Appendix E

Noise Assessment

Contents

1. Introduction

1.1. General introduction

In December 2008, TRUenergy finished the commissioning of the Tallawarra Stage A Combined Cycle Gas Turbine (CCGT) power station at Yallah, NSW. The station has a nominal operating capacity of 400 MW.

TRUenergy is also seeking approval for the construction and operation of the Tallawarra Stage B power station. The Stage B power station will be either a single CCGT station with a nominal capacity of 400 MW or two Open Cycle Gas Turbines (OCGT) with a nominal capacity of 300 – 450 MW.

This report provides an assessment of the noise impacts for the proposed Tallawarra Stage B power station and has considered potential noise emissions from the combined operations of both Tallawarra Stage A and Stage B.

1.2. Study objectives

The assessment of noise emissions has been undertaken in order to predict the level of impact expected at the nearest sensitive noise receiver. The assessment of noise impacts includes the measurement of the existing noise environment with attended and unattended noise surveys. This provides the basis for the setting of appropriate noise limits for the project, in accordance with NSW environmental policy. The noise impacts were assessed at locations both external to and within the boundary of the Tallawarra Lands site. These potential impacts are compared with the guidelines provided by the Department of Environment and Climate Change (DECC), which indicate where the likelihood of an unacceptable noise emission may occur. Where impacts are expected to be above the guideline noise levels, mitigation measures would be required to be incorporated as part of the project design.

The noise study includes the following components:

- Identification of residential receivers;
- Ambient noise monitoring at nearby residential locations;
- Setting of project specific noise criteria for existing residential receivers;
- Modelling of noise sources from the proposed project and prediction of noise levels at residential receivers; and
- Identification of exceedances of noise criteria and recommendation of additional mitigation where required.

1.3. History of the site

In 1954, a coal fired power station was constructed on the project site, operating until 1989. The former plant and much of its ancillary buildings have been demolished and the operational areas of the site remediated. The then owner of the site, Pacific Power, prepared an Environmental Impact Statement (EIS) to support the Development Application for a new CCGT power station (Tallawarra Stage A).

Wollongong City Council granted development consent for the CCGT power station in 1999 and the Tallawarra site was later purchased by TRUenergy[1] on 30 April 2003. As part of the approval for the current works, council has included conditions for noise impacts at sensitive receivers external to the site. Initial site works for the power station, which is currently being constructed by Alstom Power, commenced in 2004 with commercial operation expected to commence prior to the end of 2008.

As part of a separate approval process, TRUenergy are investigating future land use options for the remainder of the Tallawarra Lands site. TRUenergy submitted a pre-rezoning submission to Wollongong City Council in July 2005 to facilitate this proposal. A Local Environment Study (LES) has since been prepared for the site and submitted in draft form for review. The LES identifies preferred categories of development including industrial, commercial, residential and conservation areas within the Tallawarra Lands boundary, and a draft Local Environment Plan (LEP) has been prepared for the site. The impact of noise emissions from both the Stage A and the proposed Stage B plant on potential residential areas within the Tallawarra Lands site boundary have been considered in this noise assessment.

[1] TXU was purchased by TRUenergy in 2005

2. Pre-construction noise environment

2.1. Local setting

The project site is located south of Wollongong on the eastern coast of NSW, overlooking Yallah Bay between the suburbs of Koonawarra and Albion Park. The power station site is located within a relatively undeveloped area, on the western side of Lake Illawarra. The existing noise environment around the power station site is largely influenced by its location near Lake Illawarra, which is the main water body in the Illawarra catchment area.

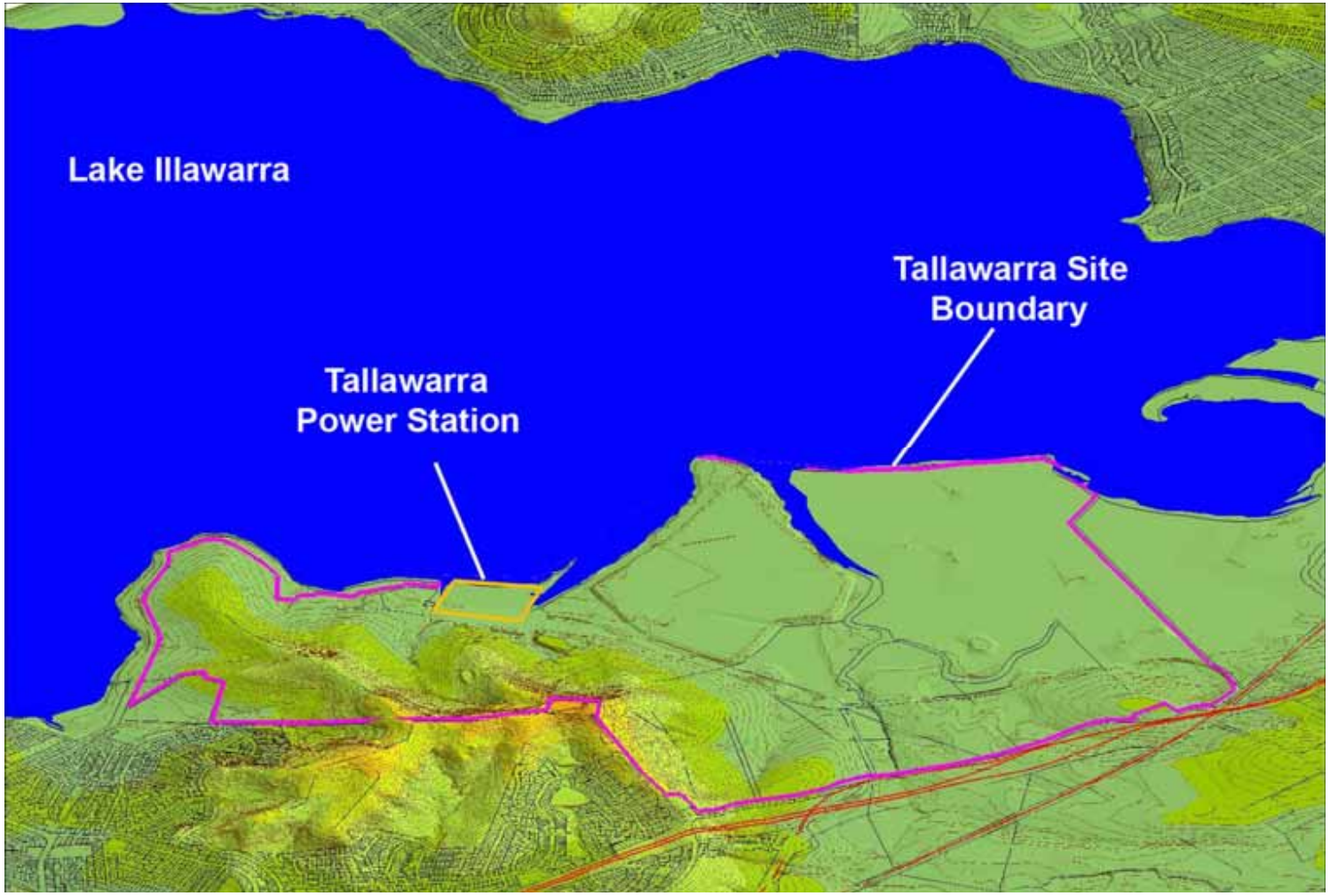
The local area has a large residential population, the majority of which would be classified as urban or suburban with some rural residential properties located further from the coast. Across Lake Illawarra are the residential areas of Oak Flats, Mount Warrigal, Lake Illawarra and Windang. South and southwest of the site are residential areas of Albion Park, Haywards Bay and Yallah. To the north of the site is the residential area of Koonawarra which continues to the west of the site and is separated from the power station site by Mount Brown.

Local industry closely follows the Southern Freeway, which runs along the south coast and connects into the Princes Highway, providing the road connection between Wollongong and the south. The proximity of such an important traffic route means that traffic noise is also a feature of the area for locations that are adjacent to or have a line of sight to the road network.

Other noise sources include the BHP steel mill which operates in Port Kembla some distance to the north. Due to the size of the industry and the fact that it operates 24 hours a day, it is audible from some locations around Lake Illawarra during the quietest part of the night time as a low humming noise.

Figure 2-1 presents a topographic view of the site and surrounding area.

- **Figure 2-1 Topography surrounding Tallawarra site**



2.2. Background noise measurements

In accordance with the NSW government requirements, it is necessary to conduct noise monitoring for the proposed project to enable the setting of appropriate criteria with respect to the existing environment. In general, to identify the trends in background noise levels, one week of ambient noise monitoring must be undertaken. DECC further categorises one 24-hour monitoring period into the following three assessment periods:

- Day – 7:00 am to 6:00 pm;
- Evening – 6:00 pm to 10:00 pm; and
- Night – 10:00 pm to 7:00 am.

In order to quantify the noise environment at residential locations near the Tallawarra power station, noise levels were measured using both attended and unattended monitoring methods. The measurements were undertaken in accordance with the DECC Industrial Noise Policy (INP) (January 2000). The identification of noise sensitive receivers is taken from Table 2.1 of the INP, which list various types of receivers that may be considered to be sensitive to noise emissions from industrial sources.

When measuring noise levels, the use of statistical descriptors is necessary to understand and describe how variations in the noise environment occur over any given period. A list of common descriptors used in this noise assessment, as well as their meaning, is given below.

- L_{A10} – the noise level exceeded for 10 percent of the 15 minute interval, this is commonly referred to as the average-maximum level;
- L_{A90} – the noise level exceeded for 90 percent of the 15 minute interval. This is commonly referred to as the background noise level and represents the quietest 90 seconds in a 15 minute period;
- L_{Aeq} – the noise level having the same energy as the time varying noise level over the 15 minute interval.
- L_{Amax} maximum noise level measured at a given location over the 15 minute interval.

2.3. Monitoring locations

The locations for noise monitoring were selected based on their proximity to the Tallawarra power station site, freedom from extraneous noise sources and the availability and willingness of the owners to have the noise monitors located on their property. **Table 2-1** lists the locations of the noise surveys while **Figure 2-2** shows the noise monitoring locations in relation to the Tallawarra site and the local area. In the figure the blue dots represent the unattended monitoring locations and the red circles indicate the location of the attended noise surveys.

- **Figure 2-2 Tallawarra site and monitoring locations**

- **Table 2-1 Noise monitoring locations**

ID	Address	Description
T1	Tallawarra Site South	Located in the south of the development site, near the wetlands area.
T2	Carlyle Street, Koonawarra	The properties on Carlyle Street are adjacent to the Tallawarra site to the east of the power station
T3	Tallawarra Site North	The monitoring site was located on the ridgeline to the north of the power station with the Tallawarra site.
T4	Wyndarra Way, Koonawarra	The monitoring site was located in the backyard of a property in the existing residential area to north of the Tallawarra site.

2.4. Results of noise monitoring

During the preconstruction monitoring period there was no influence from noise sources within the Tallawarra Lands. The measured noise levels were therefore representative of the ambient noise sources in the area. The monitoring was completed in two parts using unattended noise loggers and attended monitoring where noise sources were measured and their individual influences on the environment were noted.

2.4.1. Attended noise monitoring

Attended monitoring was undertaken during a day and a night time period at three locations around the Tallawarra site. These locations were at or near the locations where unattended noise monitors were positioned. The monitoring locations within the Tallawarra Lands site did not have attended monitoring undertaken due to access restrictions during the night time. At the southern Tallawarra monitoring site, however, attended monitoring was undertaken at the boundary of the Tallawarra site and Hayward's Bay residential development, which is considered to be representative of noise levels at the T1 location.

Attended monitoring was undertaken over 15-minute intervals using a Bruel & Kjaer 2260 Type 1 Sound Level Meter. The calibration of the meter was checked before and after the monitoring period and difference in calibration levels did not vary. Weather conditions during the attended measurements would be described as calm to light winds with clear skies and moderate temperatures. Results of attended monitoring and a description of the audible noise sources at the time of the survey are presented in **Table 2-2**.

Table 2-2 Attended monitoring results

Location	Time (24hr)	Sound pressure levels (dB(A))					Comments
		L_{Aeq}	L_{A10}	L_{A90}	L_{Amax}	L_{Amin}	
Wyndarra Way (A3)	23:15	42	43	40	63	37	The night time noise levels in this area are generally dominated by the steady background level from BHP. Other influences include road traffic noise and animals such as dogs and birds.
Carlyle Street (A2)	23:50	43	44	40	60	35	Road traffic noise was variable at this location, depending on the direction of the wind. Traffic noise was dominant during some of the monitoring period. Port Kembla (BHP) was possibly audible but not dominant. Wildlife (e.g. crickets) was a noted contribution to noise level.
Hayward's Bay (A1)	00:18	51	54	40	66	36	Road traffic noise was the dominant noise source. Wildlife in the wetland area was also a major contributor to the measured noise levels. A freight train movement provided significant transient noise source at this location. BHP was not clearly audible, even during quiet periods.
Wyndarra Way (A3)	09:00	48	50	39	66	36	Local wildlife birds and dogs were audible. Other noise sources include traffic noise, planes, and the BHP site. General noise sources also included children playing and some construction (distant) activity on the nearby hillside to the south.
Carlyle Street (A2)	09:30	48	50	46	57	42	Road traffic was the dominant noise source. Some animal noise (birds, dogs) was also audible. During this measurement, winds were gusty and moderate from the north east.
Hayward's Bay (A1)	10:05	56	58	51	72	48	Some earth moving equipment was active on the eastern part of the development. The dominant noise source was traffic on the Southern Freeway/Princes Highway and the occasional light plane. Winds were gusty from the NNE during the measurement.

During the night time measurements, the background (L_{A90}) and minimum (L_{Amin}) noise levels were consistent between locations. The L_{Aeq} levels were also closely matched at Wyndarra Way and Carlyle Street, with both having similar noise environments during the survey period. At the Hayward's Bay location, while the background and minimum noise levels were comparable, the L_{Aeq} noise level was affected by road traffic noise and loud events such as the movement of freight trains.

The Carlyle Street location may also be affected by train noise, however, no train movements were observed during the monitoring at this location.

At both the Carlyle Street and Hayward's Bay locations, the background noise levels demonstrate a significant increase compared to the other sites due to road traffic noise from the Southern Freeway and the Princes Highway. At Wyndarra Way, the minor variation between the day time and night time background noise levels indicates that the noise levels are not greatly affected by traffic noise and other influences during the day time.

2.4.2. Unattended monitoring

Unattended noise monitoring was undertaken at locations identified in **Table 2-1** and **Figure 2-2** for a nominal period of 14 days between 2 March and 15 March 2007. The unattended monitoring was undertaken with automatic noise loggers that measure environmental noise and store the results in memory. The loggers used were ARL type 316, 215 and 015 and had been NATA tested by the supplier within the last 12 months. The loggers were set to record a range of noise indices at 15 minute intervals. This data was used to determine the median values for the L_{Aeq}, L_{A90}, L_{A10} and L_{A1} descriptors for the day, evening and night time periods. The calibration of the noise loggers was checked before and after the monitoring period and the drift was noted to be less than 0.5 dB(A).

The Rating Background Level (RBL) is the overall, single-figure, background level representing each of the day, evening or night assessment periods over the whole monitoring period. This is the level used for assessment purposes. It is defined as the median value of all the day, evening or night assessment background levels over the monitoring period. A summary of the noise data is shown in **Table 2-3** and the daily graphs are provided in **Appendix A.**

- **Table 2-3 Results of Unattended Noise Monitoring**

Location	Monitoring Dates	Rating Background Level (RBL)			L_{Aeq} over the assessment period		
		Day	Evening	Night	Day	Evening	Night
T1	2/03/07 - 15/03/07	36 dB(A)	36 dB(A)	39 dB(A)	49 dB(A)	48 dB(A)	47 dB(A)
T2	2/03/07 - 15/03/07	41 dB(A)	43 dB(A)	38 dB(A)	45 dB(A)	48 dB(A)	44 dB(A)
T3	2/03/07 - 15/03/07	34 dB(A)	33 dB(A)	31 dB(A)	46 dB(A)	40 dB(A)	37 dB(A)
T4	2/03/07 - 15/03/07	34 dB(A)	36 dB(A)	33 dB(A)	49 dB(A)	47 dB(A)	38 dB(A)

Monitoring locations T1 and T2 are exposed to road and rail traffic and therefore have a greater noise influence from these sources than the monitoring locations at T3 and T4. This is evidenced in

the higher overall background noise levels and the minor variation in the L_{Aeq} noise levels. Location T3 on the Tallawarra Lands site provides a good measure of general noise in the area and is less affected by temporal variations in the noise environment, such as increased local traffic movements and other activity during the evening period.

The noise data in **Table 2-3** are to be used are for the setting of criteria at existing receiver locations at T2 and T4. Locations T1 and T3 are greenfield sites within the Tallawarra Lands Boundary. These sites will be assessed in a separate development application after the land use plans for the Tallawarra site have received further consideration by TRUenergy.

3. Assessment guidelines

3.1. Overview

In January 2000, DECC[2] released the NSW *Industrial Noise Policy* (INP). This document provides the framework and process for deriving project specific noise limits for impact assessments and limits for licences that will enable the authority to regulate noise emissions from premises that are scheduled under the *Protection of the Environment and Operations Act, 1997*.

The INP is designed to determine an acceptable level of impact expected at a community level, and has been used as a guideline for the noise impact assessment for the proposed Tallawarra Stage B power station. Where the INP criteria are met, no adverse noise impacts would be reasonably expected at the closest receivers. The specific noise objectives that are presented in this report were derived in accordance with the INP.

The INP requires that the noise from a development under assessment comply with the lower of the amenity or intrusive noise criteria. The intrusive criterion is determined by the difference between the industrial noise under assessment being no more than 5 dB(A) above the Rating Background Level (RBL). The RBL is the tenth percentile of the background noise environment evaluated in the absence of industrial noise from the development in question. This is usually assessed prior to the commencement of operations and in the absence of any industrial noise sources.

The amenity criterion is based on the zoning of the residences likely to be affected by noise, the general land use near the receiver location and the extent of the existing industrial noise in the area. In general, the amenity levels are more suited to planning of noise levels rather than the assessment of project specific impacts. However, where there is an existing influence of industrial noise, the INP implements modifying factors to the criteria to account for cumulative noise impacts in order to minimise background creep and control the long term noise environment. The intrusive noise criteria are designed to account for shorter duration noise impacts and are often the most appropriate tool for assessing the effects of noise at a residential location.

3.2. Intrusive noise criteria

A noise source is considered to be non-intrusive if:

- the $L_{Aeq,\ 15\ minute}$ level does not exceed the RBL by more than 5 dB(A) for each of the day, evening and night-time periods,

[2] Formerly NSW Environmental Protection Authority (EPA)

- the subject noise does not contain tonal, impulsive, or other modifying factors as detailed in Chapter 4 of the INP.

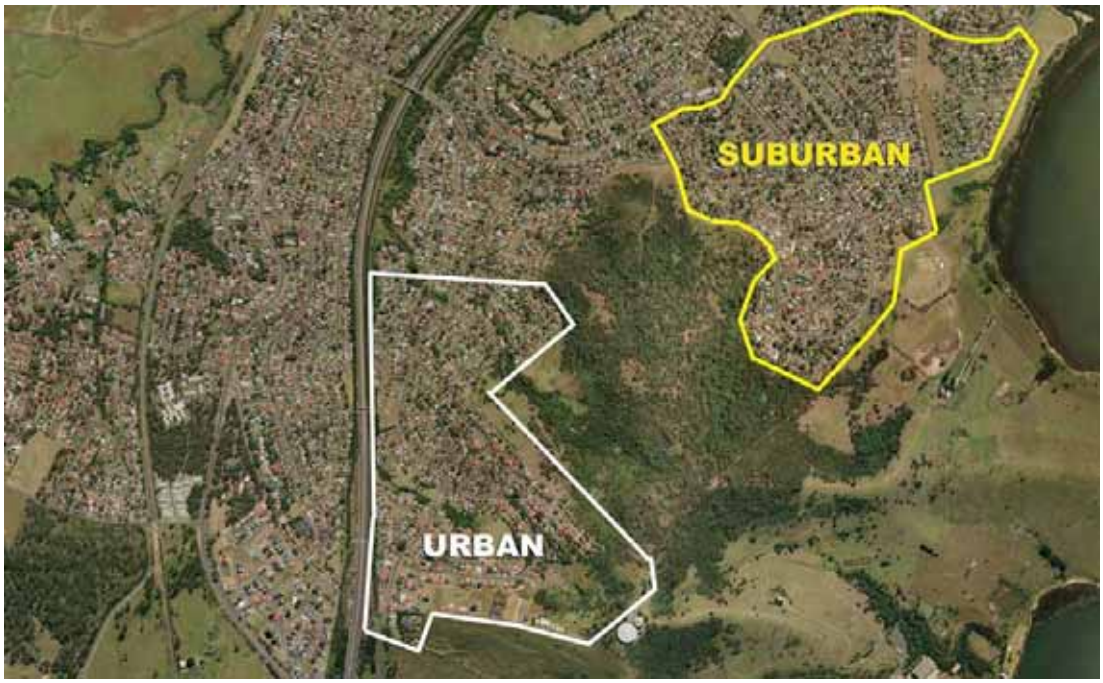
From **Table 2-3,** the lowest RBL noise levels for day, evening and night have been applied to the monitoring locations as the assessment criteria. The corresponding intrusive noise criteria for the day, evening and night time periods are presented in **Table 3-1**.

