correctly designed in the detail design process. Therefore these issues should be considered and form part of more detailed assessment if appropriate. In the event that the gas turbine supplier considers that their plant would result in a low frequency modification factor being applied at the residences, then the plant should be designed to meet a level of 5dBA below the criterion to account for low frequency noise.

4.2 Construction Noise Criteria

With respect to construction noise, the requirements outlined in Chapter 171 of the *ENCM* are usually applied and this approach is reproduced below.

Level Restrictions

(i) Construction period of 4 weeks and under.
The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 20 dB(A).

(ii) Construction period greater than 4 weeks and not exceeding 26 weeks.
The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 10 dB(A).

Time Restrictions

Monday to Friday	*7am–6pm*
Saturday	*7am–1pm (if inaudible at residential premises)*
	8am–1pm (if audible at residential premises)

No construction work to take place on Sundays or Public Holidays

Silencing

All possible steps should be taken to silence construction site equipment. It is particularly important that silenced equipment should be used on road or rail works where 24 hour operation is necessary.

There is no suggested criterion for projects that occur for greater than 26 weeks. However, the following criterion is typically used and appropriate:

The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 5 dB(A).

The construction criterion for this project is then L_{A10} 35dBA.

It is anticipated that construction will most likely take place from 7.00am to possibly up to 6.00pm during weekdays and 8.00am-1.00pm on Saturdays. Should the contractor wish to work outside these "standard" hours, they will need to apply to the relevant authorities for approval.

5 NOISE PREDICTIONS

5.1 Introduction

For this assessment, noise predictions were made using the ENM modelling software algorithm. This is a point-to-point model that takes into account the attenuation factors, including distance, ground absorption, air absorption and the effects of adverse meteorological conditions.

Intervening topography attenuates noise before it reaches receivers. Additionally, noise propagation over distances of at least several hundred metres is influenced by meteorological factors such as wind speed, wind direction and the presence of temperature inversions. In addition to increasing noise levels, these meteorological conditions significantly reduce the attenuating effect of intervening topography (and bunds) since the sound waves follow a curved path that can go over such barriers.

5.2 Noise Model Inputs

5.2.1 Meteorological Conditions

Noise levels experienced by a receiver at relatively large distances (at least several hundred metres) from a source can vary considerably under different meteorological conditions, particularly in the evening and at night. Prevailing wind and air temperature gradients will change over the course of the night time period, and hence noise levels at receivers will change, even when the noise source level is constant.

The *INP* generally directs the use of a single set of meteorological data to use in the assessment of noise impacts; however Wilkinson Murray has adopted a more rigorous approach in past assessments where noise levels at all residences are calculated under a varied set of existing meteorological conditions. Measured statistical occurrences of these conditions over a period of at least one year, divided into seasons, are then applied to the results, and a 10^{th} percentile exceedence noise level calculated, which is then compared with relevant criteria. This approach is generally more representative than one using a single set of meteorological data as it accounts for the directional distribution of prevailing winds for each residence surrounding the proposal.

This alternative assessment procedure involves significantly greater computational complexity than the use of a single set of meteorological conditions, but provides a much more direct and comprehensible description of noise impacts at a receiver. This approach of using the 10^{th} percentile calculated noise level as a measure of noise impacts on residences has been considered acceptable by the DECC for previous similar assessments. This alternative procedure is considered appropriate for this project.

Hourly data for an entire year (2005) was processed for the site by URS using CSIRO's The Air Pollution Model (TAPM) assimilated with data from a meteorological station located within Parkes Airport. The station at the airport does not provide all the required parameters (such as required to calculate temperature inversions) and as such TAPM has been used by URS to account for the insufficient data. This data has been further processed by WM such that it could be used to model the effect that meteorological conditions around the site have on noise propagating from the site to the receivers.

The weather conditions that have been considered when calculating the noise levels for this project are summarised in the following section. Appendix C details the meteorological conditions modelled in order to perform a statistical analysis of the effect of meteorology. It is

to be noted that for the purposes of calculating the 10th percentile exceedence noise level during enhanced meteorological conditions such as wind (the INP requires assessment of winds of 3m/s or less), the occurrence of winds ≤0.5m/s and >3m/s have been combined. This is an acceptable approach because at wind speeds >3m/s there is likely to be noise generated by the wind itself and as such the noise level during these periods can be considered to be "equivalent" to the noise generated by calms. This assumption allows a calculation of the 10th percentile exceedence noise level.

Acoustically Neutral Meteorological (Calm Isothermal) Condition

An acoustically neutral condition is considered to occur when the wind is calm (≤0.5m/s) and there are no temperature gradients present. During the day, this includes a temperature of 20.7ºC and occurrence relative humidity of 65.0%, during the evening 17.5ºC and 79.6% and during the night time 15.6ºC and 81.6%.

These conditions have been modelled for both the operational and construction (day only) phases of the project.

Meteorological Conditions (Adverse) that will enhance the Propagation of Noise

During the night time period, the worst case noise levels are likely to be experienced during both temperature inversions and wind. Temperature inversions are rarely present (if so their occurrence is low) during the daytime or evening periods. Therefore, the most significant meteorological effect during the daytime and evening periods is wind.

These conditions have been modelled for the operational phase of the project. The data from URS was processed by WM and the occurrence of the following five wind speed categories; 0.75m/s, 1.25m/s, 1.75m/s, 2.25m/s and 2.75m/s (encompassing a 0.25m/s range either side) determined. At speeds of greater than 3m/s, enhancement of noise propagation does not occur as the wind also generates noise. For each of the aforementioned speeds, the occurrence of the wind direction at every 45 degrees (encompassing a 22.5 degree range either side) is also determined.

In particular during the night time period, the effect of wind is also modelled both with a temperature inversion of 3º/100m and without a temperature inversion. A temperature inversion has been determined by considering the stability class. A stability class between Class A and E is assigned no temperature inversion (0°/100m inversion), whereas a Class F is a 3°/100m temperature inversion.

Several conditions are considered for each season and each time period, please refer to Appendix C.

The probability of occurrence for all the above-mentioned conditions have been calculated and the noise level that occurs 10% of the time for each DECC defined time period (day, evening and night) during each season is presented at each receiver and this is compared against the relevant operational criteria.

6 ASSESSMENT OF OPERATIONAL NOISE

Given the potential that this power plant may operate at any time, it is appropriate to develop operating scenarios for all time periods.

6.1 Operational Activities

The power plant is intended to operate as a "peaking plant". Although, as previously noted, the plant will not under normal circumstances operate after 8.00pm, it may operate during exceptional circumstances at any time of the day. Hence noise was assessed assuming operation at any time.

6.2 Assumed Sound Power Levels

Table 6-1 summarises details such as the overall noise emissions from the primary plant items associated with the Peaking Power Plant and the height of each source.

The noise levels used are from a compilation of data previously used by Wilkinson Murray together with data from various manufacturers, however are considered typical of a "standard" power plant.

Table 6-1 Information Regarding Noise Emissions of Main Peaking Power Plant Equipment

Plant Item	Sound Power Level L_{Aeq} (dBA)	Source Height (m)	Comments
Generator Transformer	86	5	Standard Design
Exhaust Stack	81 (1)	13	Directional - vertical
Air Intake	98	9.5	Directional - to the south
Gas Turbine & Generator Enclosure	106	8	Assumed the middle enclosure is shielded by the outer enclosures

Note: 1) Sound power level reduced by nominally 5dBA (from 86 to 81dBA) to allow for directivity (conservatively assumed losses at 90 degrees to vertical discharge).

Only the larger and potentially noisier plant / equipment items have been modelled in detail. Other plant items that have been assessed (but not modelled) include the transformers – both low and high voltage that typically have sound power levels < 80dBA. Any small or localised noise sources, such as pipe-work could be treated individually with screens/enclosures or lagging and the like. Correct vibration isolation will be necessary.

There will be blast walls built near the transformers, however the acoustic effect of these are negligible and have not considered in the calculation.

The unmitigated noise levels have been calculated using the ENM modelling software and are summarised in Table 6-2. In the columns labelled "Adverse Meteorological Conditions", the noise level presented is the level which would be exceeded 10 percent of the time. In calculating this level all meteorological conditions are considered, and the probability of their occurrence taken into account.

Table 6-2 Summary of Calculated Noise Levels to Existing Residences - Unmitigated

Location No.	Time Period	Calculated $L_{Aeq,15min}$ Noise Level (dBA)		Noise Criteria $L_{Aeq,15min}$(dBA)
		Calm Isothermal Condition	Adverse Meteorological Condition	*INP*
1	Daytime	32	33	35
	Evening		34	
	Night Time	33		
2	Daytime	<20	<20	
	Evening			
	Night Time			
3	Daytime	19	19	
	Evening		22	
	Night Time	20	21	
4	Daytime	13	13	
	Evening		15	
	Night Time	14		
5	Daytime	<20	<20	
	Evening			
	Night Time			
6	Daytime	<20	<20	
	Evening			
	Night Time			

The calculated noise levels meet the criteria at all residential receivers. At locations 2, 5 and 6 the noise levels will always be less than 20dBA.

6.3 Assessment of the Potential for Sleep Disturbance

The potential for sleep disturbance within the residences will likely be greatest during the early morning hours (notionally, 2.00-4.00am) when background noise levels are at their lowest.

Based on previous experience with similar power plants it is understood that there are no sources identified that will produce instantaneous, short-duration, high-level noise events. If a gas turbine begins (or ceases) operation in the early hours of the morning, this will not occur instantaneously but a gradual process. Should a gas turbine be operating into the night or early morning period, the process is relatively steady state and free of instantaneous events.

Furthermore there is no reason for the site to be visited during the night-time period even it there is a need to operate the facility. Any repairs or maintenance would obviously be scheduled during the daytime period.

It can be concluded that the potential risk of activities associated with the development that may disturb the sleep of nearby residences is negligible.

7 TRAFFIC NOISE ASSESSMENT

This section assesses the impact of increased noise potentially impacting residential receivers due to additional road traffic generated by the development.

The functional category of this road is considered to be "sub-arterial" (RTA Road Design Guide 1996) and using the NSW Department of Environment & Conservation (DEC) document, the *NSW Environmental Criteria for Road Traffic Noise (ECRTN)*, the applicable noise criteria refer to a daytime (7.00am-10.00pm) $L_{Aeq,15hr}$ 60dBA level and a night time (10.00pm-7.00am) $L_{Aeq,9hr}$ 55dBA level. Traffic generating developments are allowed an increase above these limits of 2dB, once all reasonable and feasible mitigation is considered. Analysing the classified traffic data and the estimated vehicle movements during the construction phase as supplied by URS, and given the fact that this is the only access, the 2dB limit applies.

There will be minor increases in road noise during the peak construction activities however, there is minimal risk of exceeding the 2dB limit. During the operational stage, there would be minor, light vehicle activity as required and as such negligible impact expected. Given the low risk of exceeding the 2dB limit, a further detailed assessment is not deemed necessary.

8 VIBRATION ASSESSMENT

This section provides a qualitative appreciation of the effect of vibration from both the operation of the facility and its construction.

In terms of vibration sources identified during the construction stage, likely plant would include rollers, dozers and like. Given that the nearest existing residential receivers will approximately 1000m away from the closest area of works, the vibration levels would not be perceptible and therefore not impact on the residences.

Once operational, all rotating plant items of the peaking power plant will be required to be correctly aligned and balanced. It is therefore unlikely that any vibration levels will be perceptible past the site boundary.

Given the low risk associated with vibration impacts (both annoyance and structural damage) a detailed vibration assessment is not deemed necessary.

9 CONSTRUCTION NOISE ASSESSMENT

This section of the report is a preliminary assessment of the potential impact of noise during construction.

The works would involve the following:

- General site clearing and earthworks for the site establishment;
- Drainage, utility and internal road works;
- Construction of the foundations;
- Erection of heavy plant items (gas turbines, generators, step-up transformers);
- Construction of the minor buildings, and fitout;
- Landscaping; and
- Commissioning.

Construction would be undertaken over a duration of approximately 6-7 month. A separate section addresses construction noise from laying of the gas pipeline.

The impact of blasting (if required) is not considered in this report.

Only 1 location is impacted by noise from construction of both the plant and the pipeline, and it is discussed in Section 9.5.

9.1 Construction Activities Involving Fixed & Mobile Plant

To predict the typical worst case noise levels at typical construction stages over the duration of the project, the following typical scenarios have been considered.

Scenario 1

A worst case month where activities, including earthworks, construction of the internal roads, and construction of the foundations is anticipated to occur simultaneously.

Scenario 2

A worst case month where activities including, construction of the minor buildings, fitout and landscaping is anticipated to occur simultaneously.

Scenario 3

This represents the activities occurring towards the end associated with commissioning. This essentially is the noise that will be experienced during operation and as such is not assessed.

9.2 Plant Items & Assigned Sound Power Levels

For the two construction stages, URS have supplied indicative information and activities of the likely plant to be used. The sound power level (SWL) of these plant items has been sourced from Wilkinson Murray's extensive database of actual measured plant items under different usage. Table 9-1 summarises the plant used during each scenario together with its respective SWL and number of items.

Table 9-1 Equipment Numbers & L_{A10} Sound Power Levels

Plant / Equipment Item	L_{A10} Sound Power Level (dBA)	No. of Items Modelled	
		Scenario 1	Scenario 2
Grader	110	1	0
Water Cart	108	1	0
20 to 30t Excavator	110	1	0
D8 Dozer	113	1	0
Scraper	115	2	0
Roller	112	0	1
Crane	103	0	1
Concrete/Brick/Tile Saw	105	0	1
Concrete/Haul Truck	112	4	2
Concrete Pump	108	1	0
Compressor	103	0	1
General Power Tools	95	0	1
Portable Generator	110	0	1

All equipment listed in Table 9-1 would not be working at the maximum power levels simultaneously. Experience indicates that these maximum noise levels occur only rarely, and the L_{A10} noise levels will be at least 7dBA below the maximum levels. For this reason, 7dBA was subtracted from the calculated "worst case" maximum noise levels to give an estimate of the typical L_{A10} noise level from the site. Using the assumed plant items and their associated maximum sound power levels (with consideration given to the operational changes, intermittent processes and changes in distance of mobile plant), the combined L_{A10} sound power levels for each scenario is:

- Scenario 1 116dBA (123-7)
- Scenario 2 111dBA (118-7)

9.3 Calculated Noise Levels

Table 9-2 summarises the calculated noise levels (unmitigated) at the existing residences for calm isothermal conditions.

Table 9-2 Calculated Construction Noise Levels at Existing Receivers

Location No.	Calculated Noise Level $L_{Aeq,15min}$ (dBA)		Noise Criteria $L_{Aeq,15min}$ (dBA)
	Scenario 1	Scenario 2	
1	44	39	35
2	<20	<20	35
3	23	<20	35
4	<20	<20	35
5	<20	<20	35
6	<20	<20	35

Note: The more stringent criteria between Saturdays and weekdays are shown.

Table 9-2 shows that no exceedances are predicted except to Velvedere (Location 1). A 9dBA exceedance is predicted for the worst–case month. Adequate noise mitigation measures will be provided to ensure compliance with the *INP* for Rural setting environments. See Section 9.5 for further discussion of management of noise to this location.

9.4 Construction Noise Level from Laying Pipeline

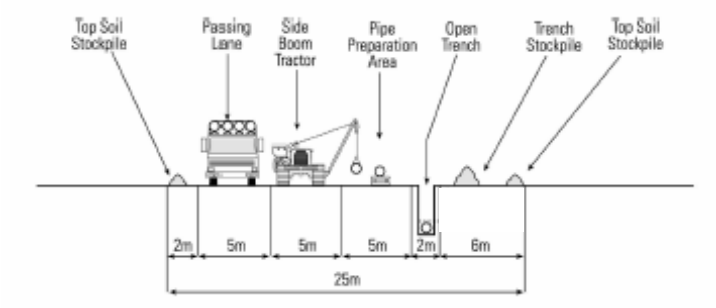
Figure 9-2 shows the proposed route of the gas pipeline to be constructed. The Pipeline will be constructed in accordance with the requirements of AS 2885 and the APIA *Code of Environmental Practice*.

Construction activities will be typical of modern pipeline projects and will involve the following key steps:

- Clearing of vegetation and grading of the right-of-way to prepare a safe construction area and to protect and preserve top soil.
- Creation of a trench in which to lay the pipeline. This will be undertaken by a trenching machine or excavator, but could involve rock hammers or blasting in isolated areas if necessary, although this scenario is unlikely given that preliminary studies indicate that encountering rock breaking is unlikely.
- Crossing watercourses by open cut, boring or horizontal directional drilling methods.
- Crossing of railway and major roads by open cut, boring or horizontal directional drilling methods appropriate to the requirements of the respective asset owners.
- Installation of cathodic protection systems
- Cleaning up and restoring the construction right-of-way and all disturbed work areas.
- Installation of appropriate signage

Figure 9-1 shows the typical site set up.

Figure 9-1 Typical Construction Right-of-Way



As the construction site moves along as the pipe is laid, it is estimated that any residence will be impacted by the noise for less than 4 weeks. Hence the noise criterion for this construction is background plus 20dBA. A minimum background of 30dBA is assumed for all residences, hence the noise criterion is 50dBA. The Velvedere residence at Location 1 is a special case considered in Section 9.5.

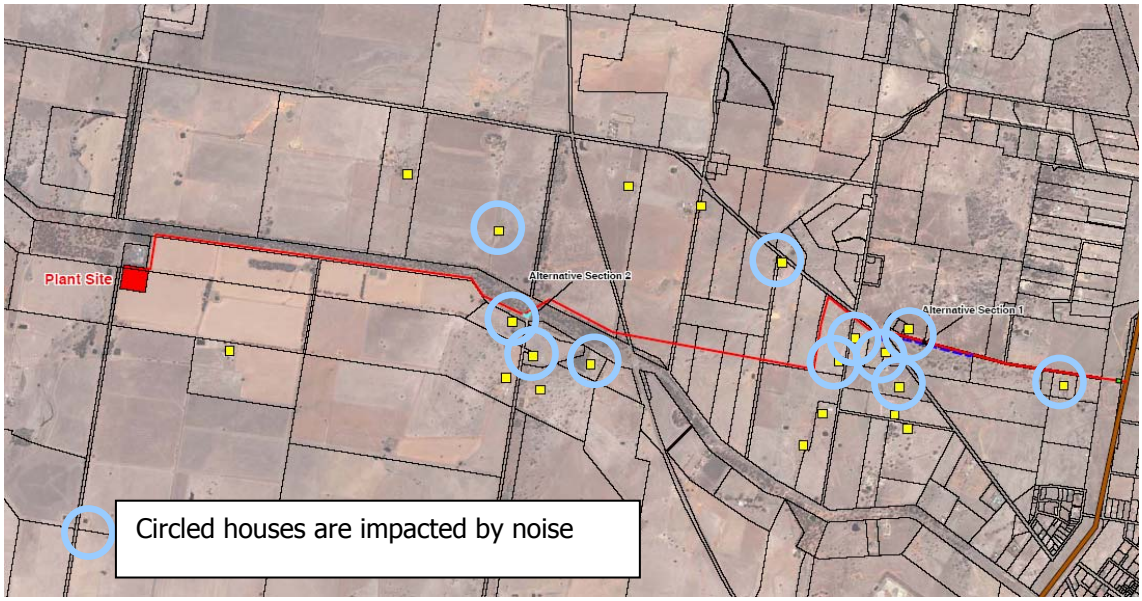
Noise from the site will vary according to the equipment being used, but typically there would be an excavator and one truck operating at any time. Using the sound power levels of Table 9-1 for an excavator and a truck, a typical site sound power level of 113dBA is estimated. If rock breakers are necessary a sound power level of 122dBA could be expected.