3.3. Amenity noise criterion

The amenity criteria apply to the L_{Aeq} level determined for the period of assessment of day, evening or night. The definition of the noise amenity classification for the area surrounding the Tallawarra site is "urban" and "suburban", depending on the proximity to the road and rail network. Urban regions are generally defined as having characteristically heavy and continuous traffic flows during peak periods, and are near commercial or industrial districts. Suburban areas are typically those with local traffic flows with decreasing noise levels during the evening period and limited commerce or industry.

Figure 3-1 presents a graphical representation of the urban and suburban areas defined for the Proposal. The vegetated area in the middle of the two amenity zones follows a natural ridgeline, which shields residences from industry noise and the traffic from the Southern Freeway to the west.

- **Figure 3-1 Definition of amenity criteria adjacent to Tallawarra lands**



The INP recommends that for residences located in an urban area, an acceptable amenity criteria would be an $L_{Aeq\ (Period)}$ of 60, 50 and 45 dB(A) and $L_{Aeq\ (Period)}$ of 55, 45 and 40 dB(A) for a suburban area for the day, evening and night periods respectively.

3.4. Project specific noise criteria

The INP aims to control cumulative noise impacts from the combined effects of a proposed project and existing industrial noise sources by modifying the amenity criteria according to the level of an existing industrial noise impact. Where there is an existing industrial noise influence, the amenity criteria are decreased in accordance with Table 2.2 of the INP.

Based on site observations and the result of noise measurements, there is no existing industrial noise sources at the Carlyle Street location. At Wyndarra Way, the night time noise levels do reflect an influence from industrial noise in the direction of Port Kembla.

The amenity criteria used for the Wyndarra Way area would be for a suburban area, having a night time criterion of 40 dB(A). This criterion is then modified to account for the influence from existing industrial noise sources, estimated at approximately L_{Aeq} 38 dB(A). From Table 2.2 of the INP, a penalty of -4dB(A) is applied to the acceptable amenity criteria, making the project specific noise criterion at Wyndarra Way 36dB(A) during the night time period. The amenity criterion for the area around Carlyle Street remains unmodified due to the absence of any identifiable industrial noise influences. The amenity noise criteria for each residential receiver are presented with the other criteria in **Table 3-1**. Location T4 is shown bold to indicate the modified night time criteria. The lower of the Amenity or Intrusive criterion has been selected as the project specific level for each location.

Table 3-1 Derivation of Project Specific Noise Criterion

Criteria Description	Day	Evening	Night-time
Intrusiveness Criteria	$L_{Aeq15\ min}$	$L_{Aeq15\ min}$	$L_{Aeq15\ min}$
Project Intrusiveness Criteria	RBL + 5 dB(A)	RBL + 5 dB(A)	RBL + 5 dB(A)
Project Specific RBL levels			
Location T2	41 + 5 dB(A)	43 + 5 dB(A)	38 + 5 dB(A)
Location T4	34 + 5 dB(A)	36 + 5 dB(A)	33 + 5 dB(A)
Amenity Criteria	$L_{Aeq\ 12hr}$	$L_{Aeq\ 4hr}$	$L_{Aeq\ 8hr}$
Acceptable Amenity Criteria			
Location T2	60 dB(A)	50 dB(A)	45 dB(A)
Location T4	55 dB(A)	45 dB(A)	40 dB(A)
Project Noise Criteria	$L_{Aeq15\ min}$	$L_{Aeq15\ min}$	$L_{Aeq15\ min}$
Location T2	46 dB(A)	48 dB(A)	43 dB(A)
Location T4	39 dB(A)	41 dB(A)	**36 dB(A)***

* Amended Amenity criteria see Section 3.4.

The amenity criteria for the night time are the most stringent of the noise goals, and these will be used to assess the potential for noise impacts for the proposed Stage B power station. The day, evening and night time limits at the various locations would apply to noise generated by the power station operations at any residential dwelling or noise sensitive receiver. The noise criteria for other sites assessed as part of the previous EIS for Tallawarra Stage A have been updated to meet INP assessment methodology and included in the assessment of noise impacts at these locations.

4. Assessment details

4.1. Tallawarra Stage A CCGT noise assessment

Previous noise predictions for the recently commissioned Stage A CCGT plant now in commercial operation were undertaken by Pacific Power for the EIS. The predicted noise level at the most affected receivers at this time was estimated to be less than 30 dB(A). The EIS noise assessment was undertaken against the now superseded Environmental Noise Control Manual (ENCM). The EIS found that noise criteria would be able to be achieved, however, an assessment of tonality or low frequency noise was not included in the final results. Since the submission of the EIS, the construction of the Tallawarra A CCGT has been completed allowing measurement of the actual noise emissions from at locations in and around the Tallawarra Lands site.

The previous EIS identified 10 locations around the Tallawarra site that were expected to be representative of noise sensitive receivers. These locations were later revised in the supplementary noise report produced by Pacific Power in 1999, with one site being deleted and a new site being added. The supplementary report also corrected errors made in the assessment of background noise levels calculated in the EIS.

Prior to the operation of the Stage A CCGT, further background noise monitoring for these locations was undertaken in survey by SKM in March and April 2008. A summary of the measured noise levels from this survey is presented in **Table 4-1**.

Table 4-1 EIS Receiver Location Background Noise Monitoring

Location	Rating Background Level (RBL)			L_{Aeq} over the assessment period		
	Day	Evening	Night	Day	Evening	Night
2	39	37	32	48	45	45
7	47	44	36	55	53	49
9	39	39	33	52	51	40
10	38	36	32	63	61	56
11	39	44	39	52	49	47

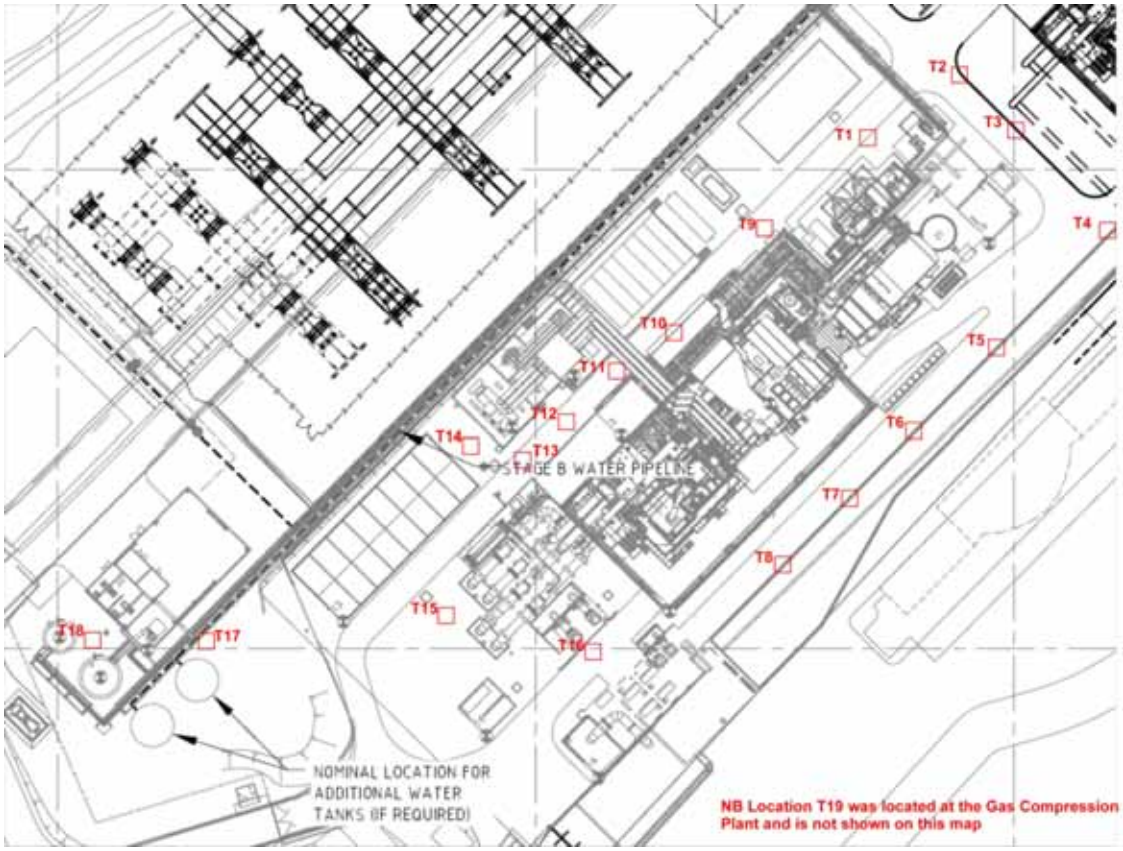
These measured levels have been used in addition to the monitoring undertaken in **Section 2.3** to determine noise criteria for the operation of the Stage B gas turbine proposal. **Figure 4-1** shows the position of five locations from the previous assessment that is relevant to the current noise impact assessment.

- **Figure 4-1 Tallawarra EIS Receiver Locations**

In February 2009 following the commissioning of the Stage A Project, additional attended monitoring was carried out at 19 locations in the area directly surrounding the Tallawarra CCGT plant as well as locations within the Tallawarra Lands. **Figure 4-2** shows the locations around the power station used to verify noise emissions from the site. Noise monitoring locations to the north of the Power Station were also assessed for both the day and night time periods to determine the influence of the operations on the Tallawarra Lands. It is important to note that the measurements of

operations of the plant were undertaken during a limited period of the early operational phase of the power station and therefore may vary as a result of further work at the site.

- **Figure 4-2 On Site Noise Measurement Locations**



The key results of the noise monitoring undertaken for the Stage A works are as follows:

- Tallawarra A plant noise is audible beyond the power station site boundary and within the Tallawarra lands, out to an approximate 800 m radius from power station stack; and
- At further distances the power station audibility is variable and dependent on a number of factors, in particular background noise sources, meteorological conditions and topography.

Based on the measurements undertaken the estimated noise contribution from the power station at 800 m from the stack are of the order of:

- L_{Aeq} = 36 – 38 dB(A) to the north of the plant; and
- L_{Aeq} = 38 – 40 dB(A) to the west of the plant.

The measured data was used to refine the noise model for the assessment of Tallawarra A and B noise impacts in the sections to follow.

4.2. Overview of noise emissions from gas turbines

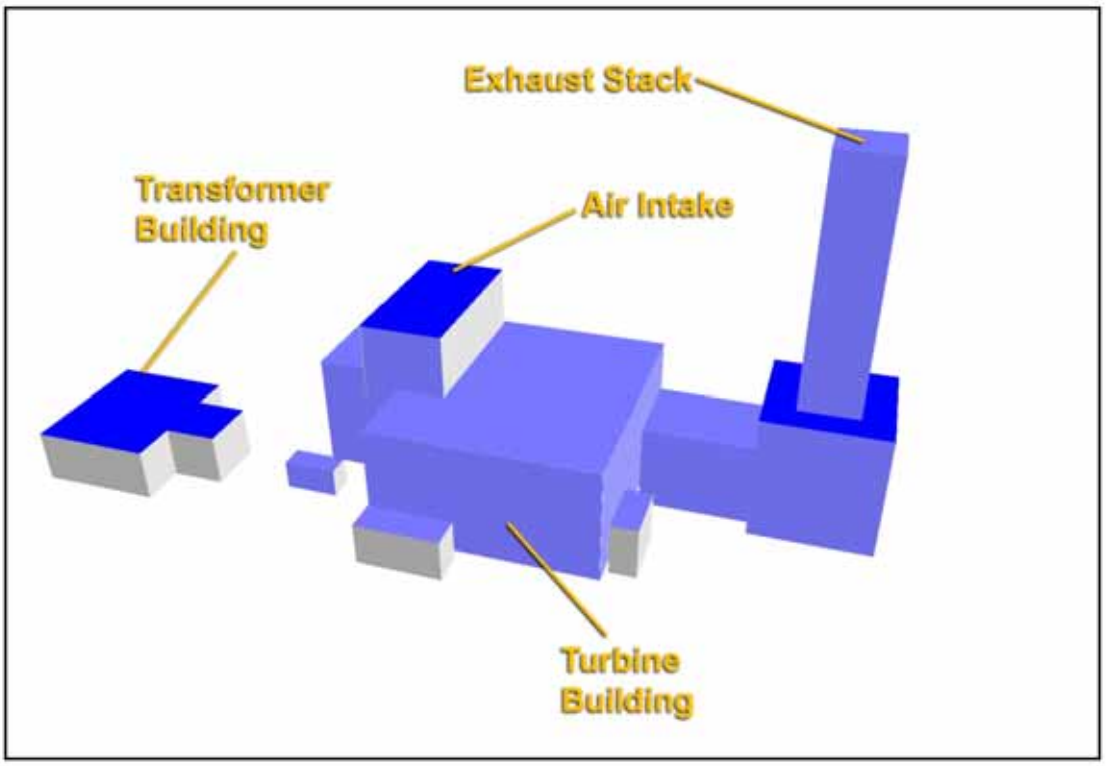
4.2.1. CCGT and OCGT plant noise emissions

Gas turbines can be a significant source of noise if appropriate attenuation is not included in the design. The major sources of noise from a CCGT or OCGT include the exhaust stack, the air intake, the turbine building and the transformer building. The Stage B CCGT also employs wet cooling towers as the heat exchange mechanism for the process water. The cooling towers alone can be a significant source of noise and must be carefully designed to provide adequate attenuation of noise emissions.

All of the above mentioned components tend to exhibit noise spectra that have a significant low frequency content, which attenuates at a slower rate than the higher frequencies and can persist over long distances. These low frequencies also tend to respond less to attenuation measures applied at the source of the emissions.

Figure 4-3 shows a block diagram of a typical OCGT plant with the main noise sources identified. The diagram assumes that other noise sources are contained within the building envelope.

- **Figure 4-3 Open Cycle Gas Turbine Noise Sources**



4.3. Assessment methodology

The assessment of noise impacts is concerned with noise emissions from the combined operations of the Stage A and Stage B plants, and the impact that this would have on nearby sensitive receivers. To determine the potential for noise emissions to cause an unacceptable impact, operations of the individual and combined units have been modelled using SoundPLAN noise modelling software.

The results of predictions from the modelling exercise are compared to the DECC intrusiveness and amenity criteria presented in **Section 3**.

Figure 4-4 presents a screen shot from the noise model showing both the Stage A and the proposed Stage B CCGT plants with respect to the surrounding local topography, which is incorporated into the assessment.

- **Figure 4-4 Modelling screen shot of proposed Stage A and Stage B CCGT plants - view of the site from the east**

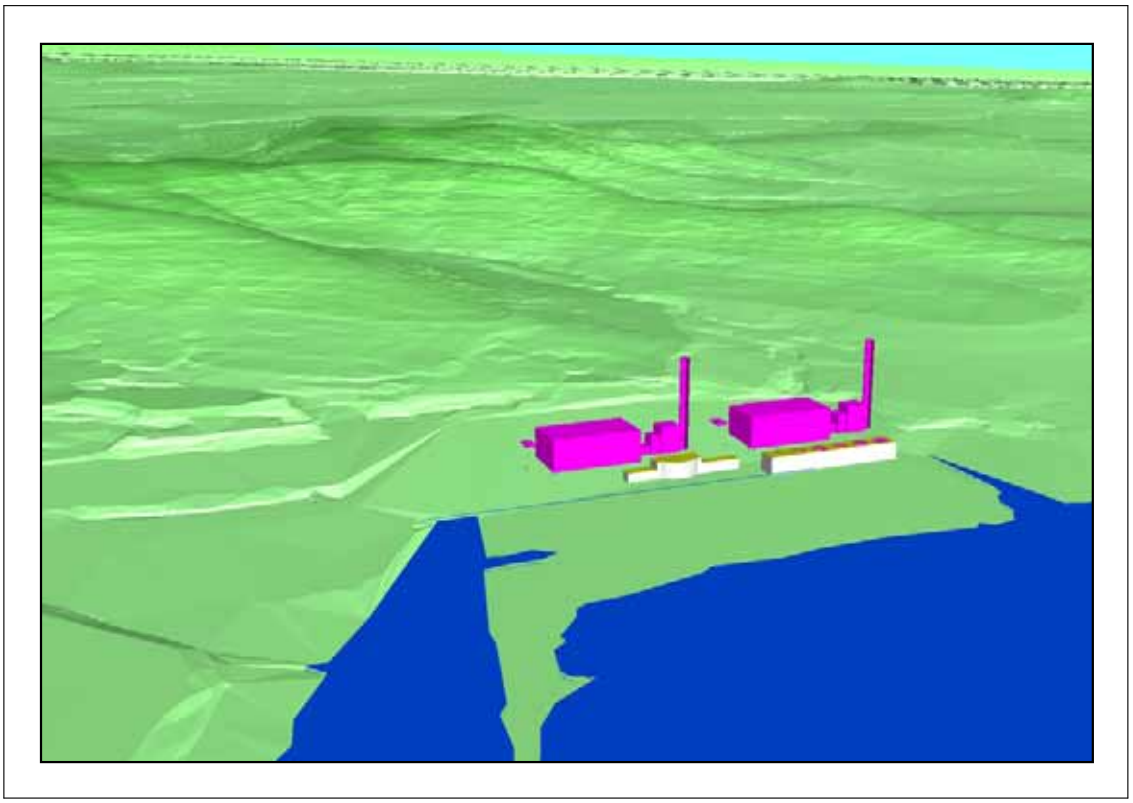
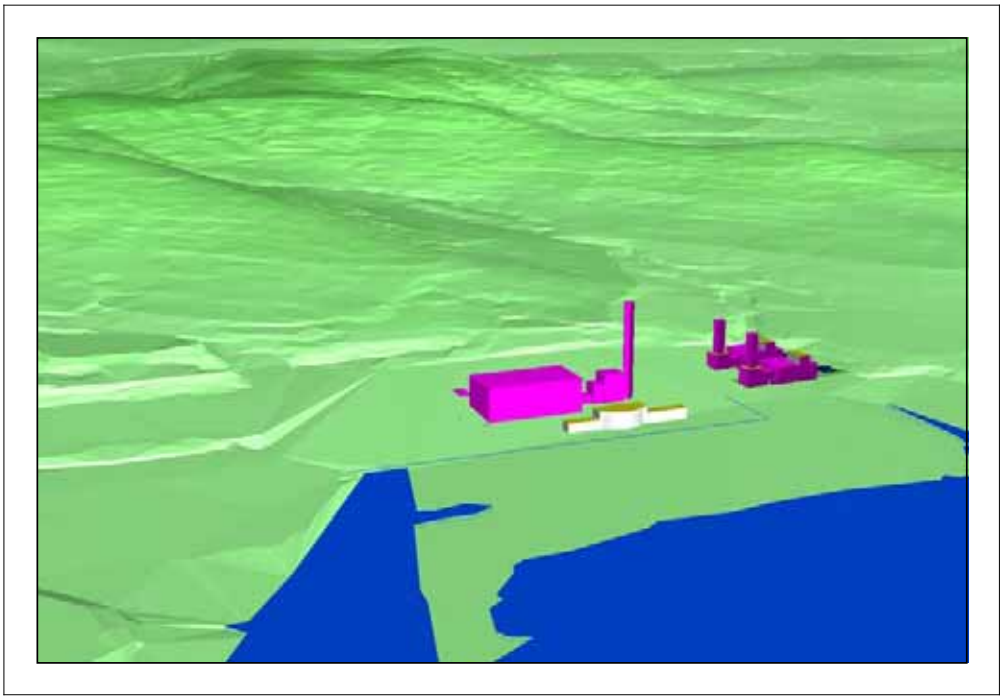


Figure 4-5 presents a screen shot from the noise model showing both the Stage A CCGT plant and the proposed Stage B OCGT.

- **Figure 4-5 Modelling screen shot of proposed Stage A CCGT plant and Stage B OCGT plants - view of the site from the east**



4.4. Consideration of meteorological conditions

Noise levels at a sensitive receiver can become louder or quieter under certain meteorological conditions. In particular, the weather conditions that cause noise to be reinforced are wind direction or atmospheric stability, known as temperature inversions. Light winds in the direction of the receiver will cause an increase in noise levels from a source by focusing propagation in that direction. Similarly, stable conditions with very light winds during the night time can cause a temperature inversion, which reflects noise back towards the ground from the upper atmosphere. Inversions are a phenomenon that can only occur during the night time and even then only under very specific atmospheric conditions. As part of the INP noise assessment procedure, the DECC recommends including an assessment of adverse meteorological conditions when:

- An occurrence of winds greater than 3 m/s for 30 percent of the time for any season during each of the assessment periods of day, evening and night occurs over each season; and
- Temperature inversions affecting the propagation of noise emission from an industrial site must be considered where the occurrence of "F" stability class (characteristic of temperature inversion conditions) is 30 percent or more during the night time winter months. In accordance with the INP, night time is considered to be between 6pm and 7am, i.e. generally 1 hour before sun down and one hour after sun up.