The noise level at any residence depends on its distance from the pipeline. Any residence within 600m of the pipeline will experience noise levels above the noise criterion of 50dBA. There are 11 residences identified within this distance. At the houses within 200m of the construction zone noise levels between 60-64dBA could be expected. All residences within this band should be notified when construction commences.

If the use of a rock breaker is necessary then noise levels would be up to 9dBA higher. All 21 houses shown on Figure 9-2 would have some noise impact if construction site was within approximately 1200m. If extensive use of rock-breakers became necessary then the use of temporary screens would mitigate the noise impact. However, preliminary studies indicate that it is unlikely that significant areas of rock requiring rock breaking would be encountered during construction of pipeline.

Some of these residences are closer to Parkes where the background noise levels could be above 30dBA. Also, the construction noise will be similar in character to agricultural machinery. These factors would mitigate the noise impact to a small extent.

Figure 9-2 Residences Impacted by Construction Noise from Pipeline



9.5 Construction Noise to Velvedere

This location is impacted by construction noise of the plant. Because it has a lower construction noise criterion than the other residences, it is also potentially impacted by construction noise from laying of the pipeline, even though it is approximately 1000m from the closest point of the pipeline.

The typical maximum levels of the pipeline construction would be 39-45dBA at this location. If this coincides with one of the noisier phases of construction of the plant, then the combined noise level could be up to 48dBA. Once the contractor is selected, the plant, processes and duration will be better known and a Construction Noise Management Plan is to be developed so that our assumptions confirmed and reasonable and feasible noise mitigation measures can be investigated if necessary. In brief, these may include:

- Selection of quiet plant and processes;
- Retrofitting reversing alarms that are quieter and display less annoying characteristics, such alarms include "smart alarms" and "quaker alarms";
- Use of temporary barriers;
- Positioning of plant / processes; and
- Limiting the "clustering" of plant / processes.
- Scheduling pipelaying near Velvedere during one of the quieter phases of construction of the plant.

As the noise will generally be similar in character to noise from agricultural equipment, the residents may not perceive it as a nuisance. The residents at Velvedere should be notified and noise mitigation be discussed as part of the Construction Noise Management Plan.

10 CONCLUSION

The construction, operational, traffic noise and vibration impacts due to the proposed peaking power plant at Parkes have been assessed by Wilkinson Murray.

With respect to noise, the following policy guidelines published by the NSW Department of Environment & Climate Change have been referenced:

- *NSW Industrial Noise Policy*, dated January 2000
- *Environmental Criteria for Road Traffic Noise,* dated May 1999
- *Noise Guide for Local Government,* dated June 2004
- *Environmental Noise Control Manual,* dated 1984

Vibration has been assessed by considering:

- The DECC's – *Assessing Vibration – A Technical Guideline,* dated February 2006
- German Standard 4150-3 – *Structural Vibration - Part 3: Effects of Vibration on Structures,* dated February, 1999.

In assessing the noise impact to the existing residences during the operation of the plant, a conservative scenario considering all 3 turbines operating during the night-time has been undertaken. This has resulted in predicted levels below criteria for all existing nearby residences. Should only 1 turbine operate, the noise levels are likely to be up to 5 dBA lower.

With regard to gas turbine power plants and the nearby residences, there is a risk (considered by WM to be medium due to the limited existing low frequency noise) that low frequency noise correction could apply if the noise mitigation is not correctly designed in the detail design process.

During the detailed design phase if the gas turbine supplier considers that their plant would result in a low frequency modification factor being applied at the residences, then the plant should be designed to meet a level of 5dBA below the criteria to account for low frequency noise.

Based on discussions with manufacturers and review of guaranteed sound power levels, a further reduction of at least 5dB is achievable with a readily available low noise turbine system.

The potential of sleep disturbance from the operation of the development were found to be negligible.

Noise impacts due to extra traffic along Condobolin Road (both during construction and operation) were found to be negligible.

A preliminary assessment of noise during the construction phase shows no exceedances except at the existing residential receiver at Location 1. These levels are to be confirmed prior to commencement with the Contractor. A Construction Noise Management Plan should be developed to ensure a suitable program and that these levels are met.

It is predicted that there will be no vibration impacts (both during construction and operation).

Note
All materials specified by Wilkinson Murray Pty Limited have been selected solely on the basis of acoustic performance. Any other properties of these materials, such as fire rating, chemical properties etc. should be checked with the suppliers or other specialised bodies for fitness for a given purpose.

Quality Assurance
We are committed to and have implemented AS/NZS ISO 9001:2000 "Quality Management Systems – Requirements". This management system has been externally certified and Licence No. QEC 13457 has been issued.

AAAC
This firm is a member firm of the Association of Australian Acoustical Consultants and the work here reported has been carried out in accordance with the terms of that membership.

Version	Status	Date	Prepared by	Checked by
A	Draft	14 December 2006	George Jenner	John Wasserman
B	Final	9 October 2007	Sam Demasi	-

APPENDIX A

GLOSSARY OF TERMS

GLOSSARY

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

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

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

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

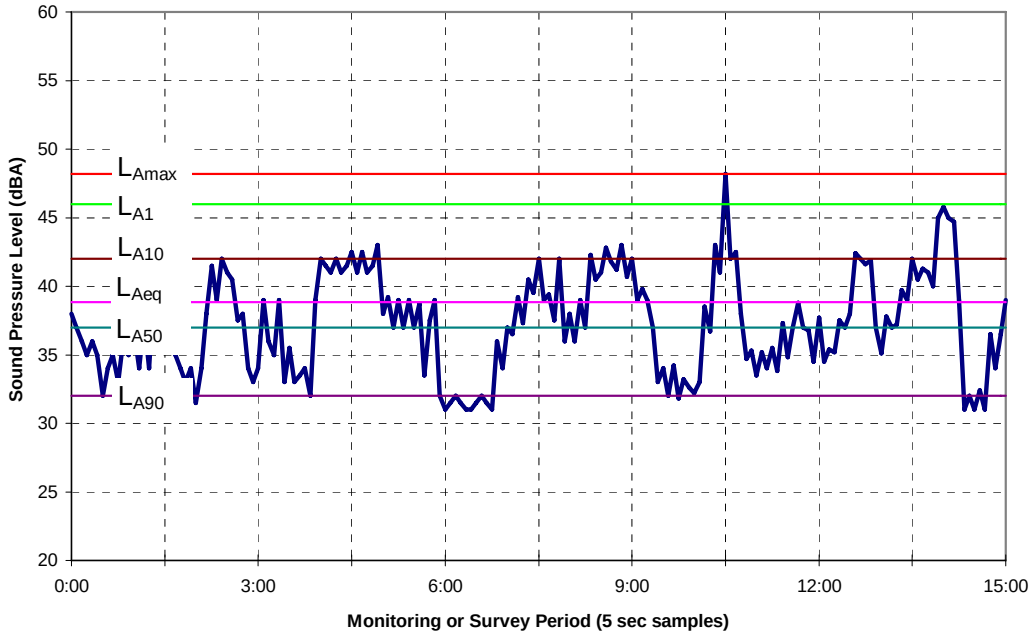
L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise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

L_{A50} – The L_{A50} level is the noise level which is exceeded for 50% of the sample period. During the sample period, the noise level is below the L_{A50} level for 50% of the time.

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

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

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

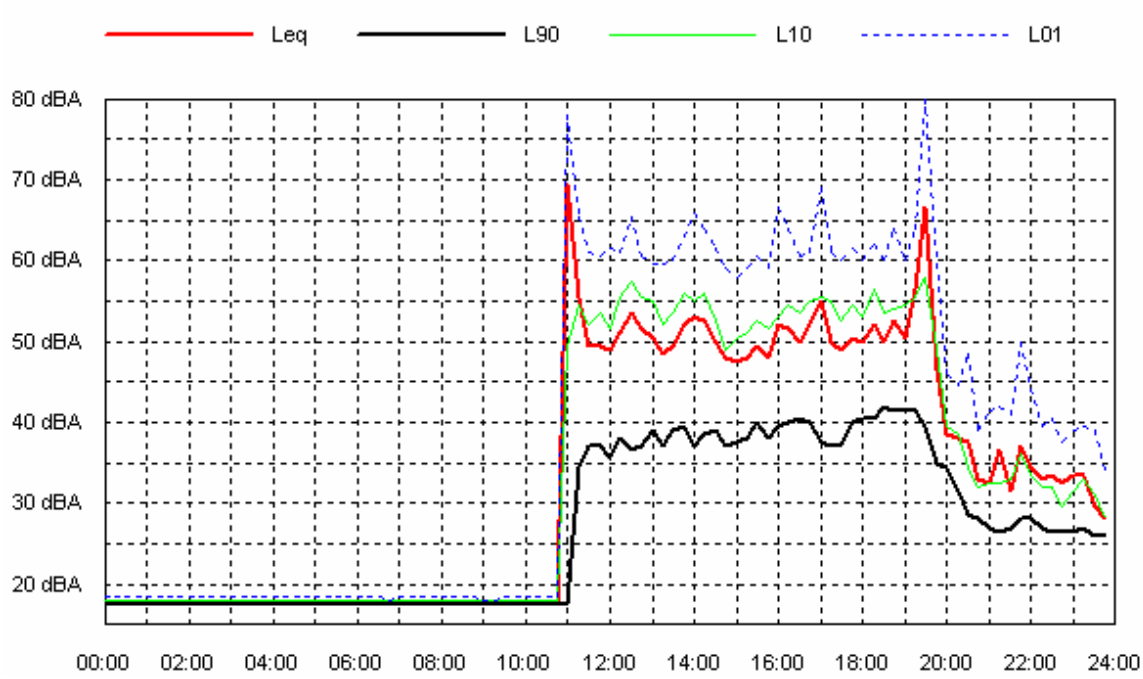

60
55
50
45
40
35
30
25
20
Sound Pressure Level (dBA)
LAmax
LA1
LA10
LAeq
LA50
LA90
0:00
3:00
6:00
9:00
12:00
15:00
Monitoring or Survey Period (5 sec samples)

APPENDIX B

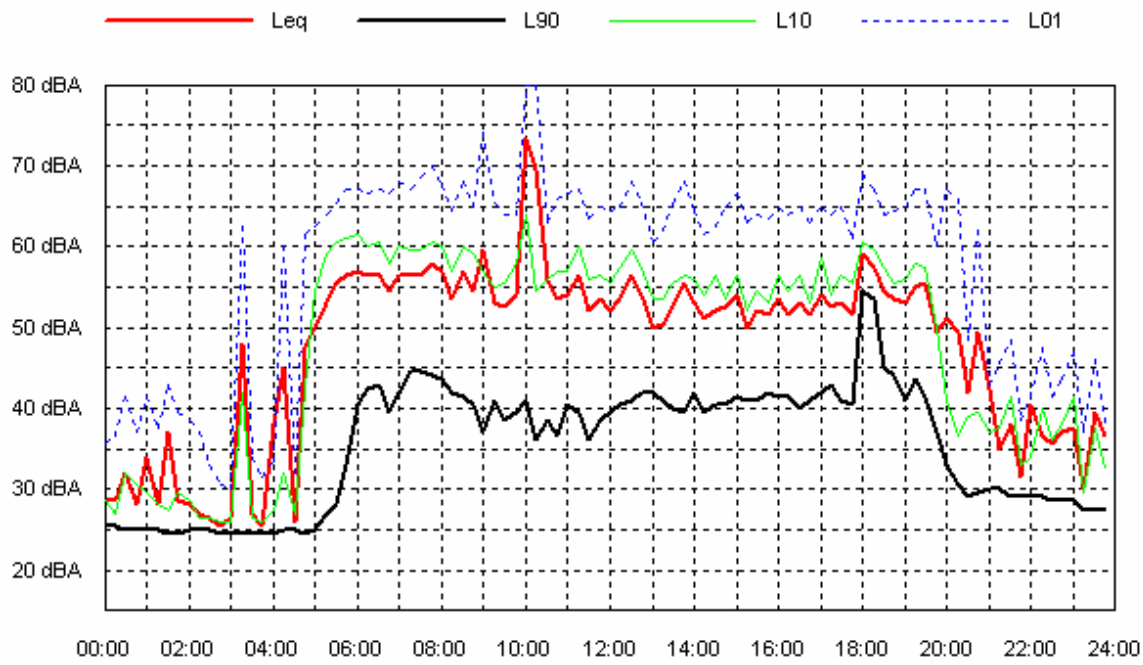
NOISE MEASUREMENT RESULTS

Location: Location 1

Thu 03 Nov 05

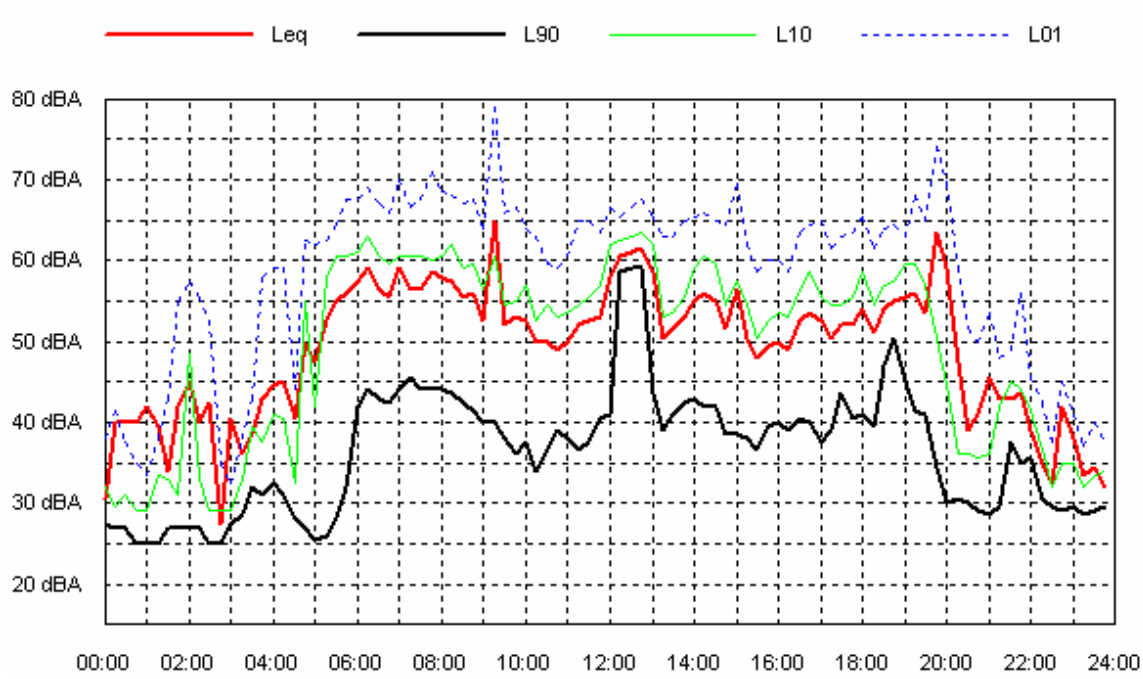


Fri 04 Nov 05

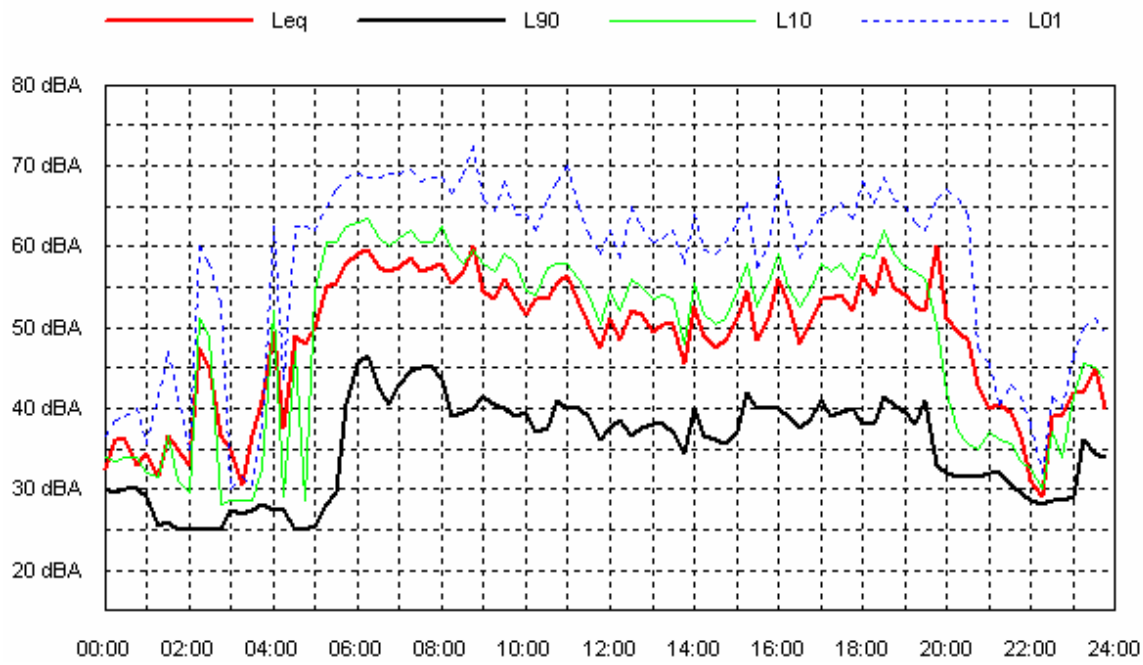


Location: Location 1

Sat 05 Nov 05

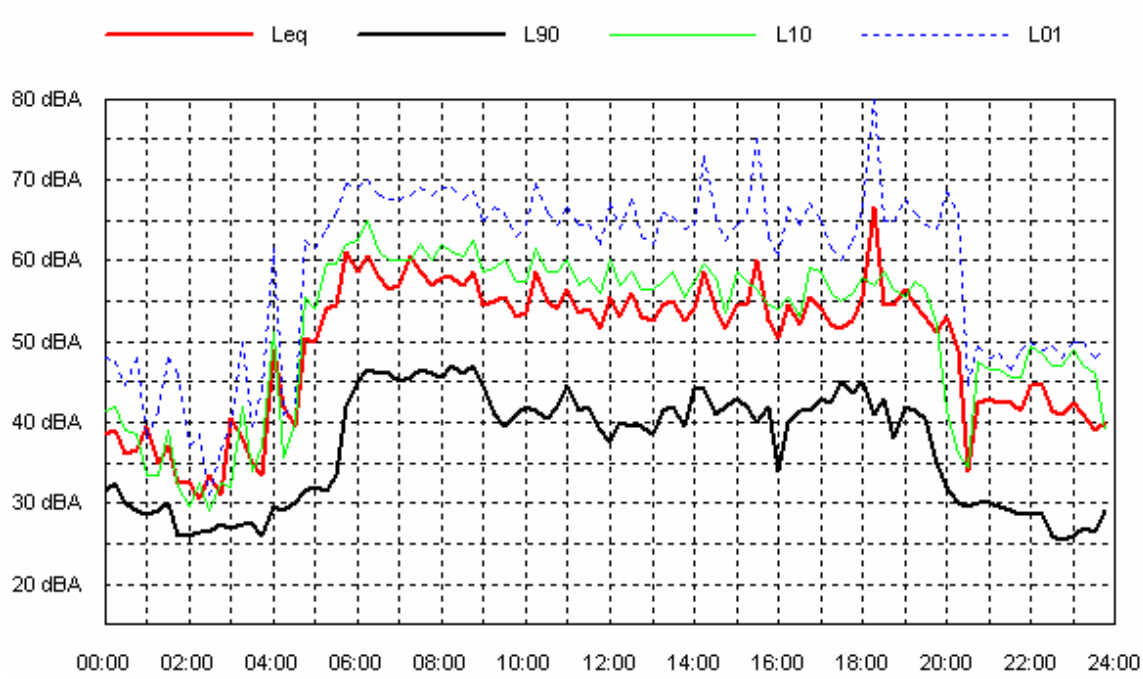


Sun 06 Nov 05

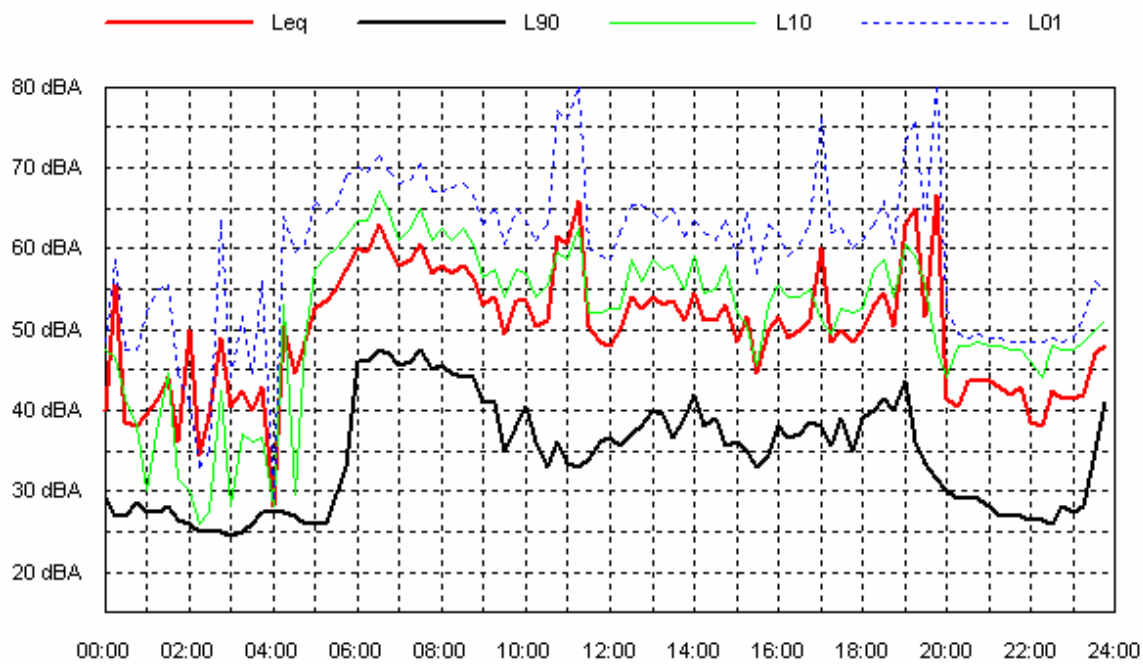


Location: Location 1

Mon 07 Nov 05

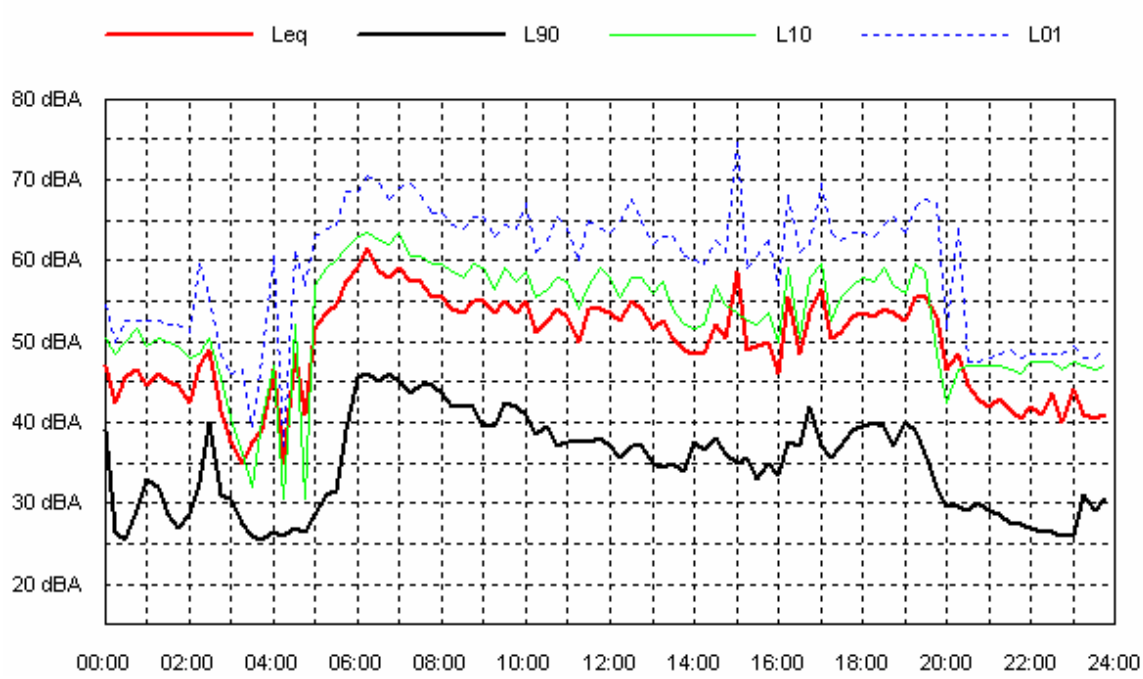


Tue 08 Nov 05

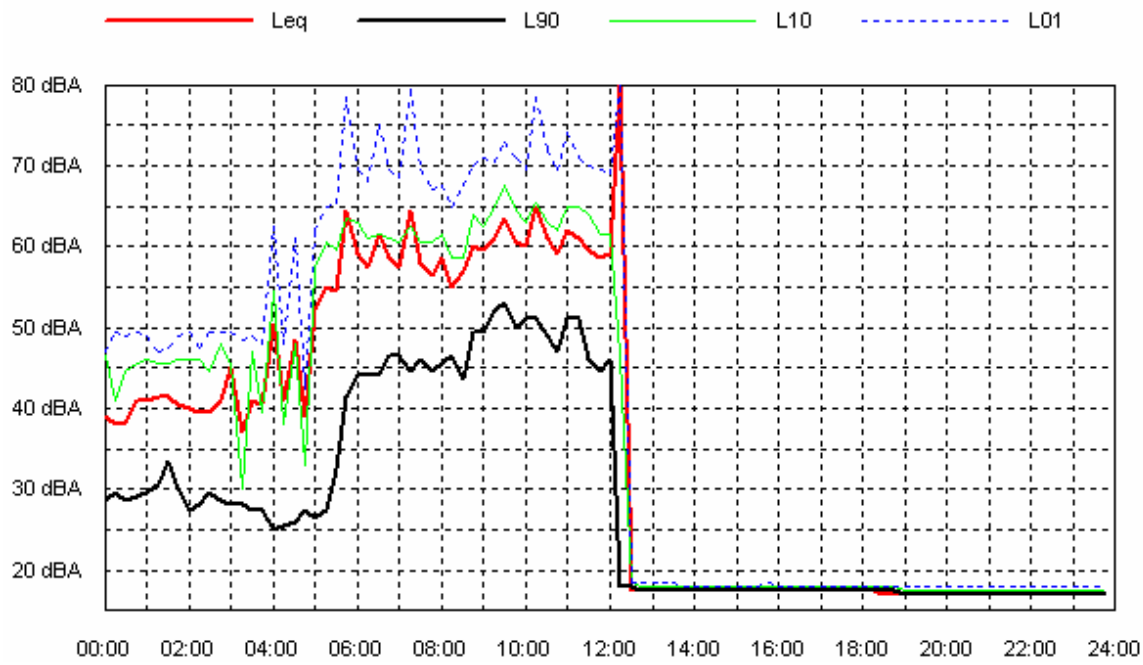


Location: Location 1

Wed 09 Nov 05



Thu 10 Nov 05



APPENDIX C

SUMMARY OF METEOROLOGICAL CONDITIONS MODELLED

Season	Period	Wind Dir	Wind Speed	Inv Strength	% Occurrence
Autumn	Day	0	0	0	60.57
Autumn	Day	0	0.75	0	0.40
Autumn	Day	45	0.75	0	0.40
Autumn	Day	90	0.75	0	0.30
Autumn	Day	135	0.75	0	0.20
Autumn	Day	180	0.75	0	0.69
Autumn	Day	225	0.75	0	0.49
Autumn	Day	270	0.75	0	0.40
Autumn	Day	315	0.75	0	0.10
Autumn	Day	0	1.25	0	0.89