Meteorological information for the project was assessed using data obtained from the DECC from the Warrawong Automatic Weather Station and has been used in the assessing the likelihood of adverse winds in the area. A table for the assessment of temperature inversions by stability class for the winter months and wind roses for the day, evening and night time periods are presented in **Appendix B**.

The wind roses indicate that on an annual basis the predominant wind direction is from a westerly direction. They also show that evening and night time drainage flows are from a westerly direction during the autumn, winter and spring seasons. In summer, night time winds tend to be from the north. Based on these observations, it is expected that during the evening and night time hours, winds would tend to direct noise emissions offshore and away from the residential areas to the north and east of the site where residential areas may be located within the Tallawarra Lands boundary.

The analysis of meteorological data has shown that there is a significant occurrence of winds from the west in winter, and a high percentage of conditions likely to cause a temperature inversion during the winter months. These data have indicated that during temperature inversion conditions, winds tend to follow drainage flow patterns from the east across Lake Illawarra to the west, having an average wind speed of 1.6 m/s. These parameters were input into the CONCAWE algorithm for the assessment of adverse meteorological conditions during the night time.

4.5. Assessment scenarios

The assessment of noise impacts for the Stage A and Stage B CCGT plants has considered the requirements of the Director-General. The key issues for noise impacts to be assessed have been reproduced below.

- The Environmental Assessment must include a noise impact assessment for the project, conducted in accordance with NSW Industrial Noise Policy (INP) (EPA, 2000);
- The assessment must include consideration of the noise impacts of the project and the adjacent Stage A plant, both cumulatively and individually;
- A particular focus on scenarios under which meteorological conditions characteristic of the locality may exacerbate impacts at sensitive receivers is required. The probability of these occurrences must be quantified;
- The assessment must evaluate impacts on the Tallawarra Lands proposal;
- The Environmental Assessment must also include an assessment of the construction noise impacts of the project, against the criteria provided in Chapter 171 of the Environmental Noise Control Manual (EPA, 2004); and
- The Environmental Assessment must clearly outline the noise mitigation, monitoring and management measures the Proponent intends to apply to the project. This must include an

assessment of the feasibility, effectiveness and reliability of proposed measures and any residual impacts after these measures have been implemented.

Two possible operational regimes exist for the proposed Stage B plant:

- normal operations where the Stage A plant is in use; and
- other times when the Stage A and Stage B plants are both in use.

The assessment of noise impacts for the Stage A CCGT plant and the Stage B OCGT plant has also considered the requirements of the Director-General and has similar operational regimes to the 2 x CCGT option.

The Stage A CCGT plant has already received approval and therefore is not the subject of assessment for this project. In addition, the Stage B plant, when operational would function as a base load plant and would most likely be online when the Stage A plant is also operational. This scenario is reflected in the cumulative noise impact assessment, making the requirement for individual assessment of the Stage B plant redundant.

Both Tallawarra Stage A and Stage B CCGT plants may be required to be in operation at anytime of the day or night, therefore a 24 hour operational scenario for both the plants has been assessed using the CONCAWE standard algorithms in SoundPLAN, which has incorporated adverse meteorological conditions into the prediction of noise levels.

4.6. Modelling results

4.6.1. Modelling results for the proposed Stage B CCGT plant

Section 4 of the INP lists modifying factor adjustments to account for certain annoying characteristics of noise emissions from industrial premises. The low frequency adjustment requires that the difference between the predicted C weighted and A weighted levels is no more than 14 dB(A), without penalty. The average difference between the C weighted and the A weighted levels calculated for the Tallawarra Stage B project is in the order of 20-24 dB when calculated at a receiver location and therefore the current assessment includes a penalty for low frequency noise. In accordance with Table 4.1 of the INP, a 5dB(A) penalty has been added to the predicted noise levels. The modelling of noise result for the CCGT has been based on a design that incorporates attenuation in the turbine building such as equipment enclosures and insulation in the walls and roof. Other external noise sources such as air intake and stack opening also include noise attenuation. Major noise sources included in the model are shown in **Table 4-2**.

- **Table 4-2 Modelled noise levels CCGT**

CCGT Plant Item	Sound Power Level dB(A)	Emission Height Range (m)
Cooling Tower	105	12
Air intake	101	14-25
Main Transformer	97	0-3
Stack Mouth	94	60
Lube Oil Cooler	94	2-4
Diffuser	93	0-7
HVAC System	93	0-3
Feed Water Pump	90	0-3
Turbine building	90	0-23

The assessment scenarios are as follows:

- Scenario 1 – Stage A and B CCGT plants showing the results for neutral weather conditions plus a 5 dB(A) low frequency noise penalty; and
- Scenario 2 - Stage A and B CCGT plants showing the results for noise enhancing weather conditions plus a 5 dB(A) low frequency noise penalty.

The results of noise modelling for each scenario are presented as noise contour calculations on aerial photography. **Figure 4-6** and **Figure 4-7** present the predicted noise levels for the combined operation of the Stage A and Stage B CCGT plants for Scenario 1 and Scenario 2, respectively. **Table 4-3** presents the point calculations of the cumulative noise impact assessment for the combined Stage A and Stage B CCGT operations, which includes the 5dB(A) penalty. The receiver locations have been assessed from both the previous and the current noise measurement locations in **Section 4.1** and **Section 2.3** respectively.

- **Table 4-3 Predicted Noise Levels Stage A and Stage B CCGT Plants**

Location ID	Description	Predicted Noise Level Neutral Conditions	Predicted Noise Level Adverse Conditions	Noise Goal dB(A)
T2	Carlyle Street, Koonawarra	28 dB(A)	30 dB(A)	43 dB(A)
T4	Wyndarra Way, Koonawarra	29 dB(A)	31 dB(A)	36 dB(A)
ML# 9	Central Park, Mongurah Pt	31 dB(A)	35 dB(A)	38 dB(A)
ML# 10	Boonarah Pt	32 dB(A)	35 dB(A)	37 dB(A)
ML# 11	Haywards Bay Estate, Yallah	26 dB(A)	31 dB(A)	44 dB(A)

Legend

- Site boundary
- Large Lot Residential
- Low Density Residential

Noise Levels

- 35dB(A)
- 40dB(A)
- 45dB(A)
- 50dB(A)
- 55dB(A)
- 60dB(A)
- 65dB(A)

0 650 1,300

Metres

1:40,000 At A4

Figure 4-6: Noise Contours - Stage A and B CCGT

Scenario 1 - Neutral Meteorological Conditions

Source: Topographic data by Streetworks.
Site Aerial - TRU Energy, Jan 2009

April 9, 2009
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Figure 4-7: Noise Contours - Stage A and B CCGT

Scenario 2 - Adverse Meteorological Conditions

Source: Topographic data by Streetworks.
Site Aerial - TRU Energy, Jan 2009

April 9, 2009
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4.6.2. Modelling results for the proposed Stage B OCGT plant

The modelling of noise results for the OCGT has been based on a design that incorporates attenuation in the turbine building such as equipment enclosures and insulation in the walls and roof. Other external noise sources such as air intake and stack opening also include noise attenuation measures. Major noise sources included in the model are shown in **Table 4-5.**

- **Table 4-4 Modelled Noise Levels OCGT**

Plant Item	Sound Power Level dB(A)	Emission Height Range (m)
Diffuser Housing	102	0-8
Stack Mouth	100	40
Stack Casing	100	0-40
Main Transformer	100	0-3
Turbine building	99	0-11
HVAC System	95	0-3
Lube Oil Cooler	94	0-4
Air intake	90	15-22

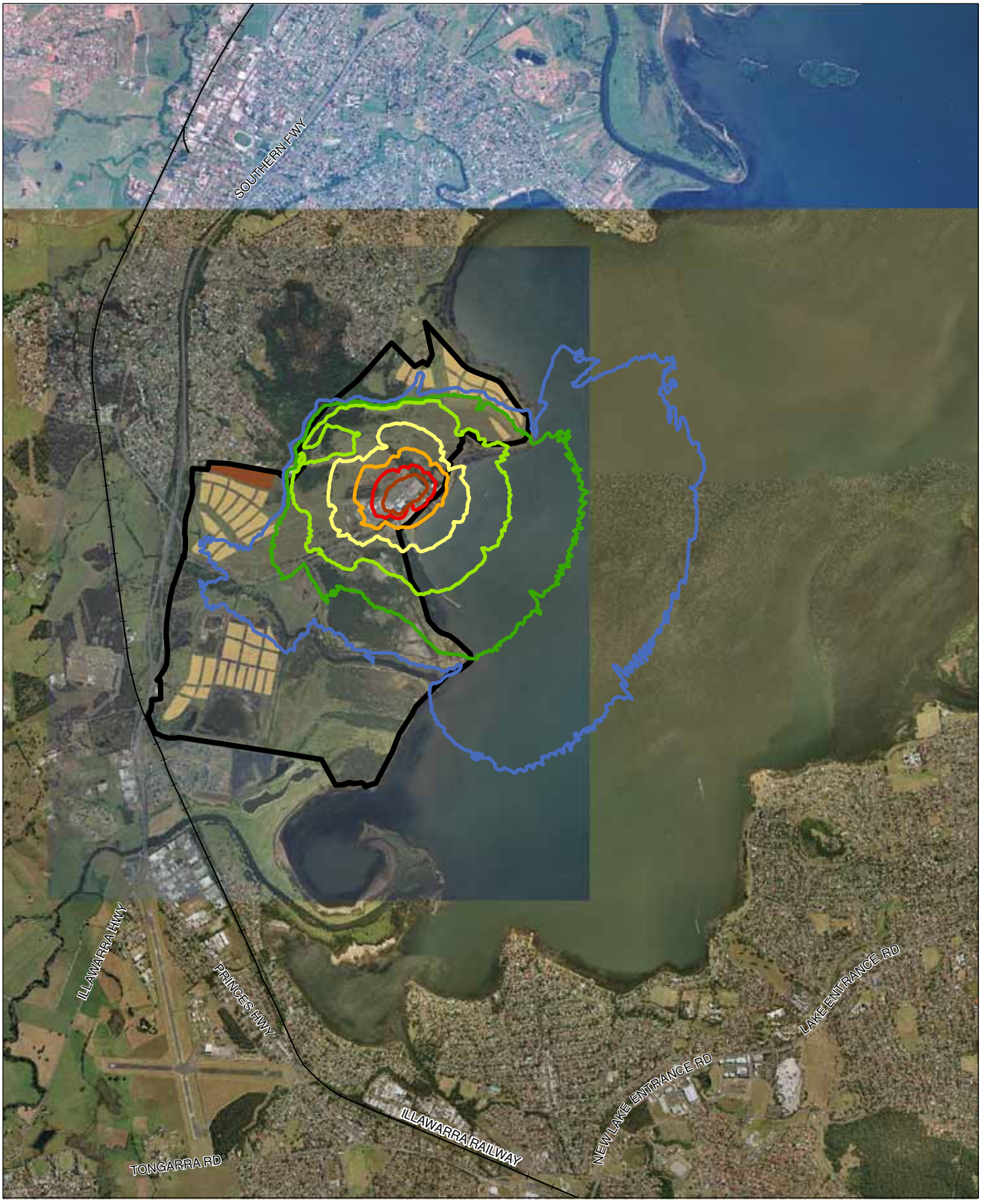
The assessment scenarios are as follows:

- Scenario 1 – Stage A CCGT and Stage B OCGT plants showing the results for neutral weather conditions plus a 5 dB(A) low frequency noise penalty; and
- Scenario 2 – Stage A CCGT and Stage B OCGT plants showing the results for noise enhancing weather conditions plus a 5 dB(A) low frequency noise penalty.

The results of the noise modelling for each scenario for the OCGT are presented as noise contours on aerial photography. **Figure 4-8** and **Figure 4-9** present the predicted noise levels for the combined operation of the Stage A CCGT plant and the Stage B OCGT plant for Scenario 1 and Scenario 2 respectively. **Table 4-5** presents the point calculations of the cumulative noise impact assessment for the Stage A CCGT and Stage B OCGT combined operations, which includes the 5dB(A) penalty and adverse meteorological assessment.

- **Table 4-5 Predicted Noise Levels for Stage A CCGT plant and Stage B OCGT plant**

Location ID	Description	Predicted Noise Level Neutral Conditions	Predicted Noise Level Adverse Conditions	Noise Goal dB(A)
T2	Carlyle Street, Koonawarra	27 dB(A)	28 dB(A)	43 dB(A)
T4	Wyndarra Way, Koonawarra	26 dB(A)	27 dB(A)	36 dB(A)
ML# 9	Central Park, Mongurah Pt	30 dB(A)	33 dB(A)	38 dB(A)
ML# 10	Boonarah Pt	30 dB(A)	33 dB(A)	37 dB(A)
ML# 11	Haywards Bay Estate, Yallah	25 dB(A)	28 dB(A)	44 dB(A)



Legend

- Site boundary
- Large Lot Residential
- Low Density Residential

Noise Levels

- 35dB(A)
- 40dB(A)
- 45dB(A)
- 50dB(A)
- 55dB(A)
- 60dB(A)
- 65dB(A)

0 650 1,300

Metres

1:40,000 At A4

Figure 4-8: Noise Contours – Stage A CCGT and Stage B OCGT

Scenario 1 - Neutral Meteorological Conditions

Source: Topographic data by Streetworks.
Site Aerial - TRU Energy, Jan 2009

April 9, 2009
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Figure 4-9: Noise Contours - Stage A CCGT and Stage B OCGT

Scenario 2 - Adverse Meteorological Conditions

Source: Topographic data by Streetworks.
Site Aerial - TRU Energy, Jan 2009

April 7, 2009
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4.7. Discussion of air-borne noise predictions

The modelling for both the Stage B CCGT and OCGT plants indicates that under neutral conditions, noise levels are predicted to be lower than the identified noise criteria at all receiver locations external to the Tallawarra Lands boundary.

When a 5 dB(A) low frequency noise penalty is added to the predicted results, noise levels at these locations would still remain lower than the project specific noise criteria in **Table 3-1**. The noise level assumed for this operation is based on limited data for this type of equipment and therefore has the potential to be reduced during the equipment tendering process.

The locations to the west and north of the site will benefit from a significant amount of topographic shielding as well as a large distance separation between the power station and the residential areas. This influence is highlighted by the noise contours showing an exaggerated effect in a south easterly direction across Lake Illawarra.

North of the Tallawarra Lands boundary, noise from the Power Station may extend into suburban areas of Koonawarra/Kanahooka adjacent to the lake. The potential for these impacts to occur would however only be under the worst case adverse meteorological conditions and are likely to be only marginally above background noise levels. Under adverse weather conditions, noise from the Southern Freeway would also be audible in this location and would potentially mask any impacts from the Power Station. This location should therefore be included in any future noise monitoring programs to ensure that background noise levels are accurately identified.

Within the Tallawarra Lands the predicted noise levels would vary between 15 dB(A) up to 50 dB(A) in the areas immediately to the west and to the north of the power station. This impact extends further to the north and south of the power station when the 5 dB(A) penalty is added to the predicted levels. Further discussion of impacts within the Tallawarra Lands is provided in Section 4.8 to follow.

4.8. Tallawarra Lands Noise Assessment

The Director-General's Requirements for the Tallawarra B project require an assessment of noise impacts on the proposed Tallawarra Lands development area. TRUenergy gained approval for its pre-rezoning submission from Wollongong City Council in September 2005 when council resolved to prepare a draft Local Environmental Study (LES) for the site. A LES has since been prepared and was adopted by Wollongong City Council in April 2007. The LES identified a range of preferred categories for development including industrial, commercial, residential and conservation areas.

In addition to the assessment of noise impacts for sensitive receivers external to the Tallawarra site, the DECC has requested that Project Specific Noise Levels (PSNL) be developed in accordance with

the INP for the Tallawarra Lands area. The predicted noise levels from Tallawarra A and Tallawarra B (both as a CCGT and OCGT plant) are shown in **Figure 4-10** and **Figure 4-11** respectively.

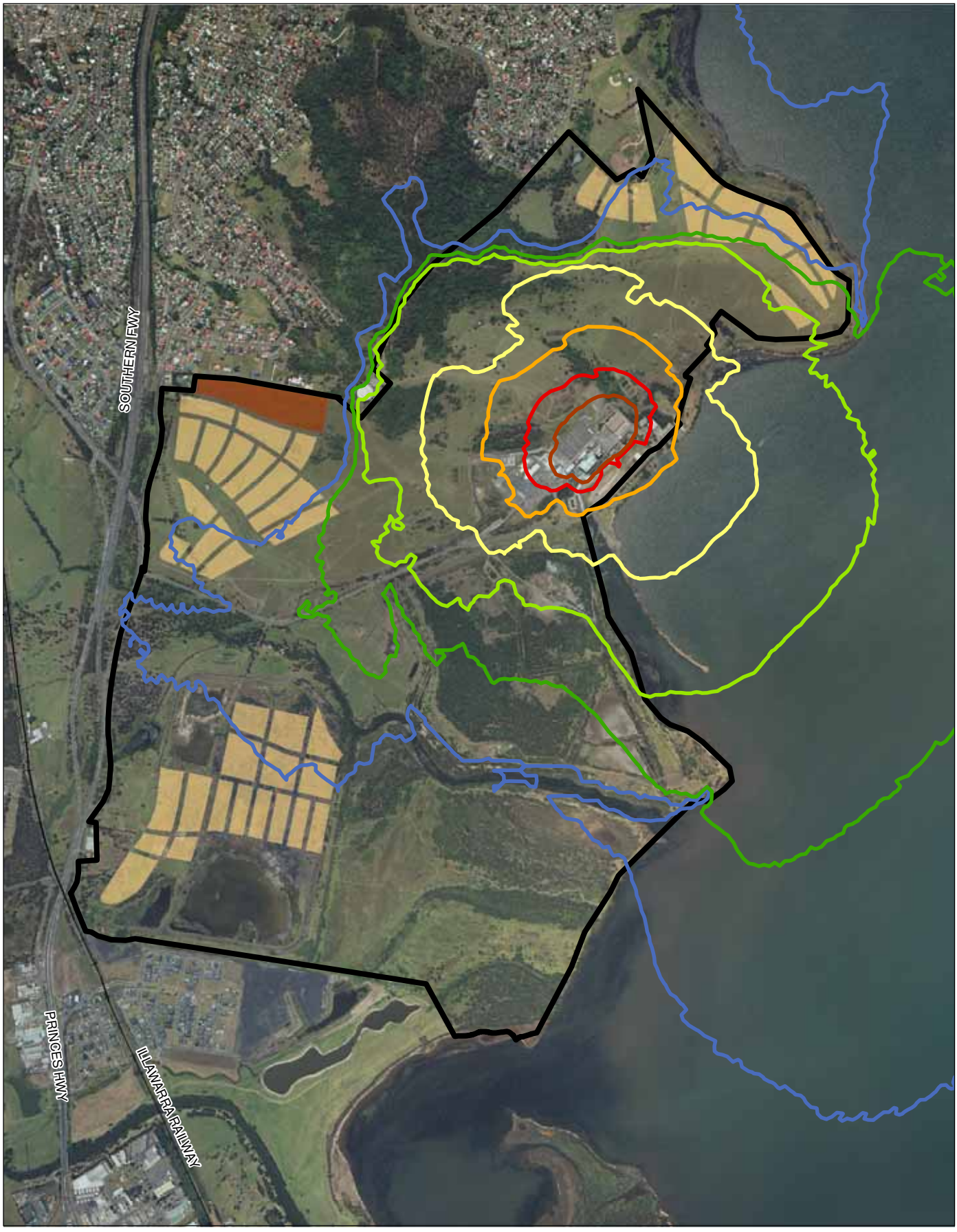
Setting PSNL for the Tallawarra Lands is considered premature at this stage of the project as this development will be the subject of a separate approval process and as such there are no firm development plans for the site, which is a key consideration when developing noise criteria. A more appropriate approach would be to set PSNL when an application is made for the land development at which time the power station operation and its impacts on the proposed Tallawarra Lands may be assessed in accordance with the relevant guidelines.

The setting of project noise goals for the Tallawarra Lands development would need to include the operations of the Tallawarra A plant which has recently entered commercial operation. As the application for development and the final design of the Tallawarra Lands Development Project will be post the operational start up of the Tallawarra A, the noise criteria for the development must consider this existing influence.

The INP does not provide design noise criteria or assessment procedures for future residential developments in areas that have an existing industrial noise influence and therefore the development of noise criteria for the proposed Tallawarra Lands is not straightforward. There are several methods that may be used to develop suitable noise criteria for the Tallawarra Lands project which are discussed below, although these should be explored further during the approvals process for the Lands development.

The INP provides two forms of noise criteria to limit noise impacts from industrial developments; the intrusiveness and amenity criteria. The intrusiveness criteria can only be used to develop noise criteria for a proposed industrial development to inform the design of the site so as to generate a L_{Aeq} noise level at an existing receiver of no more that background plus 5 dB(A). These criteria cannot be imposed on an existing industrial noise source and therefore the amenity criteria should be used to determine the appropriate level for a new receiver.

The acceptable noise levels for an urban receiver identified in Table 2.1 of the INP are 60, 50 and 45 dB(A) for day, evening and night time respectively. In areas exposed to industrial noise impacts up to 39 dB(A), the level of industrial noise compared to the night time amenity criteria would be 6 less than the ANL. When referenced to Table 2.2 of the INP, this noise level would attract no additional cumulative noise penalties, making development within areas with existing industrial noise impacts less than this level acceptable.



Legend

- Site boundary
- Large Lot Residential
- Low Density Residential

Noise Levels

- 35dB(A)
- 40dB(A)
- 45dB(A)
- 50dB(A)
- 55dB(A)
- 60dB(A)
- 65dB(A)

0 250 500

Metres

1:20,000 At A4

SKM

Figure 4-10: Noise Contours and Tallawarra Lands Structure Plan

Stage A & B CCGT - Scenario 1

Source: Topographic data by Streetworks.

April 23, 2009

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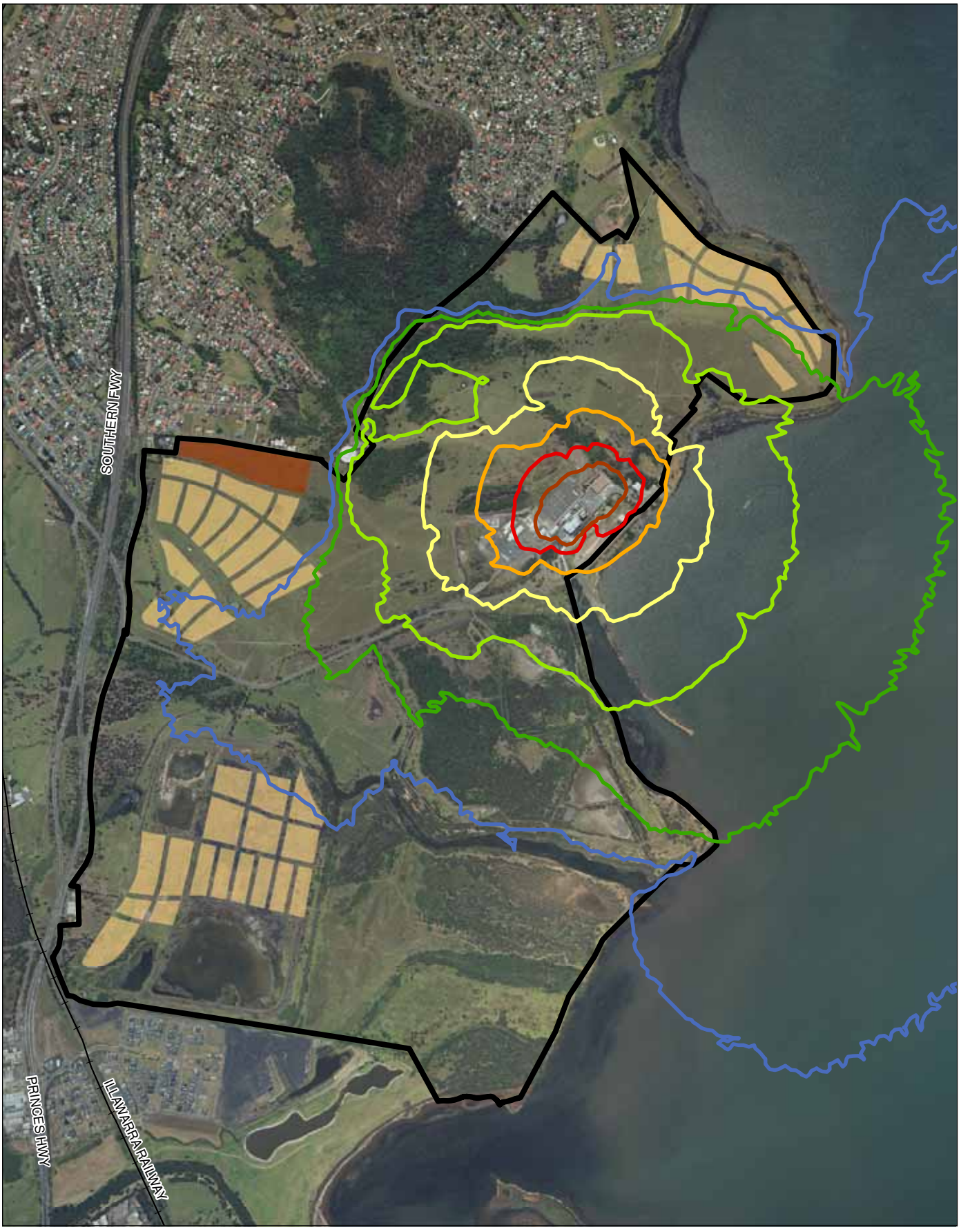


Legend

- Site boundary
- Large Lot Residential
- Low Density Residential

Noise Levels

- 35dB(A)
- 40dB(A)
- 45dB(A)
- 50dB(A)
- 55dB(A)
- 60dB(A)
- 65dB(A)

0 250 500

Metres

1:20,000 At A4

SKM

Figure 4-11: Noise contours and Tallawarra Lands Structure Plan

Stage A CCGT & Stage B OCGT - Scenario 1

Source: Topographic data by Streetworks.

April 23, 2009
I:\ENVR\Projects\EN02239\Technical\GIS\Template\EN02236_Ac_007_Fig4-11_Scenario1_20090409.mxd

It must be noted that future residential development in areas exposed to more than 39 dB(A) may also be acceptable through the adoption of architecturally designed buildings. For example the DECC's ECRTN identifies a night time noise criteria of 50 dB(A) as being acceptable for new residential developments affected by road traffic noise, with mitigation measures including location, internal layout and the choice of building materials and construction for dwellings. Other codes and standards recommend internal noise levels of between 30-45 dB(A), which would be achievable for the Tallawarra Lands Development for areas above 39 dB(A).

The predicted noise contours in **Figures 4-10** and **4-11** show a similar level of noise impact within the Tallawarra Lands. For the proposed residential areas on the western boundary, the predicted noise impact from the Power Station is likely to be lower than the noise influence generated by road traffic on the Southern Freeway. To the north of the site residential areas are likely to experience only marginally higher noise levels from the 2 x CCGT configuration.

4.9. Noise mitigation, measurement and management

For external receiver locations, a combination of the distance and shielding from local topography would provide a high level of attenuation. Noise impacts originating from the site on the Tallawarra Lands will depend on the specific land use, which is to be assessed in a future development application.

The noise emissions data used for modelling noise impacts for Tallawarra B has been taken from the data measured for the Tallawarra A CCGT plant. The sound power levels for the assessment were taken from direct measurement of the Stage A station, which incorporates significant attenuation measures in the construction of the plant. It is therefore necessary that the same attenuation controls identified for the Stage A plant be implemented for the proposed Stage B CCGT in order to meet the project specific noise goals outlined for this assessment.

For the OCGT, there are no specific impacts identified that would require additional treatment to meet the project noise goals. The sound power levels for this option have been identified in **Section 4.6.2**. These were based on a low noise OCGT plant design. Any further consideration of an OCGT design must therefore consider sound power levels that are at least the same or better to achieve the results predicted in this report.

Noise impacts from start up and shut down procedures may be louder than the normal operations of the plant. These events would include noise from start up ejectors, blow down valves, sirens, circuit breakers and the like. Some of these are process requirements and some are safety requirements.

Due to the intermittent nature of these activities, their effect on the predicted noise level emissions from Tallawarra B have not been included in the modelling of normal operations of noise emissions

at the external receivers. The infrequent nature of these sources is evidenced by their function, which may occur at start up, shut down or during abnormal operations.

Safety valves are expected to operate only a few times per year and last for about 30 seconds duration. Circuit breakers, which have an impulsive impact, can have noise levels of 105 dB at 25 metres distance. Measured noise levels from the supply gas line purge during a gas turbine shutdown indicate similar noise levels of 103 dB(A) at 20 metres.

It is noted that these noise events which are described as generally instantaneous have durations up to 30 seconds, and in many cases for example circuit breakers less than 1 second. Integrating these instantaneous noise events back into a 15-minute noise assessment period would have no impacts in increasing the overall noise from the power station.

These impacts have been assessed against the DECC sleep disturbance guidelines to determine the potential for impacts during these periods. The noise emissions used in the sleep disturbance noise assessment have been based on measurements made during the shutdown operation of a 175MW class OCGT plant. This is considered to be representative of the worst case for a normal OCGT shutdown, with similar events in a CCGT plant expected to occur at similar or lower levels.

While the events that generate noise emissions from start up and shut down operations are generally consistent between CCGT and OCGT plants, with OCGT plants, they often occur outside the turbine building. With CCGT plants they occur inside and are attenuated by the building enclosure and silencers. A breakdown of these noise sources and a comparison between CCGT and OCGT to support this premise is given below.

- At shut down, a volume of gas will be trapped in the gas supply system. This gas is normally released and this can create a reasonable noise – measured at 103 dB(A) at 20 m, but for a short period of up to about 30 seconds. This will be common to CCGT and OCGT. If problematic, the noise emissions can be reduced by first passing the gas through a silencer.
- At start up and shut down, the gas turbine compressor bypass valves open, venting air to the exhaust stack or in the case of a CCGT, the HRSG. This can create a short lived noisy event. This discharge is normally piped to bypass air system eventually going to the atmosphere via the exhaust silencers for an OCGT or the HRSG and then the exhaust silencers for a CCGT. On a CCGT plant, this would be silenced within the building and therefore would not be audible outside.
- During start up, noise from the start up ejector may occur.
- When a generator breaker opens or closes an instantaneous noise is emitted. In an OCGT plant this is maybe outside. In a CCGT plant, this is normally inside and therefore heavily attenuated by the building enclosure. There are also breakers in the switch yard, which cannot be readily attenuated.

- In an abnormal operational situation, the HRSG safety valves of a CCGT plant may open to relieve the pressure in the steam system. This discharge normally flows through silencers to the atmosphere. This does not apply to OCGT, which do not have a steam cycle.

The results of the modelled predictions for sleep disturbance, for the non-continuous noise emissions have been estimated based on worst case adverse meteorological conditions for each receiver and are presented in **Table 4-6.**

Table 4-6 Predicted L_{AMax} Noise Levels Adverse Meteorological Conditions

Location ID	Description	Predicted Noise Level Adverse Conditions	Sleep Disturbance Noise Goal
T2	Carlyle Street, Koonawarra	31 dB(A)	53 dB(A)
T4	Wyndarra Way, Koonawarra	30 dB(A)	46 dB(A)
ML# 9	Central Park, Mongurah Pt	42 dB(A)	48 dB(A)
ML# 10	Boonarah Pt	43 dB(A)	47 dB(A)
ML# 11	Haywards Bay Estate, Yallah	38 dB(A)	54 dB(A)

The results of the predictions indicate that even under adverse meteorological conditions the sleep disturbance criteria would not be exceeded. Furthermore, the noise emissions from start up and shutdowns, circuit breakers and other abnormal operational noise sources have the potential to be mitigated in most cases, should this be found to be necessary.

While the start up and shut down activities are not likely to cause a significant impact at any external receivers, these activities would be managed through the implementation of the Operational Environmental Noise Management Plan developed for Tallawarra A, Ref 7142-037-02-01 Rev 2.

4.10. Construction noise impact assessment

Construction activities on the site have been completed for the Stage A CCGT plant. These activities were not audible from the residential monitoring locations during the attended noise survey. The same distance separation and topographic shielding that provides noise attenuation for the Stage A CCGT works would also provide significant benefit to the construction activities for the proposed Stage B plant. It is expected that the construction activities for the proposed Stage B plant would be of a similar noise level and therefore would not be audible at residential locations during normal construction hours.

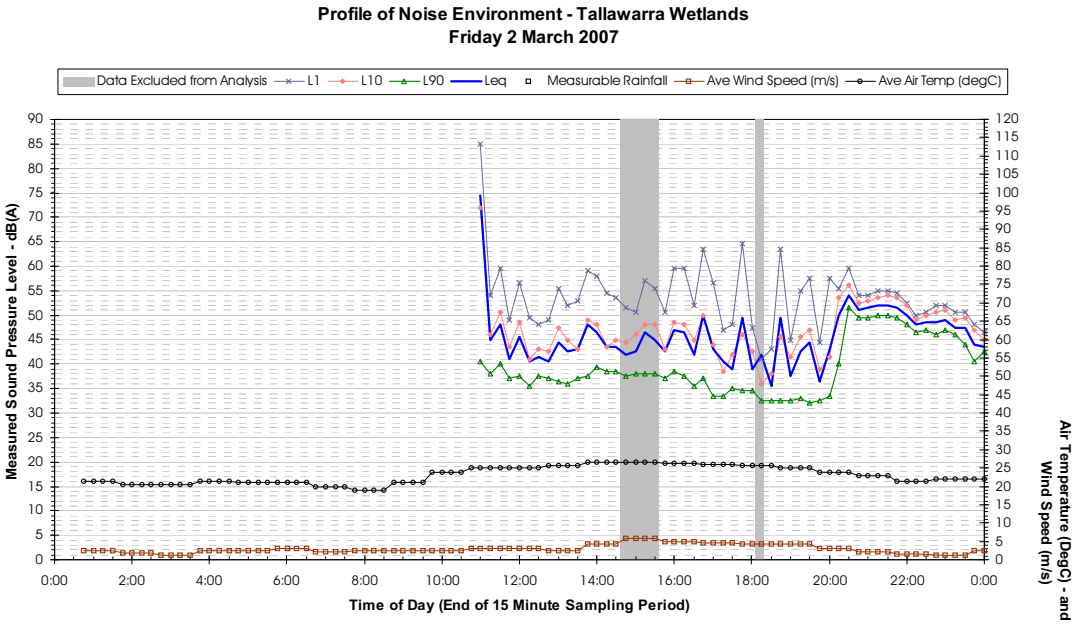
5. Conclusion

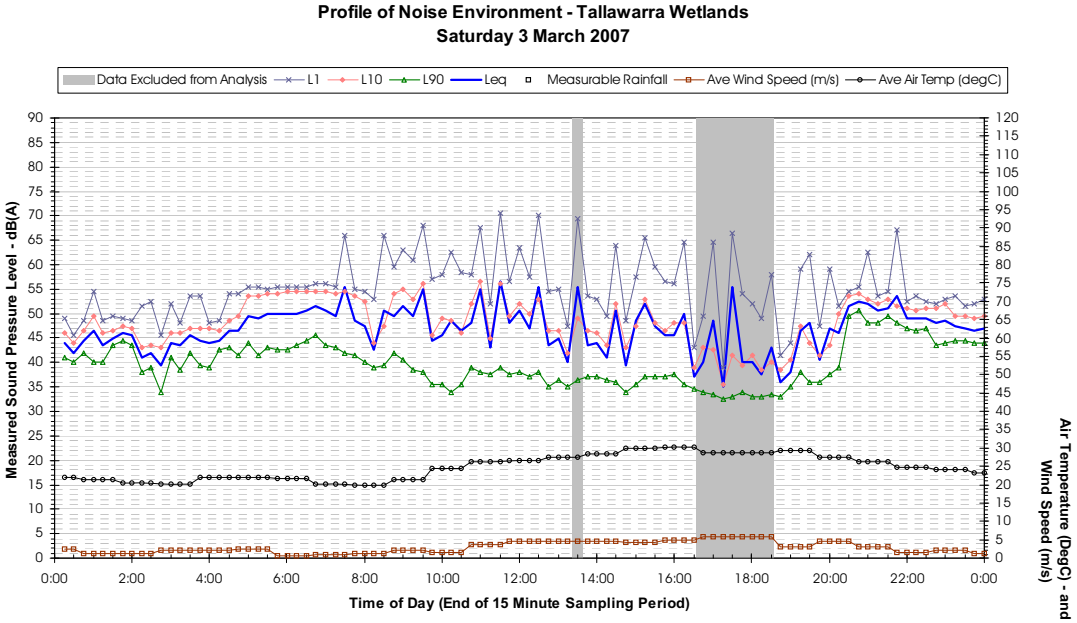
5.1. General conclusions

An assessment of operational and construction noise impacts has been undertaken by SKM for the proposed Tallawarra Stage B plant. Noise modelling identified all sources for the simultaneous operation of both the Stage A and Stage B (CCGT or OCGT) plants for any day, evening or night time period. The assessment included the effects from adverse weather conditions and a 5 dB(A) penalty for low frequency noise emissions in accordance with Section 4 of the INP.

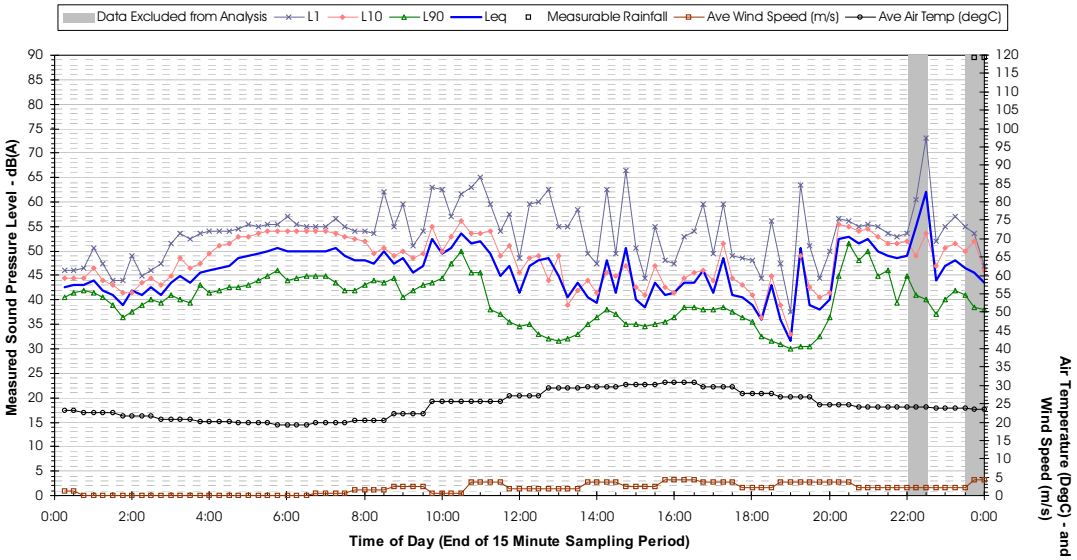
The assessment indicates that noise levels from the combined operations of the Stage A and Stage B plants would be below the project specific noise criteria at locations external to the Tallawarra Lands project and therefore comply with the INP requirements at noise sensitive receivers. Construction noise during normal working hours is not expected to be audible at existing residential locations, based on the inaudibility of current construction activities.