Autumn	Day	45	1.25	0	1.09
Autumn	Day	90	1.25	0	0.69
Autumn	Day	180	1.25	0	0.79
Autumn	Day	225	1.25	0	0.89
Autumn	Day	270	1.25	0	0.59
Autumn	Day	315	1.25	0	0.30
Autumn	Day	0	1.75	0	0.59
Autumn	Day	45	1.75	0	1.48
Autumn	Day	90	1.75	0	0.89
Autumn	Day	135	1.75	0	0.49
Autumn	Day	180	1.75	0	1.19
Autumn	Day	225	1.75	0	0.99
Autumn	Day	270	1.75	0	1.68
Autumn	Day	315	1.75	0	0.59
Autumn	Day	0	2.25	0	2.57
Autumn	Day	45	2.25	0	3.36
Autumn	Day	90	2.25	0	1.58
Autumn	Day	135	2.25	0	0.79
Autumn	Day	180	2.25	0	0.59
Autumn	Day	225	2.25	0	2.17
Autumn	Day	270	2.25	0	0.99
Autumn	Day	315	2.25	0	1.09
Autumn	Day	0	2.75	0	1.28
Autumn	Day	45	2.75	0	1.88
Autumn	Day	90	2.75	0	1.38
Autumn	Day	135	2.75	0	0.89
Autumn	Day	180	2.75	0	1.28
Autumn	Day	225	2.75	0	1.78
Autumn	Day	270	2.75	0	0.49
Autumn	Day	315	2.75	0	0.69
Autumn	Day	0	0	3	0.10
Autumn	Day	225	2.25	3	0.10
Autumn	Day	225	2.75	3	0.10
Autumn	Day	270	2.75	3	0.10
Autumn	Day	315	2.75	3	0.10