Appendix A Unattended monitoring daily graphs





Profile of Noise Environment - Tallawarra Wetlands
Sunday 4 March 2007



Profile of Noise Environment - Tallawarra Wetlands
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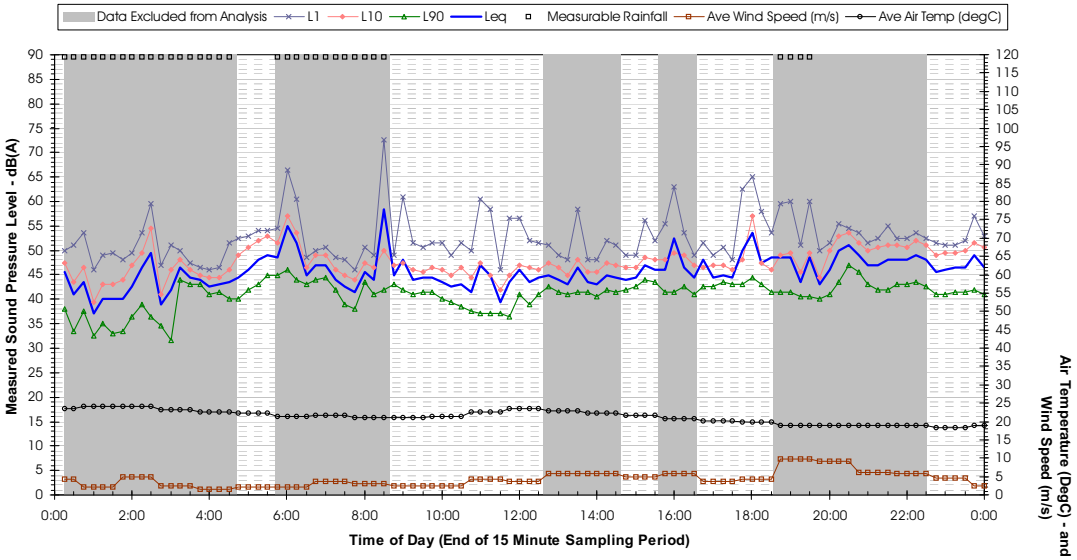
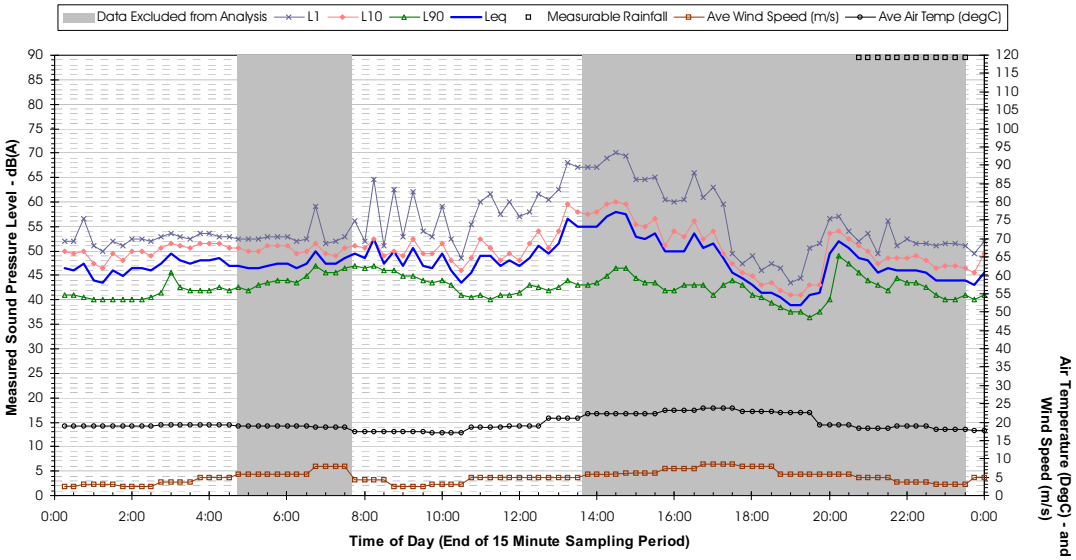
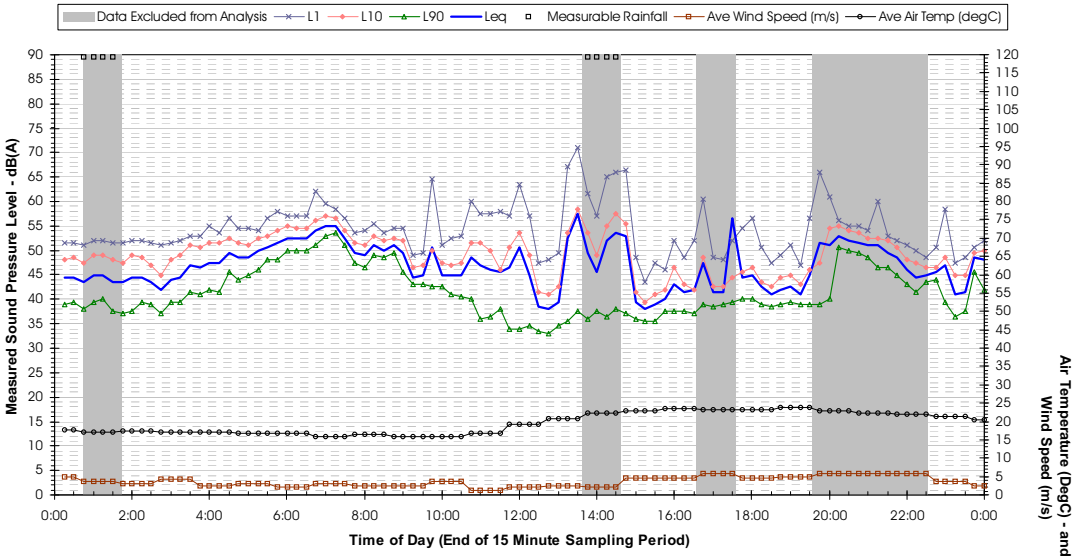


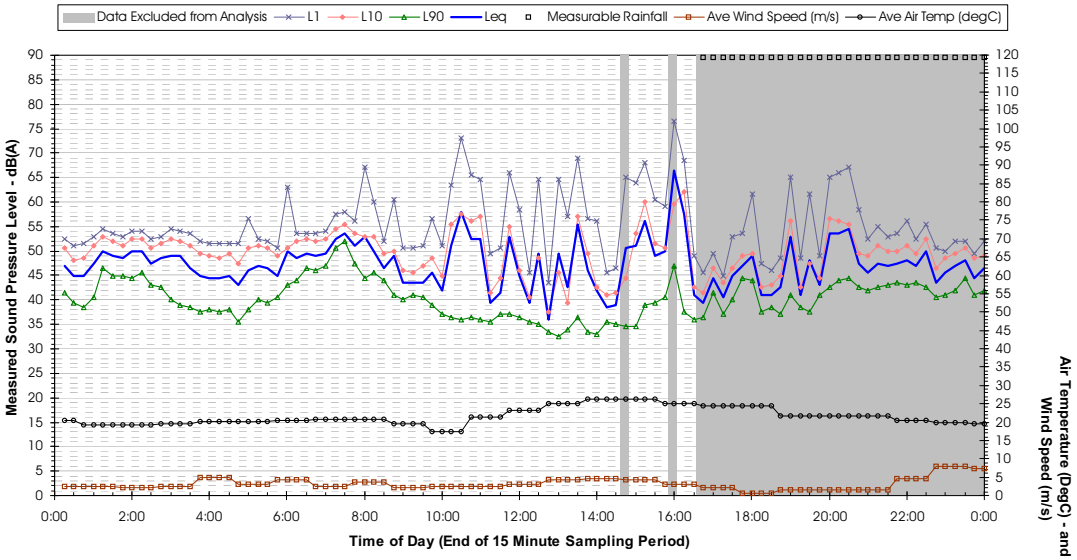
Profile of Noise Environment - Tallawarra Wetlands
Tuesday 6 March 2007



Profile of Noise Environment - Tallawarra Wetlands
Wednesday 7 March 2007



Profile of Noise Environment - Tallawarra Wetlands
Thursday 8 March 2007



Profile of Noise Environment - Tallawarra Wetlands
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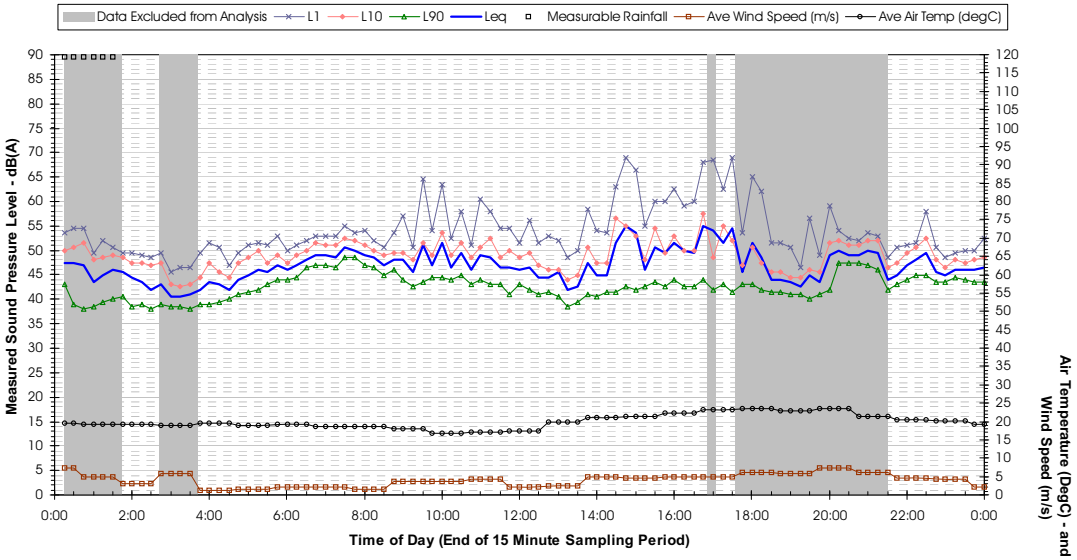

Profile of Noise Environment - Tallawarra Wetlands
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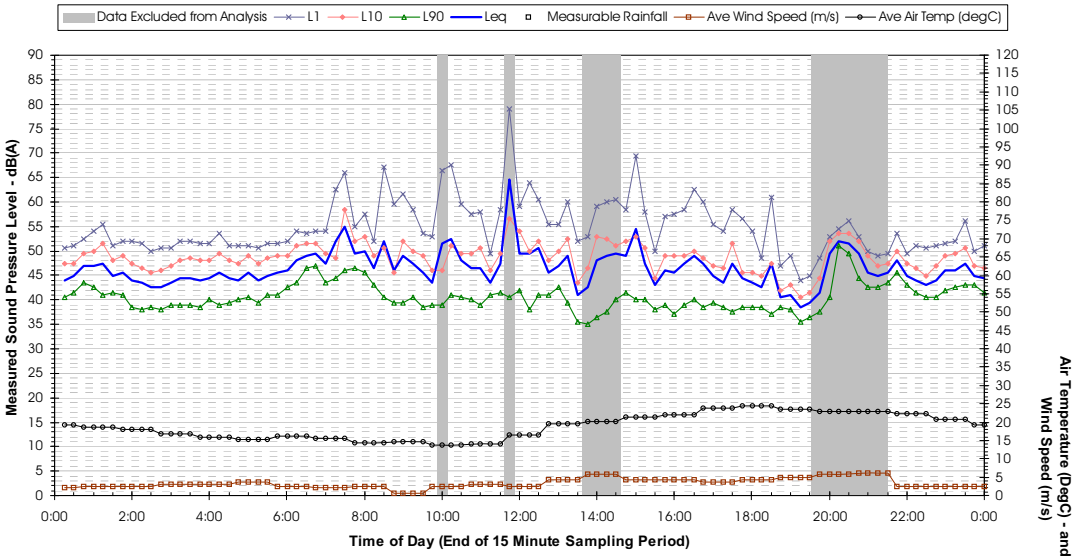

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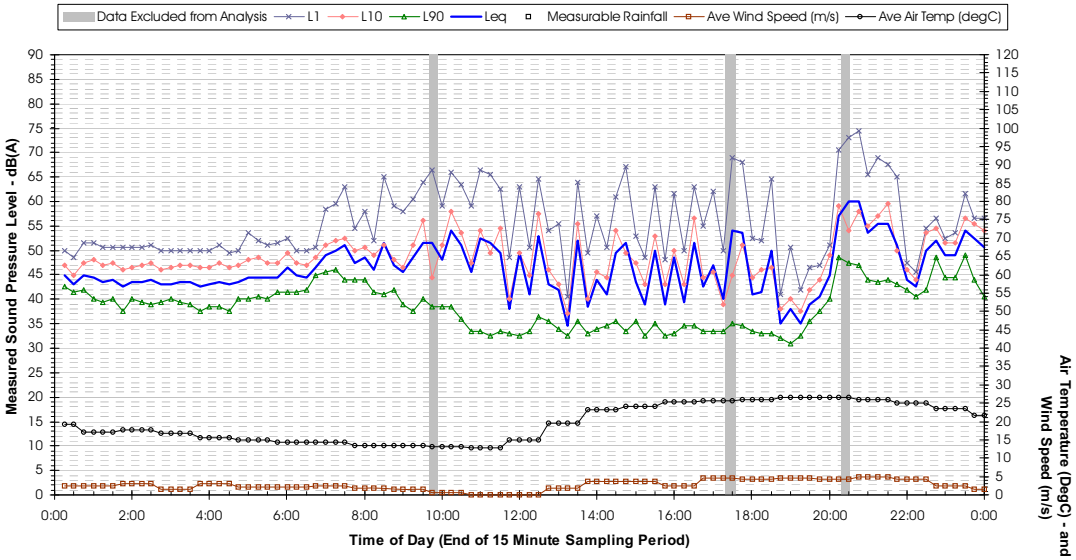

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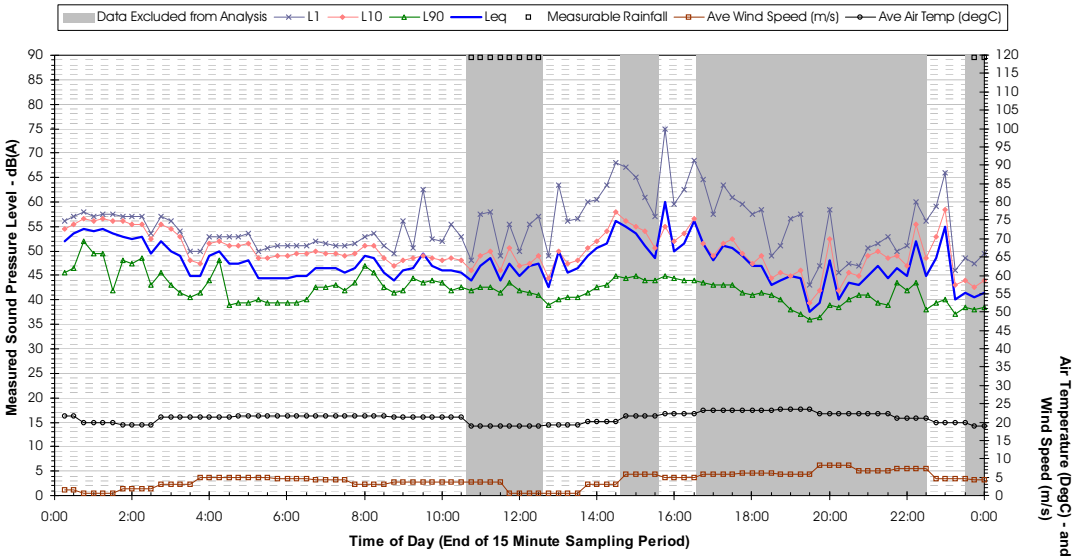

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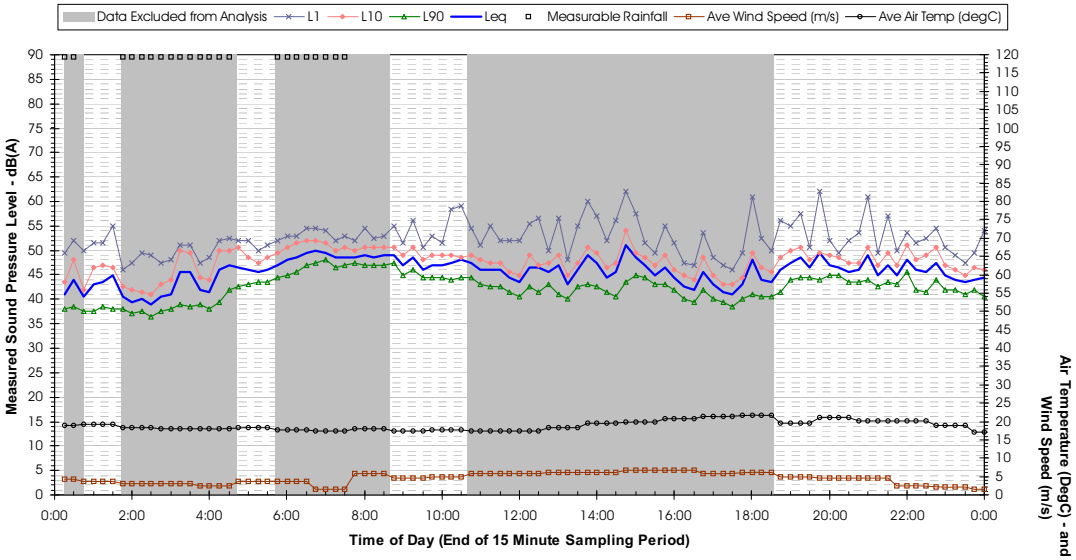
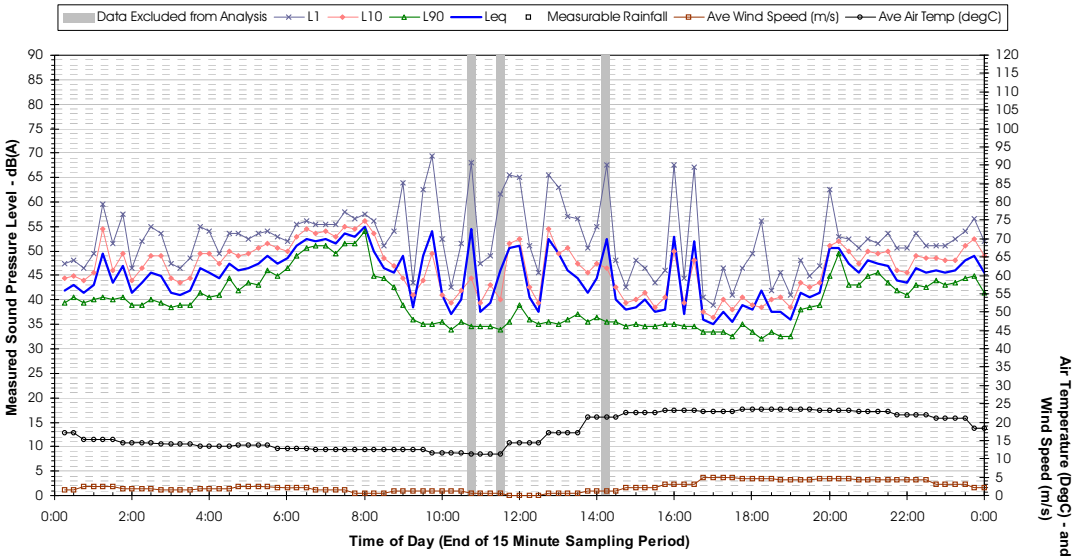
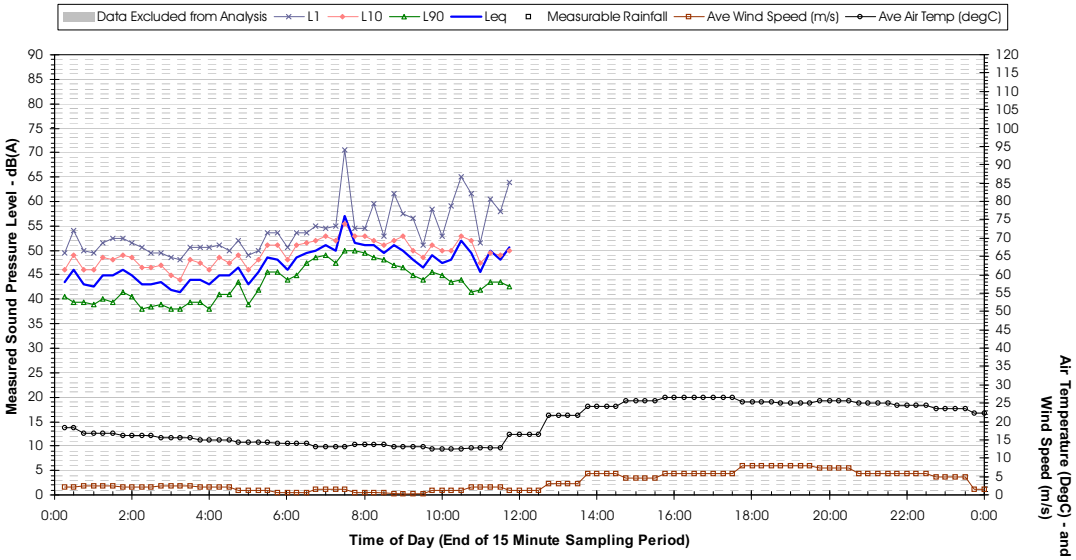


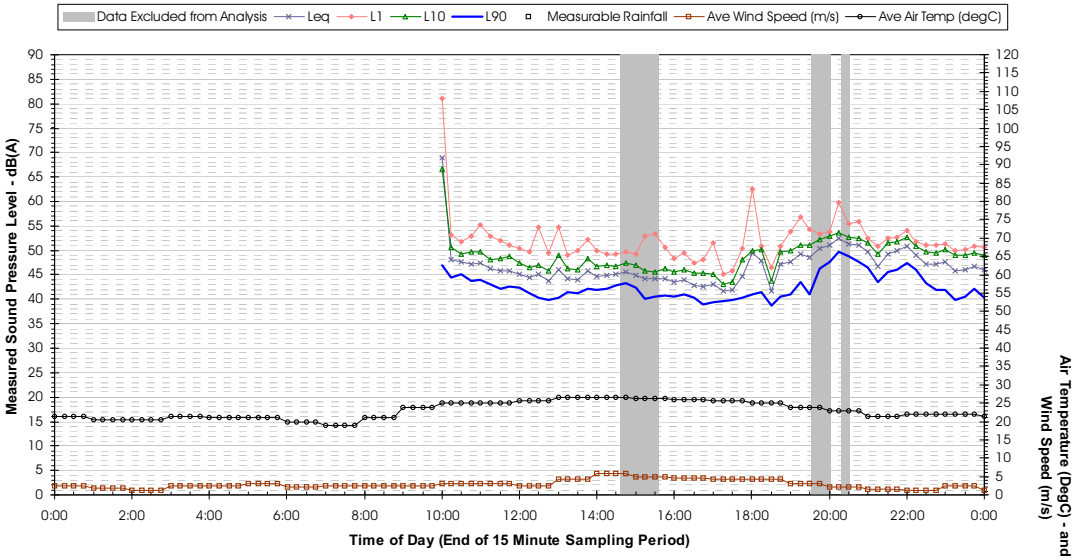
Profile of Noise Environment - Tallawarra Wetlands
Wednesday 14 March 2007