Season	Period	Wind Dir	Wind Speed	Inv Strength	% Occurrence
Autumn	Evening	0	0	0	36.68
Autumn	Evening	90	0.75	0	0.27
Autumn	Evening	180	0.75	0	0.54

Autumn	Evening	225	0.75	0	0.82
Autumn	Evening	225	1.75	0	0.54
Autumn	Evening	90	2.25	0	0.27
Autumn	Evening	225	2.25	0	0.27
Autumn	Evening	270	2.25	0	0.82
Autumn	Evening	0	2.75	0	0.27
Autumn	Evening	180	2.75	0	0.27
Autumn	Evening	0	0	3	13.59
Autumn	Evening	90	0.75	3	0.27
Autumn	Evening	225	0.75	3	0.27
Autumn	Evening	315	0.75	3	0.27
Autumn	Evening	0	1.25	3	0.27
Autumn	Evening	45	1.25	3	1.90
Autumn	Evening	90	1.25	3	0.54
Autumn	Evening	135	1.25	3	0.27
Autumn	Evening	180	1.25	3	1.36
Autumn	Evening	225	1.25	3	0.82
Autumn	Evening	0	1.75	3	0.54
Autumn	Evening	135	1.75	3	0.27
Autumn	Evening	180	1.75	3	0.27
Autumn	Evening	315	1.75	3	0.27
Autumn	Evening	0	2.25	3	0.27
Autumn	Evening	45	2.25	3	6.25
Autumn	Evening	90	2.25	3	4.62
Autumn	Evening	135	2.25	3	2.45
Autumn	Evening	180	2.25	3	5.16
Autumn	Evening	225	2.25	3	4.35
Autumn	Evening	0	2.75	3	0.82
Autumn	Evening	45	2.75	3	0.82
Autumn	Evening	90	2.75	3	5.71
Autumn	Evening	135	2.75	3	2.17
Autumn	Evening	180	2.75	3	3.53
Autumn	Evening	225	2.75	3	2.17

Season	Period	Wind Dir	Wind Speed	Inv Strength	% Occurrence
Autumn	Night	0	0	0	35.51
Autumn	Night	0	0.75	0	0.24
Autumn	Night	45	0.75	0	0.24
Autumn	Night	90	0.75	0	1.57
Autumn	Night	135	0.75	0	0.36
Autumn	Night	180	0.75	0	0.85
Autumn	Night	225	0.75	0	0.36
Autumn	Night	270	0.75	0	0.12
Autumn	Night	0	1.25	0	0.24
Autumn	Night	45	1.25	0	1.21
Autumn	Night	90	1.25	0	0.85
Autumn	Night	135	1.25	0	0.36
Autumn	Night	180	1.25	0	0.60
Autumn	Night	225	1.25	0	0.48
Autumn	Night	270	1.25	0	0.12
Autumn	Night	45	1.75	0	0.24

Autumn	Night	90	1.75	0	0.12
Autumn	Night	180	1.75	0	0.12
Autumn	Night	225	1.75	0	0.12
Autumn	Night	315	1.75	0	0.12
Autumn	Night	0	2.25	0	0.36
Autumn	Night	45	2.25	0	1.69
Autumn	Night	90	2.25	0	1.21
Autumn	Night	135	2.25	0	0.72
Autumn	Night	180	2.25	0	0.12
Autumn	Night	225	2.25	0	0.24
Autumn	Night	0	2.75	0	0.12
Autumn	Night	45	2.75	0	0.36
Autumn	Night	90	2.75	0	0.72
Autumn	Night	135	2.75	0	0.12
Autumn	Night	180	2.75	0	0.36
Autumn	Night	225	2.75	0	0.12
Autumn	Night	0	0	3	8.45
Autumn	Night	45	0.75	3	0.48
Autumn	Night	90	0.75	3	0.12
Autumn	Night	0	1.25	3	0.24
Autumn	Night	45	1.25	3	2.78
Autumn	Night	90	1.25	3	1.45
Autumn	Night	135	1.25	3	0.60
Autumn	Night	180	1.25	3	0.60
Autumn	Night	225	1.25	3	0.24
Autumn	Night	270	1.25	3	0.12
Autumn	Night	45	1.75	3	0.97
Autumn	Night	90	1.75	3	0.85
Autumn	Night	135	1.75	3	0.12
Autumn	Night	225	1.75	3	0.60
Autumn	Night	270	1.75	3	0.12
Autumn	Night	315	1.75	3	0.12
Autumn	Night	0	2.25	3	0.36
Autumn	Night	45	2.25	3	9.18
Autumn	Night	90	2.25	3	5.80
Autumn	Night	135	2.25	3	0.85
Autumn	Night	180	2.25	3	1.93
Autumn	Night	225	2.25	3	1.33
Autumn	Night	270	2.25	3	0.12
Autumn	Night	0	2.75	3	0.36
Autumn	Night	45	2.75	3	4.35
Autumn	Night	90	2.75	3	6.28
Autumn	Night	135	2.75	3	0.24
Autumn	Night	180	2.75	3	0.72
Autumn	Night	225	2.75	3	0.60

Season	Period	Wind Dir	Wind Speed	Inv Strength	% Occurrence
Spring	Day	0	0	0	72.43
Spring	Day	0	0.75	0	0.40
Spring	Day	45	0.75	0	0.80
Spring	Day	90	0.75	0	0.20
Spring	Day	135	0.75	0	0.10
Spring	Day	180	0.75	0	0.10
Spring	Day	225	0.75	0	0.60
Spring	Day	270	0.75	0	0.20
Spring	Day	315	0.75	0	0.40
Spring	Day	0	1.25	0	0.70
Spring	Day	45	1.25	0	1.20
Spring	Day	90	1.25	0	0.20
Spring	Day	135	1.25	0	0.20
Spring	Day	180	1.25	0	0.60
Spring	Day	225	1.25	0	0.50
Spring	Day	270	1.25	0	0.90
Spring	Day	315	1.25	0	0.40
Spring	Day	0	1.75	0	1.60
Spring	Day	45	1.75	0	1.20
Spring	Day	90	1.75	0	0.30
Spring	Day	135	1.75	0	0.20
Spring	Day	180	1.75	0	1.00
Spring	Day	225	1.75	0	0.70
Spring	Day	270	1.75	0	0.50
Spring	Day	315	1.75	0	0.70
Spring	Day	0	2.25	0	1.50
Spring	Day	45	2.25	0	1.30
Spring	Day	90	2.25	0	0.80
Spring	Day	135	2.25	0	0.20
Spring	Day	180	2.25	0	0.60
Spring	Day	225	2.25	0	1.00
Spring	Day	270	2.25	0	0.60
Spring	Day	315	2.25	0	0.70
Spring	Day	0	2.75	0	1.20
Spring	Day	45	2.75	0	0.90
Spring	Day	90	2.75	0	0.40
Spring	Day	135	2.75	0	0.20
Spring	Day	180	2.75	0	0.80
Spring	Day	225	2.75	0	1.70
Spring	Day	270	2.75	0	0.60
Spring	Day	315	2.75	0	1.40

Season	Period	Wind Dir	Wind Speed	Inv Strength	% Occurrence
Spring	Evening	0	0	0	42.03
Spring	Evening	0	0.75	0	0.82
Spring	Evening	45	0.75	0	0.55
Spring	Evening	90	0.75	0	0.27
Spring	Evening	135	0.75	0	0.82

Spring	Evening	180	0.75	0	0.55
Spring	Evening	315	0.75	0	0.27
Spring	Evening	0	1.25	0	0.27
Spring	Evening	45	1.25	0	0.27
Spring	Evening	90	1.25	0	0.27
Spring	Evening	135	1.25	0	0.27
Spring	Evening	225	1.25	0	0.55
Spring	Evening	315	1.25	0	0.27
Spring	Evening	0	1.75	0	0.55
Spring	Evening	90	1.75	0	0.27
Spring	Evening	180	1.75	0	0.27
Spring	Evening	225	1.75	0	0.27
Spring	Evening	315	1.75	0	1.10
Spring	Evening	0	2.25	0	1.10
Spring	Evening	45	2.25	0	0.55
Spring	Evening	90	2.25	0	0.55
Spring	Evening	135	2.25	0	0.55
Spring	Evening	180	2.25	0	0.27
Spring	Evening	225	2.25	0	0.55
Spring	Evening	315	2.25	0	0.27
Spring	Evening	0	2.75	0	0.55
Spring	Evening	90	2.75	0	0.55
Spring	Evening	135	2.75	0	0.27
Spring	Evening	180	2.75	0	0.55
Spring	Evening	225	2.75	0	0.82
Spring	Evening	270	2.75	0	0.55
Spring	Evening	0	0	3	9.62
Spring	Evening	135	0.75	3	0.27
Spring	Evening	180	0.75	3	0.27
Spring	Evening	0	1.25	3	1.10
Spring	Evening	45	1.25	3	1.10
Spring	Evening	90	1.25	3	0.55
Spring	Evening	135	1.25	3	0.82
Spring	Evening	180	1.25	3	0.27
Spring	Evening	225	1.25	3	1.37
Spring	Evening	270	1.25	3	0.27
Spring	Evening	315	1.25	3	0.27
Spring	Evening	0	1.75	3	0.27
Spring	Evening	45	1.75	3	0.55
Spring	Evening	90	1.75	3	1.10
Spring	Evening	180	1.75	3	1.10
Spring	Evening	270	1.75	3	0.27
Spring	Evening	315	1.75	3	0.27
Spring	Evening	0	2.25	3	0.27
Spring	Evening	45	2.25	3	4.40
Spring	Evening	90	2.25	3	3.30
Spring	Evening	135	2.25	3	0.55
Spring	Evening	180	2.25	3	2.75
Spring	Evening	225	2.25	3	1.92
Spring	Evening	270	2.25	3	1.65
Spring	Evening	315	2.25	3	0.27
Spring	Evening	0	2.75	3	0.27
Spring	Evening	45	2.75	3	1.10