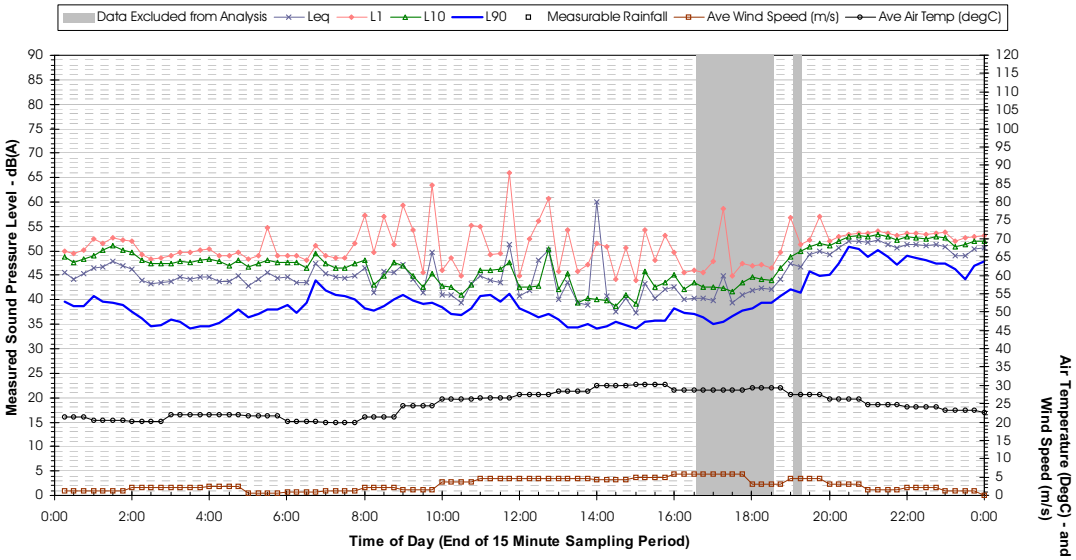
Profile of Noise Environment - Tallawarra Wetlands
Thursday 15 March 2007



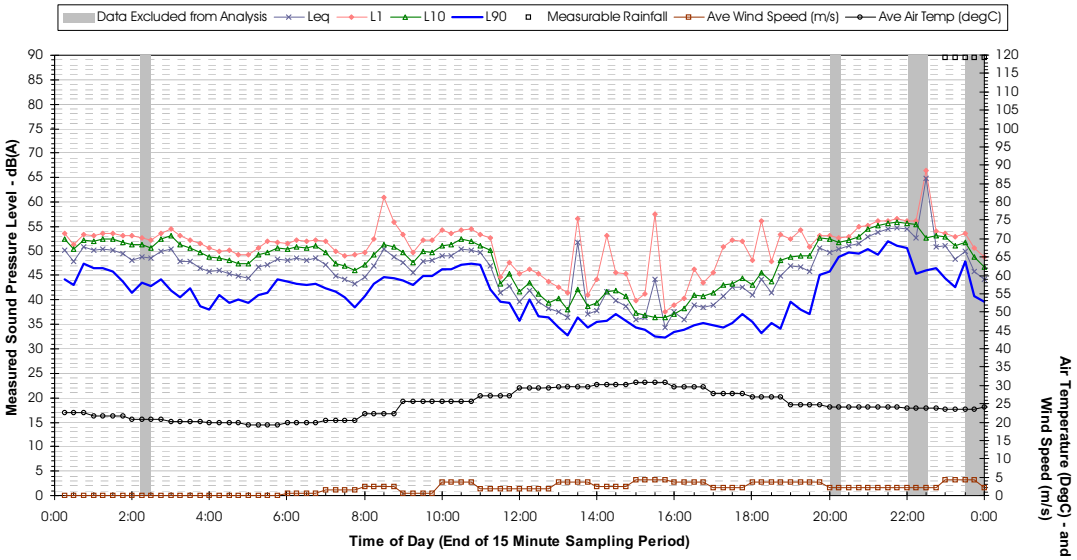
Profile of Noise Environment - Carlyle Street, Koonawarra
Friday 2 March 2007



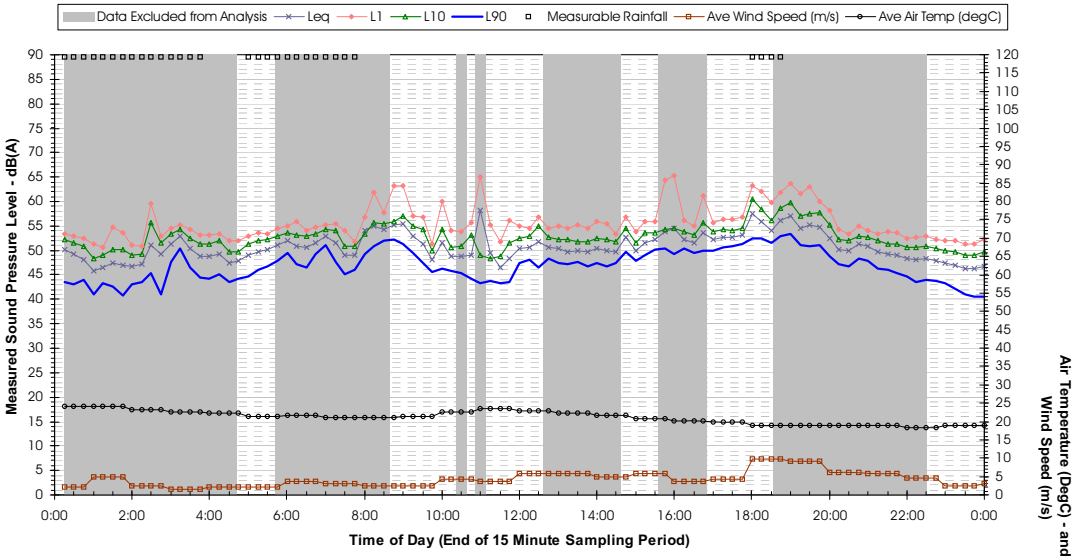
Profile of Noise Environment - Carlyle Street, Koonawarra
Saturday 3 March 2007



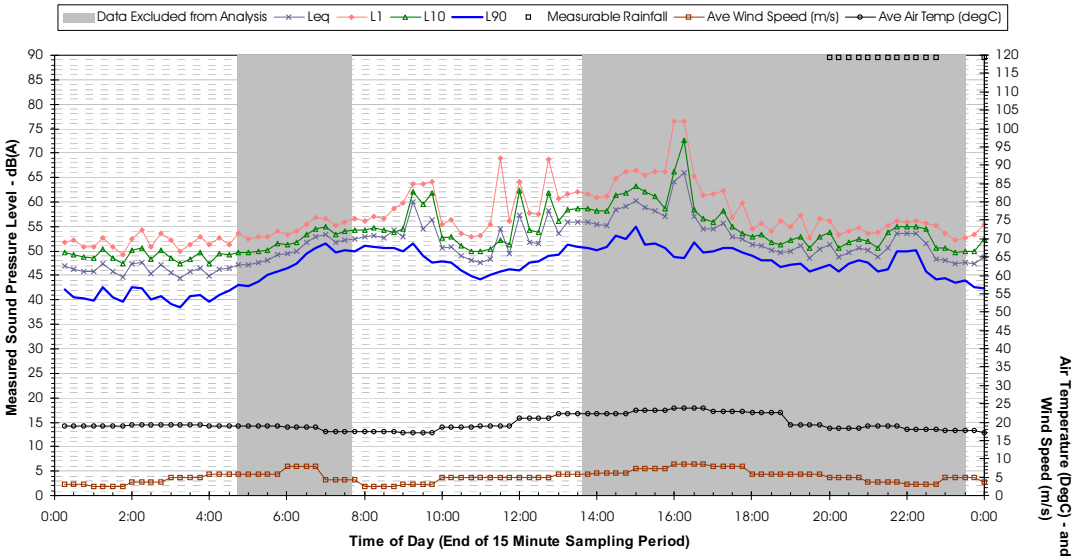
Profile of Noise Environment - Carlyle Street, Koonawarra
Sunday 4 March 2007



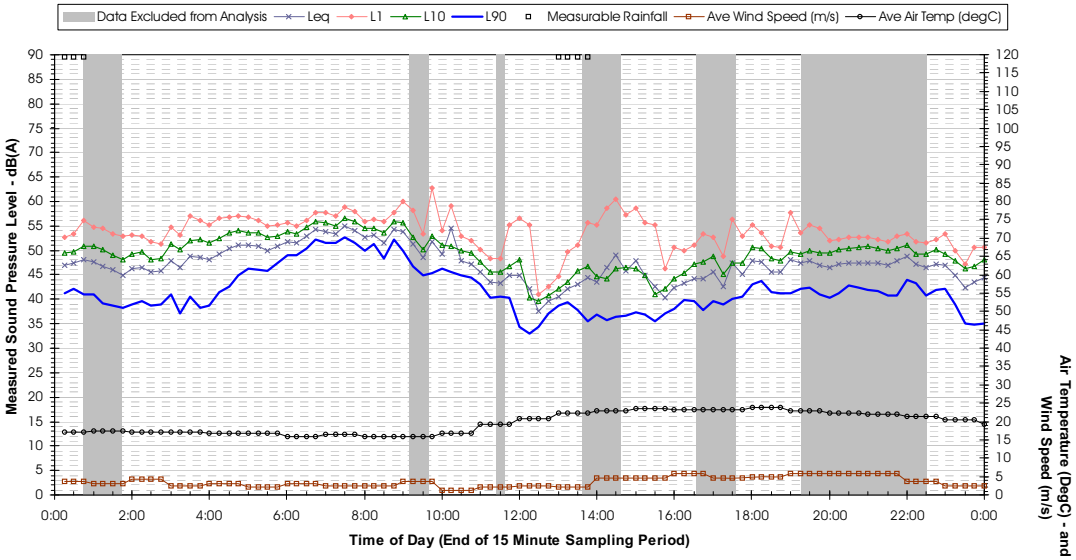
Profile of Noise Environment - Carlyle Street, Koonawarra
Monday 5 March 2007



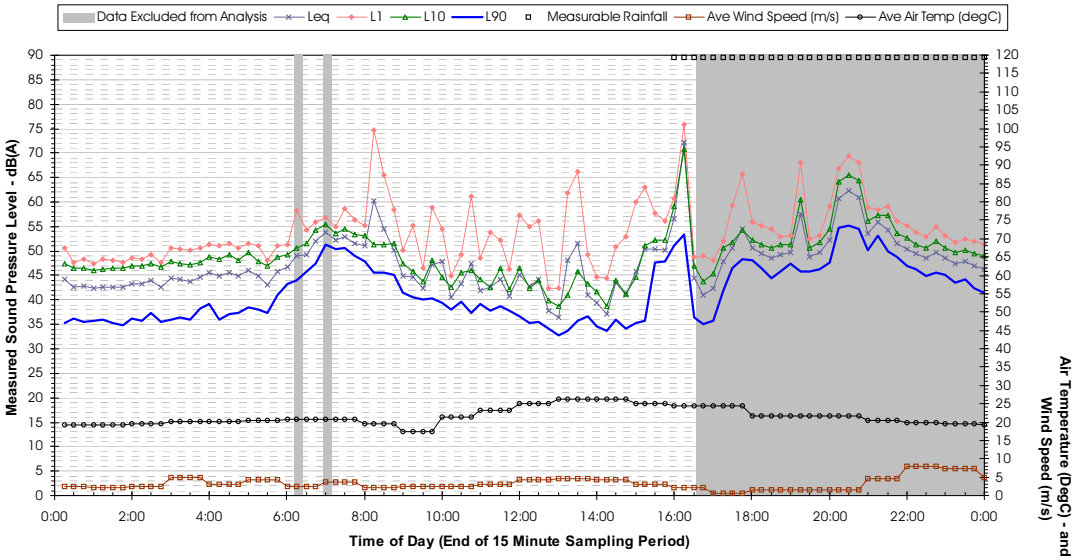
Profile of Noise Environment - Carlyle Street, Koonawarra
Tuesday 6 March 2007



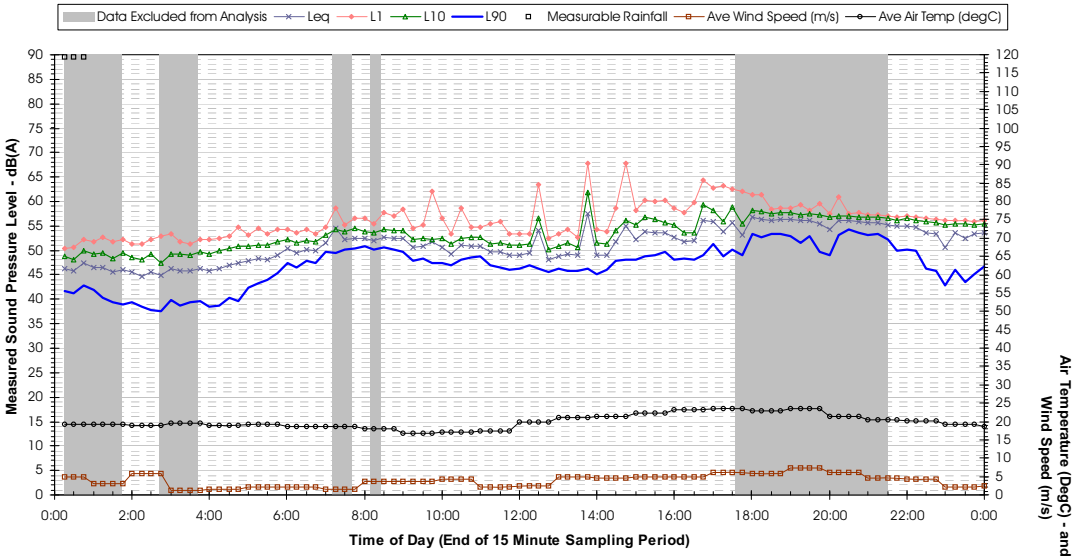
Profile of Noise Environment - Carlyle Street, Koonawarra
Wednesday 7 March 2007



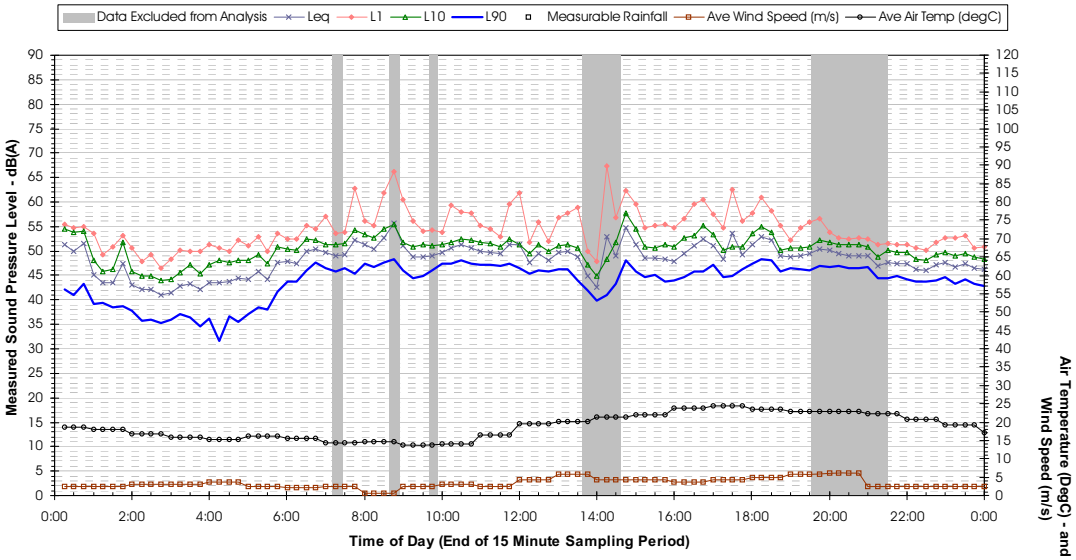
Profile of Noise Environment - Carlyle Street, Koonawarra
Thursday 8 March 2007



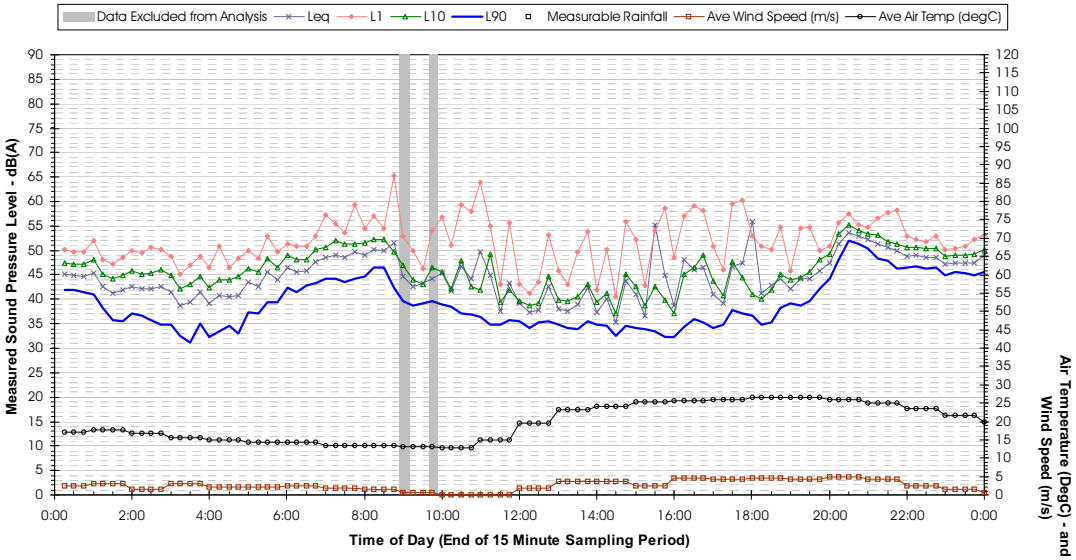
Profile of Noise Environment - Carlyle Street, Koonawarra
Friday 9 March 2007



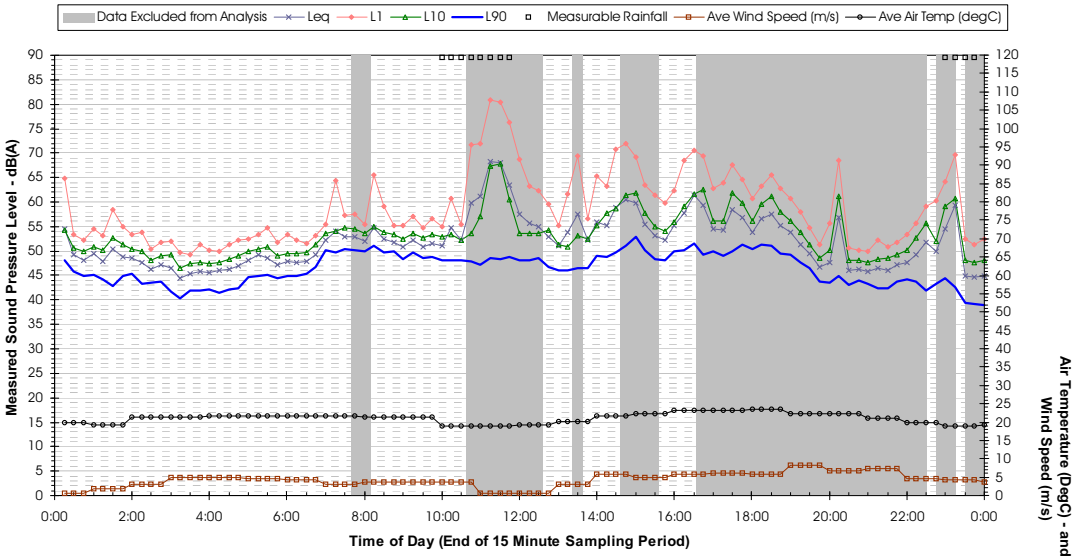
Profile of Noise Environment - Carlyle Street, Koonawarra
Saturday 10 March 2007