Spring	Evening	90	2.75	3	3.02
Spring	Evening	135	2.75	3	0.27
Spring	Evening	180	2.75	3	1.65
Spring	Evening	225	2.75	3	1.92
Spring	Evening	270	2.75	3	0.27

Season	Period	Wind Dir	Wind Speed	Inv Strength	% Occurrence
Spring	Night	0	0	0	40.29
Spring	Night	45	0.75	0	0.49
Spring	Night	90	0.75	0	0.61
Spring	Night	135	0.75	0	0.12
Spring	Night	180	0.75	0	0.24
Spring	Night	225	0.75	0	0.24
Spring	Night	270	0.75	0	0.24
Spring	Night	315	0.75	0	0.12
Spring	Night	0	1.25	0	0.61
Spring	Night	45	1.25	0	1.83
Spring	Night	90	1.25	0	1.10
Spring	Night	135	1.25	0	0.24
Spring	Night	180	1.25	0	0.37
Spring	Night	225	1.25	0	0.98
Spring	Night	270	1.25	0	0.37
Spring	Night	315	1.25	0	0.12
Spring	Night	0	1.75	0	0.37
Spring	Night	45	1.75	0	1.10
Spring	Night	180	1.75	0	0.24
Spring	Night	225	1.75	0	0.24
Spring	Night	270	1.75	0	0.12
Spring	Night	315	1.75	0	0.12
Spring	Night	0	2.25	0	0.61
Spring	Night	45	2.25	0	3.42
Spring	Night	90	2.25	0	2.32
Spring	Night	135	2.25	0	0.98
Spring	Night	180	2.25	0	0.98
Spring	Night	225	2.25	0	1.22
Spring	Night	270	2.25	0	0.12
Spring	Night	315	2.25	0	0.24
Spring	Night	0	2.75	0	0.37
Spring	Night	45	2.75	0	0.85
Spring	Night	90	2.75	0	0.37
Spring	Night	135	2.75	0	0.12
Spring	Night	180	2.75	0	0.49
Spring	Night	225	2.75	0	0.37
Spring	Night	270	2.75	0	0.24
Spring	Night	315	2.75	0	0.24
Spring	Night	0	0	3	7.20
Spring	Night	45	0.75	3	0.24
Spring	Night	225	0.75	3	0.12
Spring	Night	0	1.25	3	0.37
Spring	Night	45	1.25	3	2.20
Spring	Night	90	1.25	3	0.73
Spring	Night	135	1.25	3	0.12

Spring	Night	180	1.25	3	0.12
Spring	Night	225	1.25	3	0.37
Spring	Night	0	1.75	3	0.61
Spring	Night	45	1.75	3	0.85
Spring	Night	90	1.75	3	0.12
Spring	Night	180	1.75	3	0.12
Spring	Night	270	1.75	3	0.12
Spring	Night	315	1.75	3	0.12
Spring	Night	0	2.25	3	0.85
Spring	Night	45	2.25	3	8.30
Spring	Night	90	2.25	3	3.42
Spring	Night	135	2.25	3	0.12
Spring	Night	180	2.25	3	0.49
Spring	Night	225	2.25	3	0.98
Spring	Night	270	2.25	3	0.49
Spring	Night	0	2.75	3	0.49
Spring	Night	45	2.75	3	3.54
Spring	Night	90	2.75	3	3.17
Spring	Night	135	2.75	3	0.24
Spring	Night	180	2.75	3	0.49
Spring	Night	225	2.75	3	0.49
Spring	Night	270	2.75	3	0.24
Spring	Night	315	2.75	3	0.12

Season	Period	Wind Dir	Wind Speed	Inv Strength	% Occurrence
Summer	Day	0	0	0	76.46
Summer	Day	0	0.75	0	0.40
Summer	Day	45	0.75	0	0.30
Summer	Day	90	0.75	0	0.51
Summer	Day	180	0.75	0	0.61
Summer	Day	225	0.75	0	0.51
Summer	Day	315	0.75	0	0.10
Summer	Day	0	1.25	0	0.40
Summer	Day	45	1.25	0	0.30
Summer	Day	90	1.25	0	0.51
Summer	Day	135	1.25	0	0.40
Summer	Day	180	1.25	0	0.30
Summer	Day	225	1.25	0	0.20
Summer	Day	270	1.25	0	0.61
Summer	Day	315	1.25	0	0.51
Summer	Day	0	1.75	0	0.71
Summer	Day	45	1.75	0	1.31
Summer	Day	90	1.75	0	0.61
Summer	Day	135	1.75	0	0.10
Summer	Day	180	1.75	0	0.51
Summer	Day	225	1.75	0	0.81
Summer	Day	270	1.75	0	0.81
Summer	Day	315	1.75	0	0.30
Summer	Day	0	2.25	0	1.01
Summer	Day	45	2.25	0	0.61
Summer	Day	90	2.25	0	0.40
Summer	Day	135	2.25	0	0.71
Summer	Day	180	2.25	0	0.40
Summer	Day	225	2.25	0	1.21
Summer	Day	270	2.25	0	0.30
Summer	Day	315	2.25	0	0.61
Summer	Day	0	2.75	0	1.62
Summer	Day	45	2.75	0	0.51
Summer	Day	90	2.75	0	0.61
Summer	Day	135	2.75	0	0.40
Summer	Day	180	2.75	0	0.20
Summer	Day	225	2.75	0	2.63
Summer	Day	270	2.75	0	0.81
Summer	Day	315	2.75	0	0.71

Season	Period	Wind Dir	Wind Speed	Inv Strength	% Occurrence
Summer	Evening	0	0	0	49.72
Summer	Evening	45	0.75	0	0.28
Summer	Evening	90	0.75	0	0.28
Summer	Evening	135	0.75	0	0.28
Summer	Evening	0	1.25	0	0.28
Summer	Evening	225	1.25	0	0.28
Summer	Evening	45	1.75	0	0.28
Summer	Evening	90	1.75	0	0.28

Summer	Evening	225	1.75	0	0.56
Summer	Evening	315	1.75	0	0.28
Summer	Evening	0	2.25	0	0.56
Summer	Evening	45	2.25	0	0.28
Summer	Evening	135	2.25	0	0.56
Summer	Evening	180	2.25	0	0.56
Summer	Evening	225	2.25	0	0.28
Summer	Evening	270	2.25	0	0.83
Summer	Evening	315	2.25	0	0.28
Summer	Evening	45	2.75	0	0.28
Summer	Evening	90	2.75	0	0.28
Summer	Evening	135	2.75	0	0.28
Summer	Evening	180	2.75	0	0.28
Summer	Evening	315	2.75	0	0.83
Summer	Evening	0	0	3	10.56
Summer	Evening	135	0.75	3	0.28
Summer	Evening	180	0.75	3	0.28
Summer	Evening	225	0.75	3	0.28
Summer	Evening	270	0.75	3	0.28
Summer	Evening	315	0.75	3	0.56
Summer	Evening	45	1.25	3	1.39
Summer	Evening	90	1.25	3	0.83
Summer	Evening	135	1.25	3	0.56
Summer	Evening	180	1.25	3	1.39
Summer	Evening	225	1.25	3	1.11
Summer	Evening	270	1.25	3	0.28
Summer	Evening	315	1.25	3	0.28
Summer	Evening	0	1.75	3	0.83
Summer	Evening	45	1.75	3	0.56
Summer	Evening	135	1.75	3	0.28
Summer	Evening	180	1.75	3	0.28
Summer	Evening	270	1.75	3	0.28
Summer	Evening	0	2.25	3	0.56
Summer	Evening	45	2.25	3	2.22
Summer	Evening	90	2.25	3	1.67
Summer	Evening	135	2.25	3	0.83
Summer	Evening	180	2.25	3	5.00
Summer	Evening	225	2.25	3	1.67
Summer	Evening	270	2.25	3	0.56
Summer	Evening	0	2.75	3	0.28
Summer	Evening	45	2.75	3	1.94
Summer	Evening	90	2.75	3	1.11
Summer	Evening	135	2.75	3	0.56
Summer	Evening	180	2.75	3	1.94
Summer	Evening	225	2.75	3	3.06
Summer	Evening	315	2.75	3	0.56

Season	Period	Wind Dir	Wind Speed	Inv Strength	% Occurrence
Summer	Night	0	0	0	44.07
Summer	Night	45	0.75	0	0.49
Summer	Night	90	0.75	0	0.86
Summer	Night	135	0.75	0	0.74