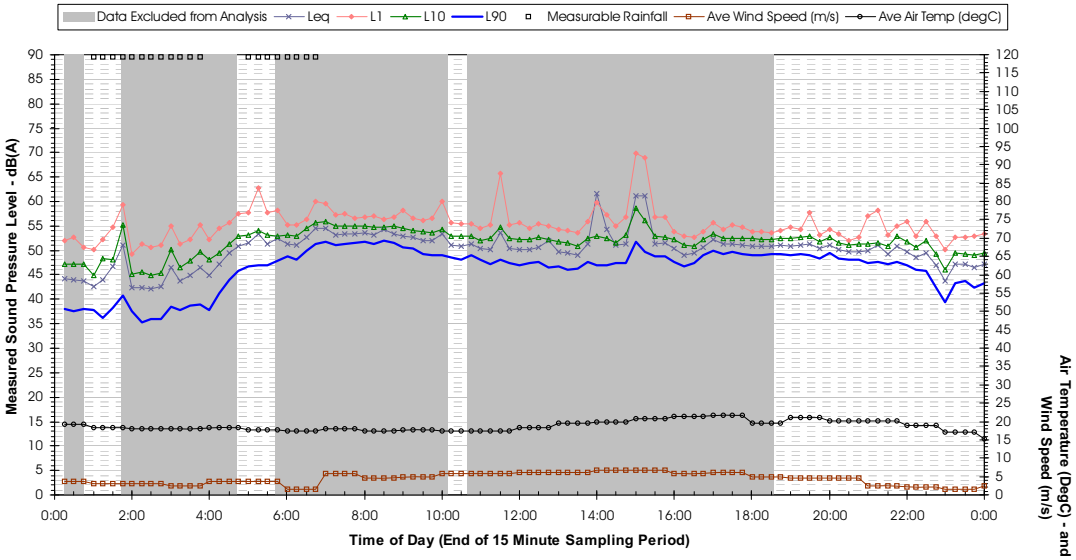
Profile of Noise Environment - Carlyle Street, Koonawarra
Sunday 11 March 2007



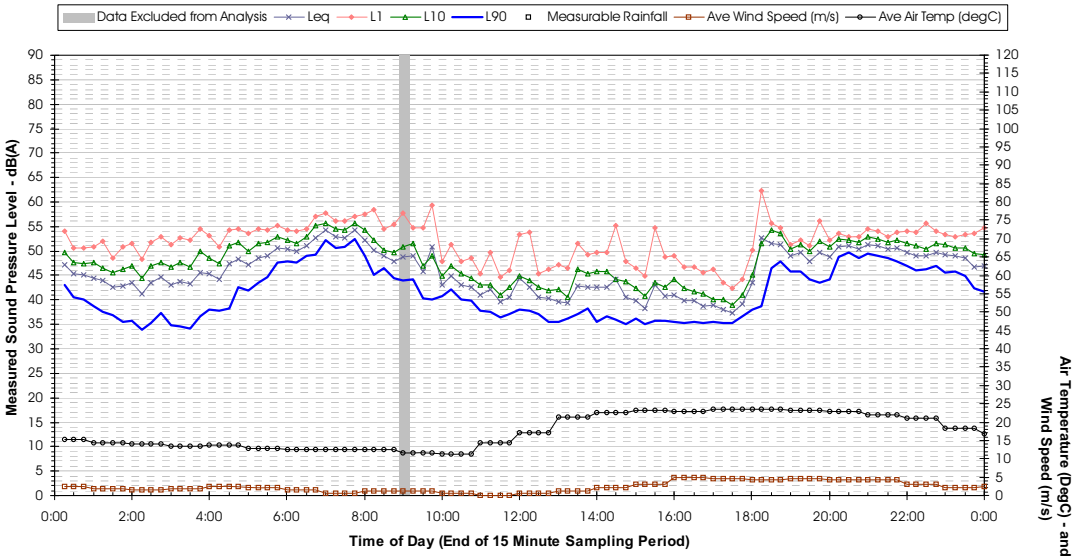
Profile of Noise Environment - Carlyle Street, Koonawarra
Monday 12 March 2007



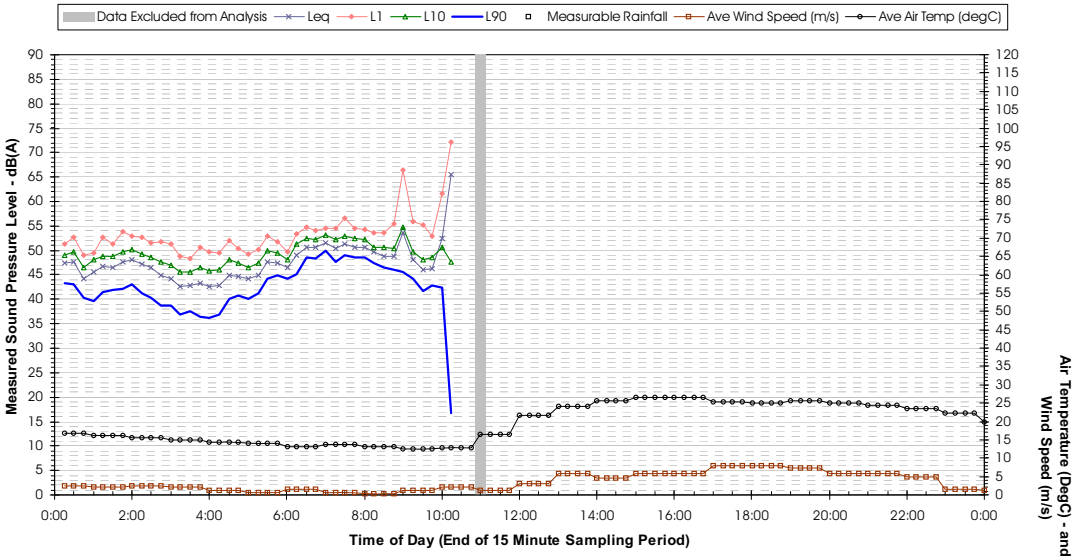
Profile of Noise Environment - Carlyle Street, Koonawarra
Tuesday 13 March 2007



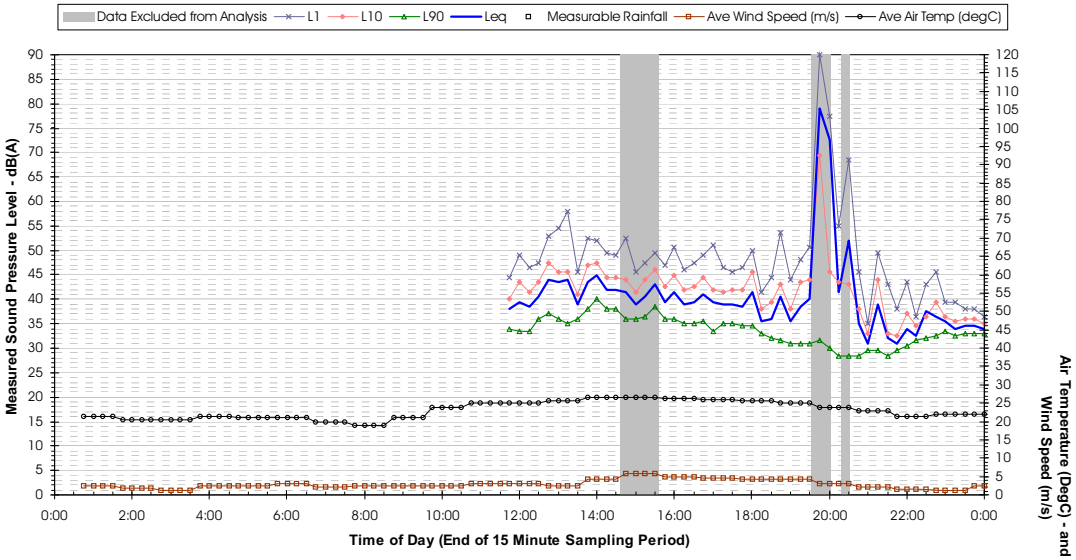
Profile of Noise Environment - Carlyle Street, Koonawarra
Wednesday 14 March 2007



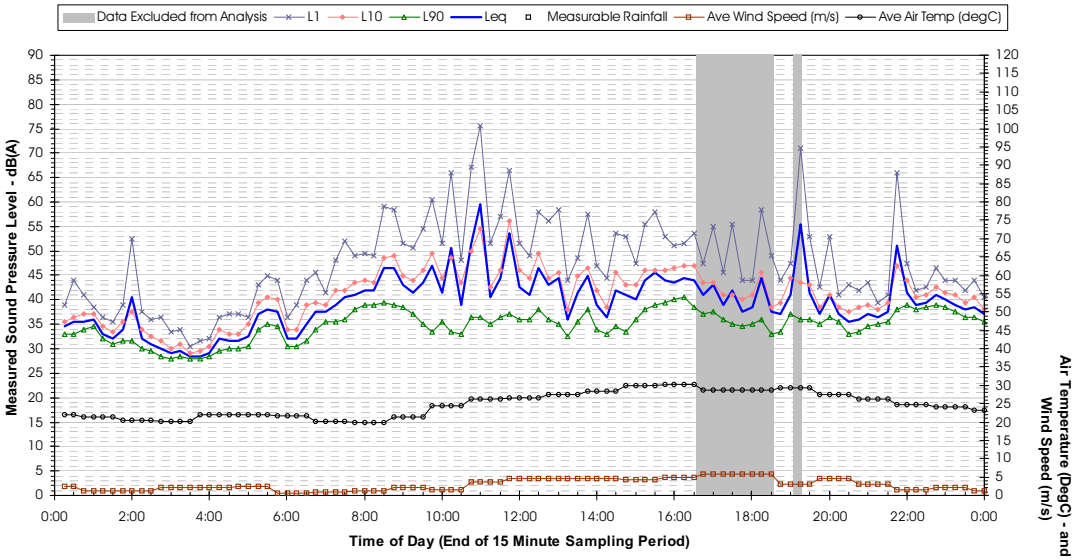
Profile of Noise Environment - Carlyle Street, Koonawarra
Thursday 15 March 2007



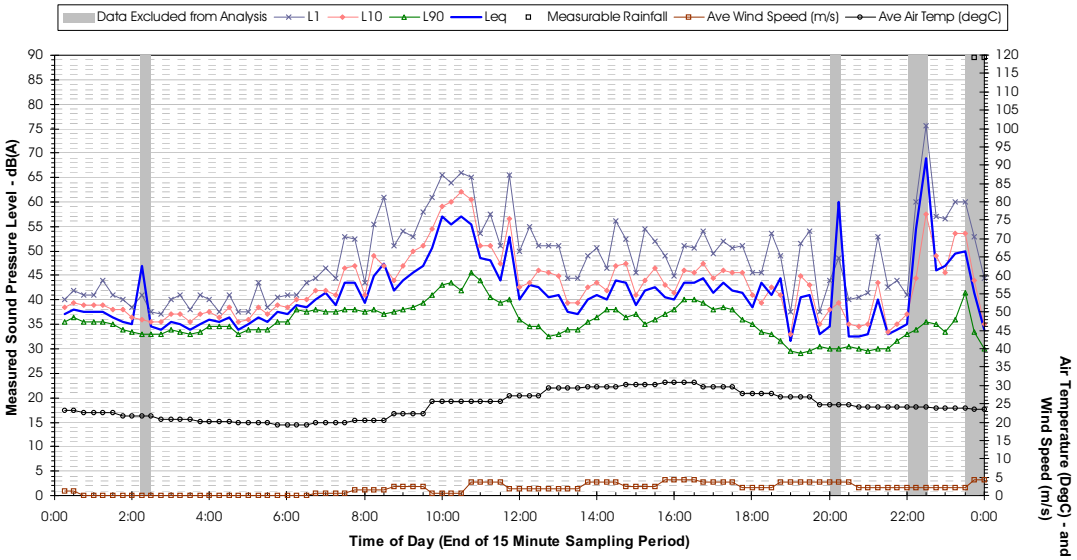
Profile of Noise Environment - Northern Boundary, Tallawarra
Friday 2 March 2007



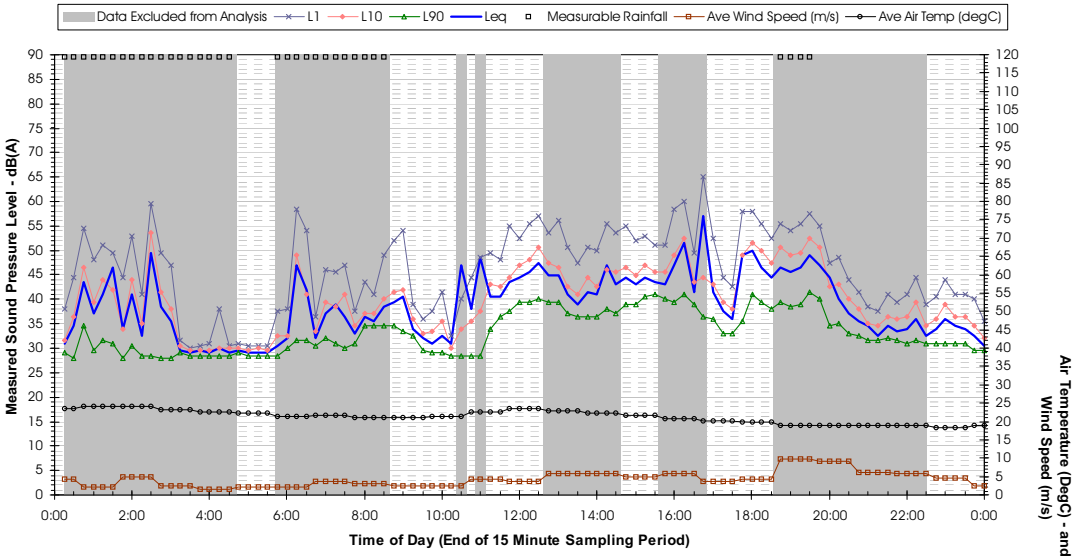
Profile of Noise Environment - Northern Boundary, Tallawarra
Saturday 3 March 2007



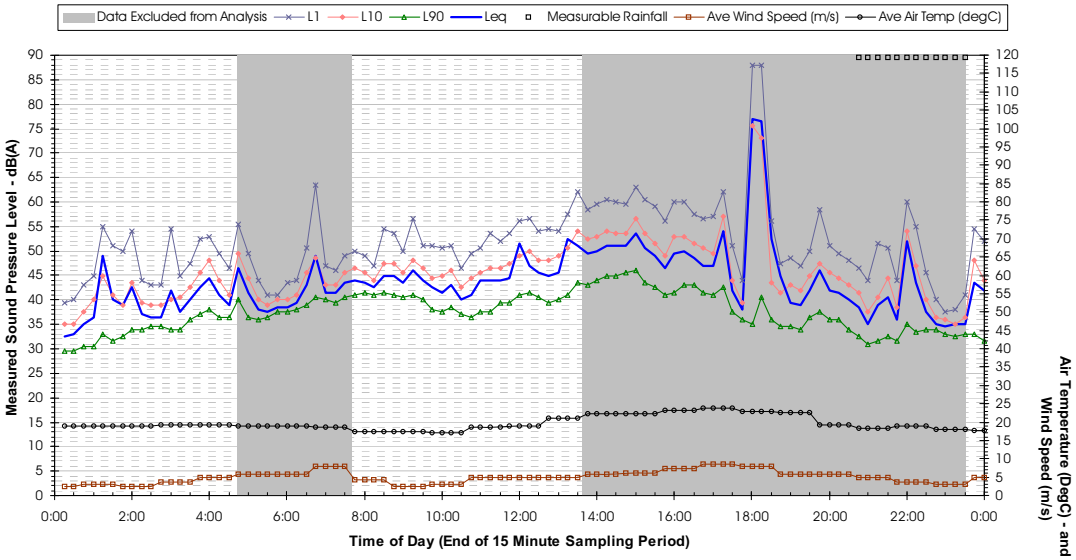
Profile of Noise Environment - Northern Boundary, Tallawarra
Sunday 4 March 2007



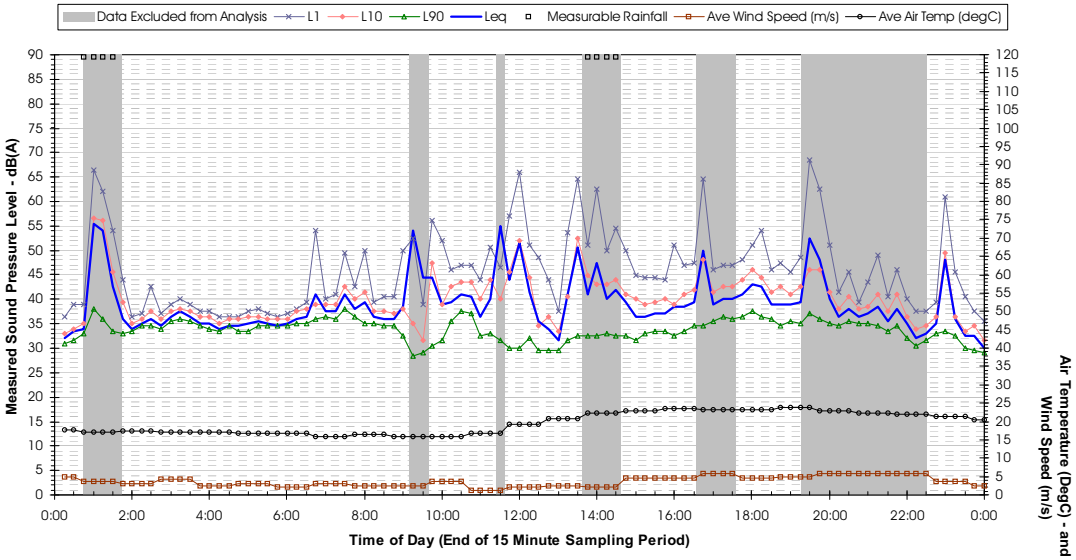
Profile of Noise Environment - Northern Boundary, Tallawarra
Monday 5 March 2007



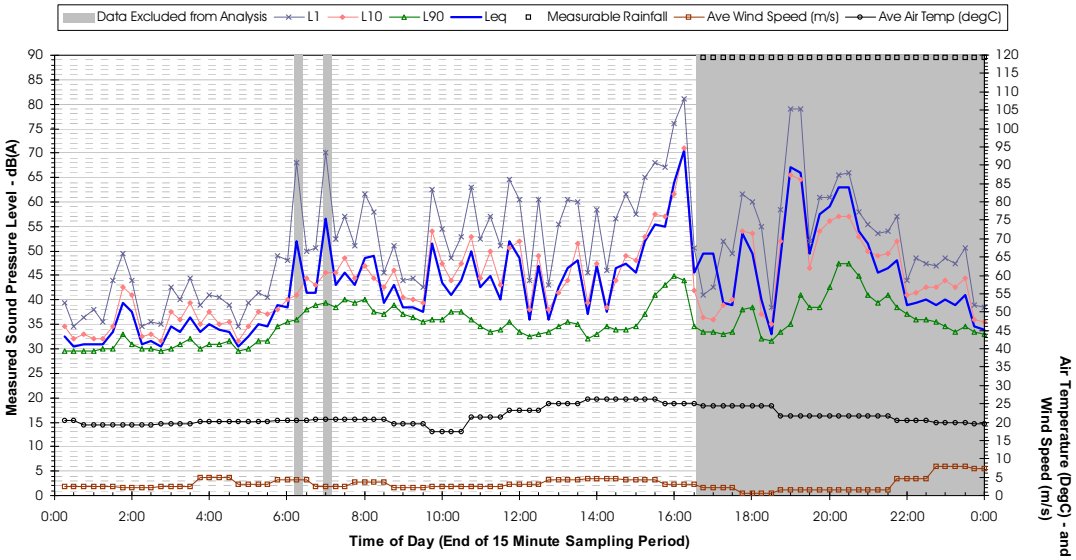
Profile of Noise Environment - Northern Boundary, Tallawarra
Tuesday 6 March 2007



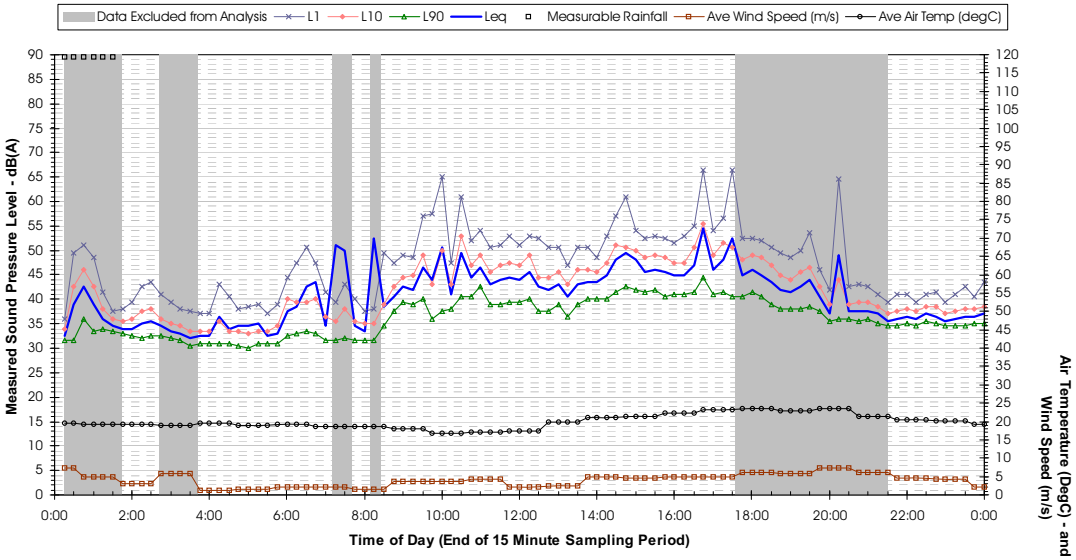
Profile of Noise Environment - Northern Boundary, Tallawarra
Wednesday 7 March 2007