Summer	Night	180	0.75	0	0.25
Summer	Night	225	0.75	0	0.12
Summer	Night	315	0.75	0	0.25
Summer	Night	0	1.25	0	0.49
Summer	Night	45	1.25	0	1.23
Summer	Night	90	1.25	0	1.11
Summer	Night	135	1.25	0	0.12
Summer	Night	180	1.25	0	0.37
Summer	Night	225	1.25	0	0.37
Summer	Night	270	1.25	0	0.37
Summer	Night	315	1.25	0	0.49
Summer	Night	0	1.75	0	0.25
Summer	Night	45	1.75	0	0.86
Summer	Night	90	1.75	0	0.62
Summer	Night	135	1.75	0	0.25
Summer	Night	225	1.75	0	0.12
Summer	Night	270	1.75	0	0.12
Summer	Night	0	2.25	0	0.62
Summer	Night	45	2.25	0	2.10
Summer	Night	90	2.25	0	1.48
Summer	Night	135	2.25	0	0.12
Summer	Night	180	2.25	0	0.25
Summer	Night	0	2.75	0	0.37
Summer	Night	45	2.75	0	0.99
Summer	Night	90	2.75	0	0.49
Summer	Night	135	2.75	0	0.25
Summer	Night	180	2.75	0	0.12
Summer	Night	225	2.75	0	0.49
Summer	Night	0	0	3	6.67
Summer	Night	0	0.75	3	0.12
Summer	Night	45	0.75	3	0.62
Summer	Night	180	0.75	3	0.25
Summer	Night	225	0.75	3	0.12
Summer	Night	0	1.25	3	0.25
Summer	Night	45	1.25	3	1.11
Summer	Night	90	1.25	3	1.23
Summer	Night	135	1.25	3	0.49
Summer	Night	180	1.25	3	0.49
Summer	Night	225	1.25	3	0.37
Summer	Night	270	1.25	3	0.12
Summer	Night	315	1.25	3	0.25
Summer	Night	0	1.75	3	0.37
Summer	Night	45	1.75	3	0.74
Summer	Night	90	1.75	3	0.62
Summer	Night	180	1.75	3	0.25
Summer	Night	225	1.75	3	0.37
Summer	Night	270	1.75	3	0.25
Summer	Night	315	1.75	3	0.12
Summer	Night	0	2.25	3	0.74
Summer	Night	45	2.25	3	6.54
Summer	Night	90	2.25	3	4.57
Summer	Night	135	2.25	3	0.12
Summer	Night	180	2.25	3	1.36

Summer	Night	225	2.25	3	1.85
Summer	Night	270	2.25	3	0.37
Summer	Night	0	2.75	3	0.74
Summer	Night	45	2.75	3	2.59
Summer	Night	90	2.75	3	3.95
Summer	Night	135	2.75	3	0.12
Summer	Night	180	2.75	3	0.62
Summer	Night	225	2.75	3	0.74

Season	Period	Wind Dir	Wind Speed	Inv Strength	% Occurrence
Winter	Day	0	0	0	67.49
Winter	Day	0	0.75	0	0.40
Winter	Day	45	0.75	0	0.49
Winter	Day	90	0.75	0	0.40
Winter	Day	135	0.75	0	0.49
Winter	Day	180	0.75	0	1.09
Winter	Day	225	0.75	0	0.20
Winter	Day	270	0.75	0	0.20
Winter	Day	315	0.75	0	0.20
Winter	Day	0	1.25	0	1.38
Winter	Day	45	1.25	0	0.79
Winter	Day	90	1.25	0	0.20
Winter	Day	135	1.25	0	0.20
Winter	Day	180	1.25	0	0.49
Winter	Day	225	1.25	0	0.59
Winter	Day	270	1.25	0	0.30
Winter	Day	315	1.25	0	0.10
Winter	Day	0	1.75	0	0.79
Winter	Day	45	1.75	0	1.19
Winter	Day	90	1.75	0	0.30
Winter	Day	135	1.75	0	0.20
Winter	Day	180	1.75	0	0.69
Winter	Day	225	1.75	0	0.69
Winter	Day	270	1.75	0	0.40
Winter	Day	315	1.75	0	0.49
Winter	Day	0	2.25	0	1.48
Winter	Day	45	2.25	0	4.55
Winter	Day	90	2.25	0	1.28
Winter	Day	135	2.25	0	0.10
Winter	Day	180	2.25	0	0.69
Winter	Day	225	2.25	0	0.79
Winter	Day	270	2.25	0	1.09
Winter	Day	315	2.25	0	0.49
Winter	Day	0	2.75	0	0.89
Winter	Day	45	2.75	0	1.28
Winter	Day	90	2.75	0	0.89
Winter	Day	135	2.75	0	0.10
Winter	Day	180	2.75	0	0.79
Winter	Day	225	2.75	0	1.78
Winter	Day	270	2.75	0	0.89
Winter	Day	315	2.75	0	0.89
Winter	Day	0	0	3	0.59
Winter	Day	90	1.25	3	0.10
Winter	Day	270	1.25	3	0.10
Winter	Day	315	1.25	3	0.10
Winter	Day	0	2.25	3	0.40
Winter	Day	90	2.25	3	0.10
Winter	Day	225	2.25	3	0.10
Winter	Day	315	2.25	3	0.20
Winter	Day	0	2.75	3	0.20

Winter	Day	135	2.75	3	0.20
Winter	Day	315	2.75	3	0.20

Season	Period	Wind Dir	Wind Speed	Inv Strength	% Occurrence
Winter	Evening	0	0	0	35.60
Winter	Evening	0	0.75	0	1.36
Winter	Evening	45	0.75	0	0.27
Winter	Evening	90	0.75	0	0.27
Winter	Evening	135	0.75	0	0.27
Winter	Evening	180	0.75	0	0.54
Winter	Evening	225	0.75	0	0.27
Winter	Evening	270	0.75	0	0.82
Winter	Evening	315	0.75	0	0.27
Winter	Evening	0	1.25	0	0.54
Winter	Evening	90	1.25	0	0.54
Winter	Evening	180	1.25	0	1.09
Winter	Evening	225	1.25	0	0.27
Winter	Evening	270	1.25	0	0.27
Winter	Evening	0	1.75	0	0.82
Winter	Evening	45	1.75	0	0.27
Winter	Evening	180	1.75	0	0.54
Winter	Evening	225	1.75	0	0.82
Winter	Evening	0	2.25	0	0.82
Winter	Evening	45	2.25	0	1.36
Winter	Evening	135	2.25	0	0.82
Winter	Evening	180	2.25	0	0.54
Winter	Evening	225	2.25	0	1.90
Winter	Evening	270	2.25	0	0.27
Winter	Evening	0	2.75	0	0.27
Winter	Evening	45	2.75	0	0.27
Winter	Evening	180	2.75	0	0.82
Winter	Evening	0	0	3	8.15
Winter	Evening	180	0.75	3	0.27
Winter	Evening	45	1.25	3	1.09
Winter	Evening	90	1.25	3	0.82
Winter	Evening	135	1.25	3	1.36
Winter	Evening	180	1.25	3	1.63
Winter	Evening	225	1.25	3	0.54
Winter	Evening	45	1.75	3	0.54
Winter	Evening	90	1.75	3	0.54
Winter	Evening	180	1.75	3	0.54
Winter	Evening	225	1.75	3	1.90
Winter	Evening	270	1.75	3	0.27
Winter	Evening	315	1.75	3	0.27
Winter	Evening	0	2.25	3	1.36
Winter	Evening	45	2.25	3	4.08
Winter	Evening	90	2.25	3	4.35
Winter	Evening	135	2.25	3	1.09
Winter	Evening	180	2.25	3	1.63
Winter	Evening	225	2.25	3	2.17
Winter	Evening	270	2.25	3	0.27
Winter	Evening	315	2.25	3	0.82

Winter	Evening	0	2.75	3	0.54
Winter	Evening	45	2.75	3	3.26
Winter	Evening	90	2.75	3	5.16
Winter	Evening	180	2.75	3	2.17
Winter	Evening	225	2.75	3	2.45
Winter	Evening	270	2.75	3	0.54
Winter	Evening	315	2.75	3	0.27

Season	Period	Wind Dir	Wind Speed	Inv Strength	% Occurrence
Winter	Night	0	0	0	34.54
Winter	Night	0	0.75	0	0.48
Winter	Night	45	0.75	0	0.48
Winter	Night	90	0.75	0	0.85
Winter	Night	135	0.75	0	0.48
Winter	Night	180	0.75	0	0.48
Winter	Night	225	0.75	0	0.60
Winter	Night	270	0.75	0	0.12
Winter	Night	315	0.75	0	0.48
Winter	Night	0	1.25	0	0.48
Winter	Night	45	1.25	0	1.45
Winter	Night	90	1.25	0	1.57
Winter	Night	135	1.25	0	0.48
Winter	Night	180	1.25	0	0.60
Winter	Night	225	1.25	0	0.72
Winter	Night	270	1.25	0	0.72
Winter	Night	315	1.25	0	0.97
Winter	Night	45	1.75	0	1.57
Winter	Night	90	1.75	0	0.85
Winter	Night	135	1.75	0	0.97
Winter	Night	180	1.75	0	0.12
Winter	Night	225	1.75	0	0.60
Winter	Night	270	1.75	0	0.36
Winter	Night	0	2.25	0	1.09
Winter	Night	45	2.25	0	4.59
Winter	Night	90	2.25	0	1.45
Winter	Night	135	2.25	0	0.24
Winter	Night	180	2.25	0	0.97
Winter	Night	225	2.25	0	0.48
Winter	Night	270	2.25	0	0.24
Winter	Night	0	2.75	0	0.72
Winter	Night	45	2.75	0	1.45
Winter	Night	90	2.75	0	1.09
Winter	Night	180	2.75	0	0.24
Winter	Night	225	2.75	0	0.60
Winter	Night	270	2.75	0	0.60
Winter	Night	315	2.75	0	0.24
Winter	Night	0	0	3	5.68
Winter	Night	90	0.75	3	0.24
Winter	Night	180	0.75	3	0.12
Winter	Night	0	1.25	3	0.48
Winter	Night	45	1.25	3	1.81
Winter	Night	90	1.25	3	0.24

Winter	Night	135	1.25	3	0.12
Winter	Night	225	1.25	3	0.12
Winter	Night	270	1.25	3	0.12
Winter	Night	315	1.25	3	0.12
Winter	Night	0	1.75	3	0.24
Winter	Night	45	1.75	3	2.17
Winter	Night	90	1.75	3	0.36
Winter	Night	270	1.75	3	0.12
Winter	Night	0	2.25	3	1.21
Winter	Night	45	2.25	3	9.42
Winter	Night	90	2.25	3	3.74
Winter	Night	225	2.25	3	0.36
Winter	Night	270	2.25	3	0.12
Winter	Night	0	2.75	3	0.48
Winter	Night	45	2.75	3	3.50
Winter	Night	90	2.75	3	4.47
Winter	Night	135	2.75	3	0.12
Winter	Night	180	2.75	3	0.24
Winter	Night	315	2.75	3	0.36