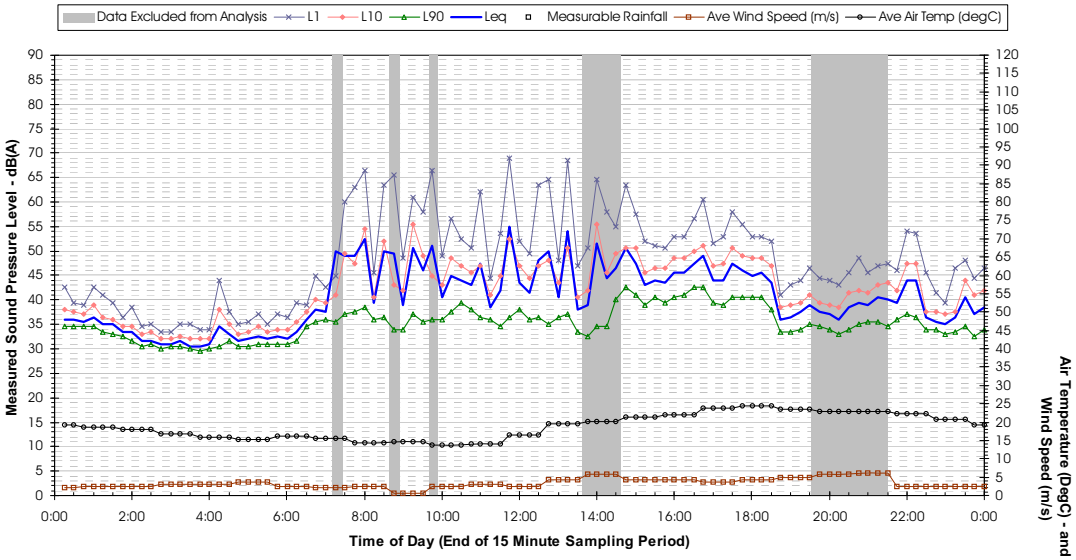
Profile of Noise Environment - Northern Boundary, Tallawarra
Thursday 8 March 2007



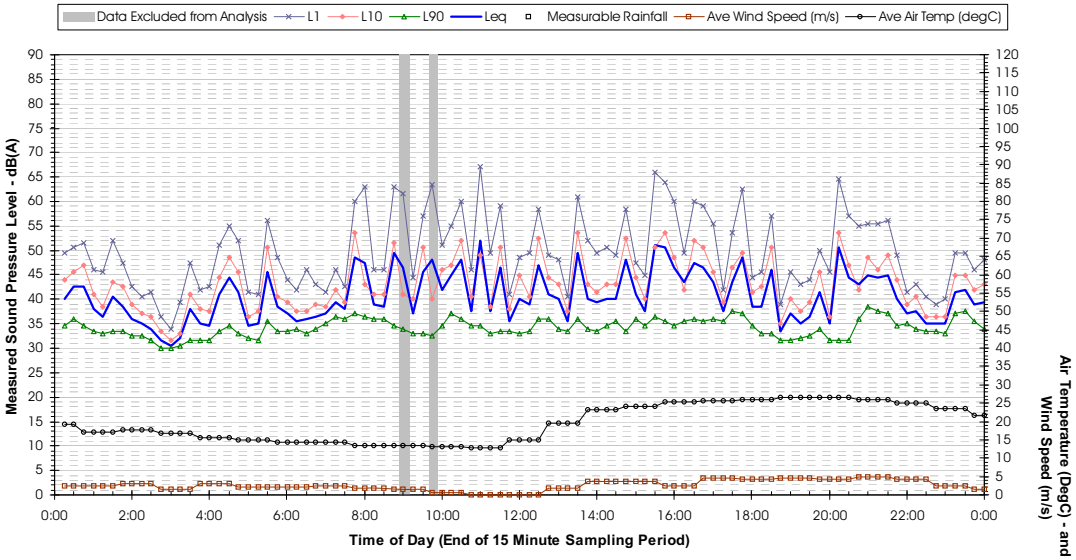
Profile of Noise Environment - Northern Boundary, Tallawarra
Friday 9 March 2007



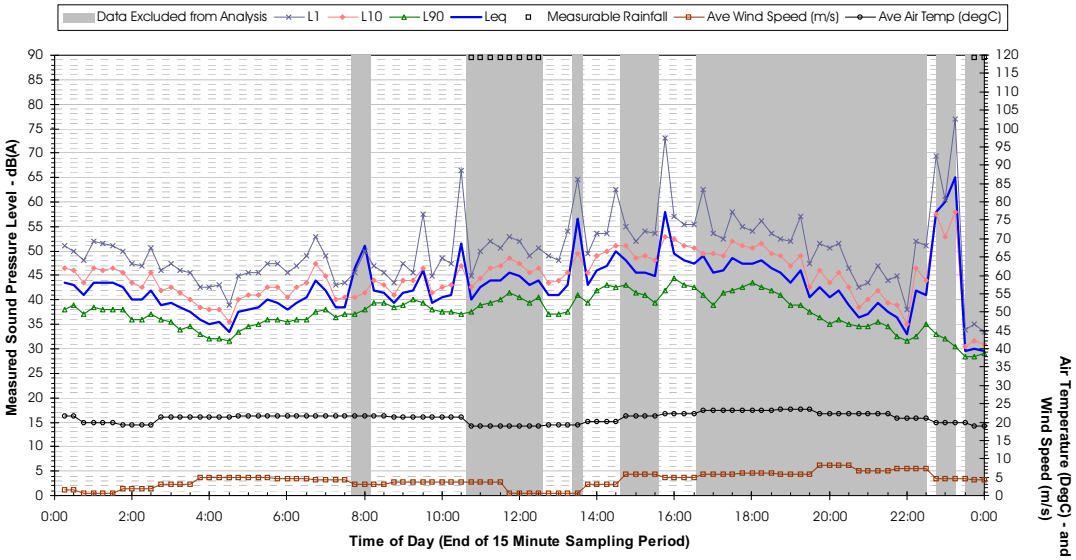
Profile of Noise Environment - Northern Boundary, Tallawarra
Saturday 10 March 2007



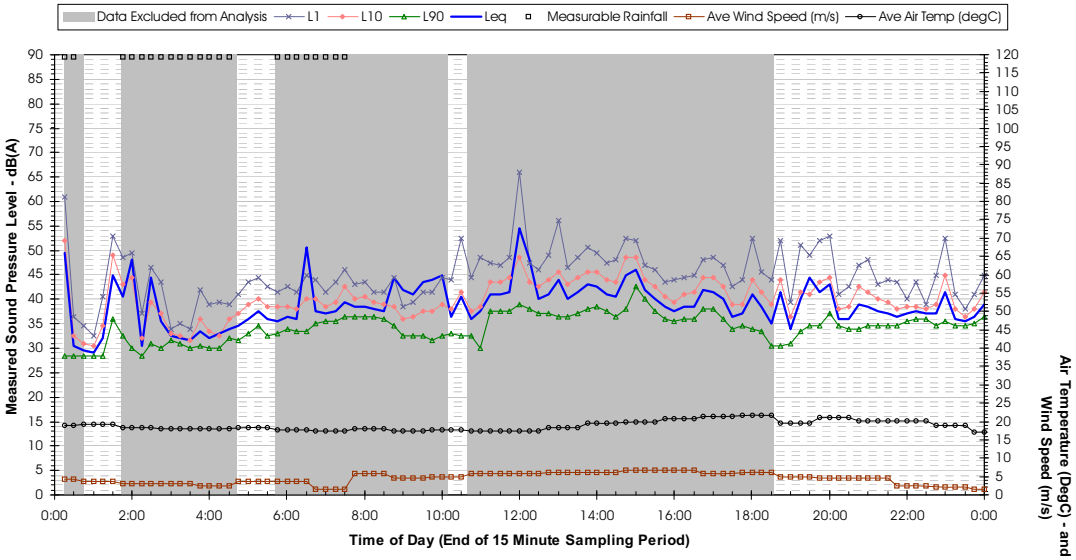
Profile of Noise Environment - Northern Boundary, Tallawarra
Sunday 11 March 2007



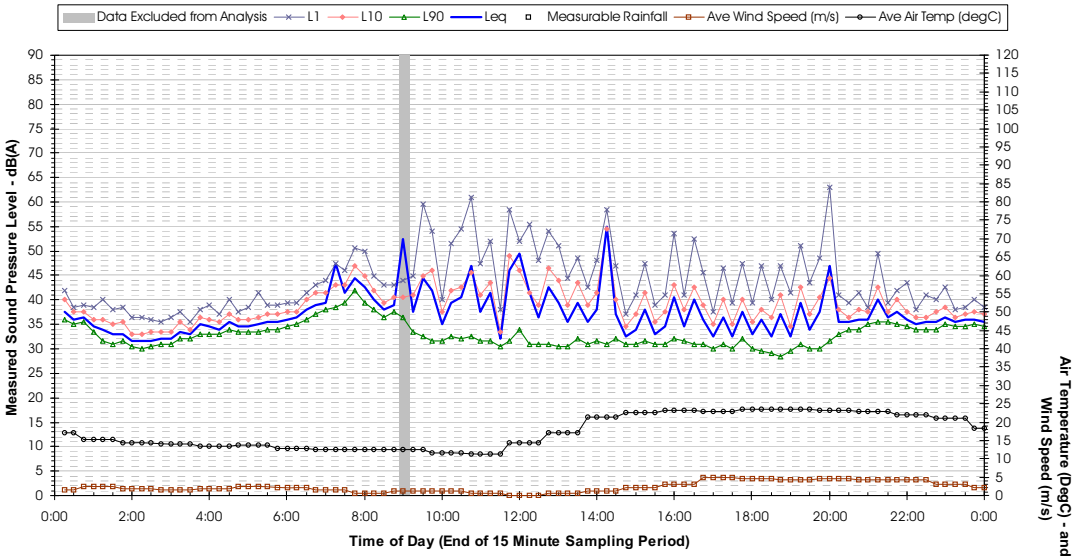
Profile of Noise Environment - Northern Boundary, Tallawarra
Monday 12 March 2007



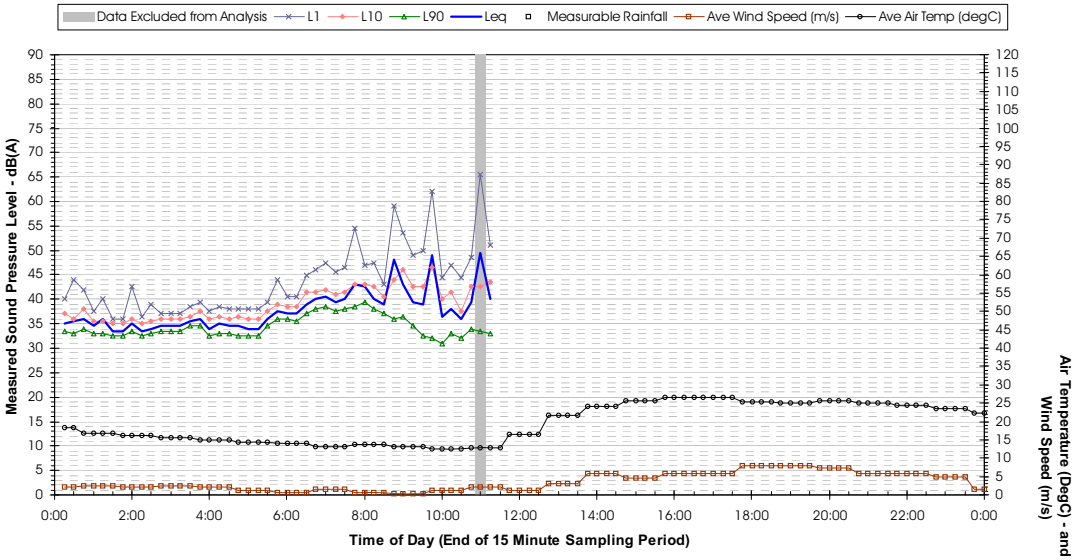
Profile of Noise Environment - Northern Boundary, Tallawarra
Tuesday 13 March 2007



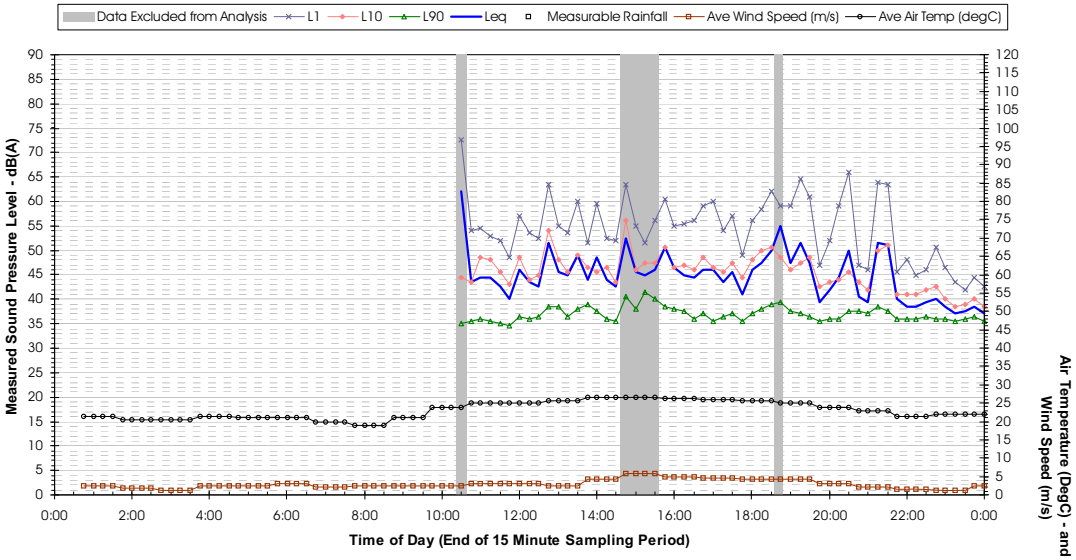
Profile of Noise Environment - Northern Boundary, Tallawarra
Wednesday 14 March 2007



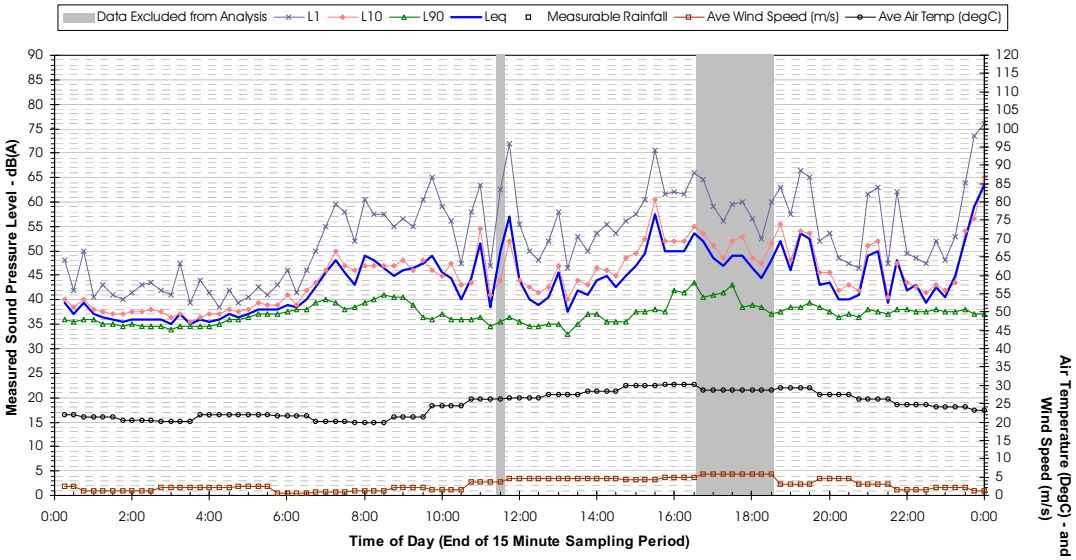
Profile of Noise Environment - Northern Boundary, Tallawarra
Thursday 15 March 2007



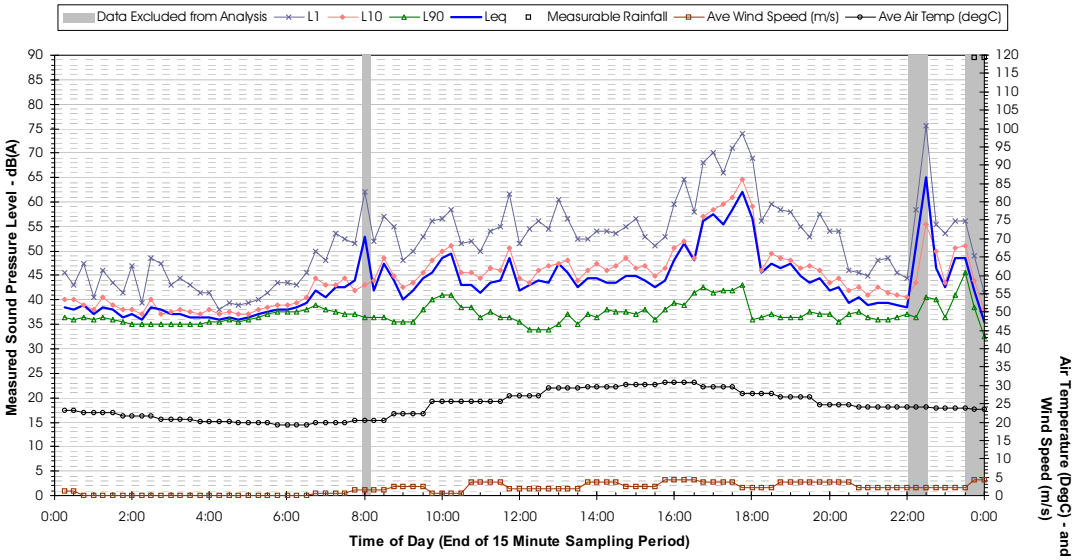
Profile of Noise Environment - Wyndarra Way, Koonawarra
Friday 2 March 2007



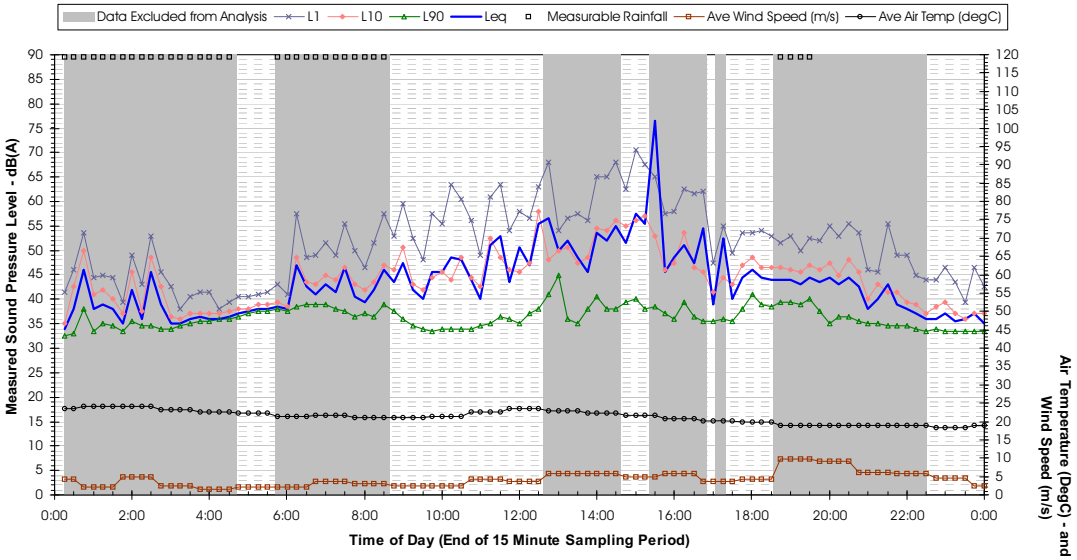
Profile of Noise Environment - Wyndarra Way, Koonawarra
Saturday 3 March 2007



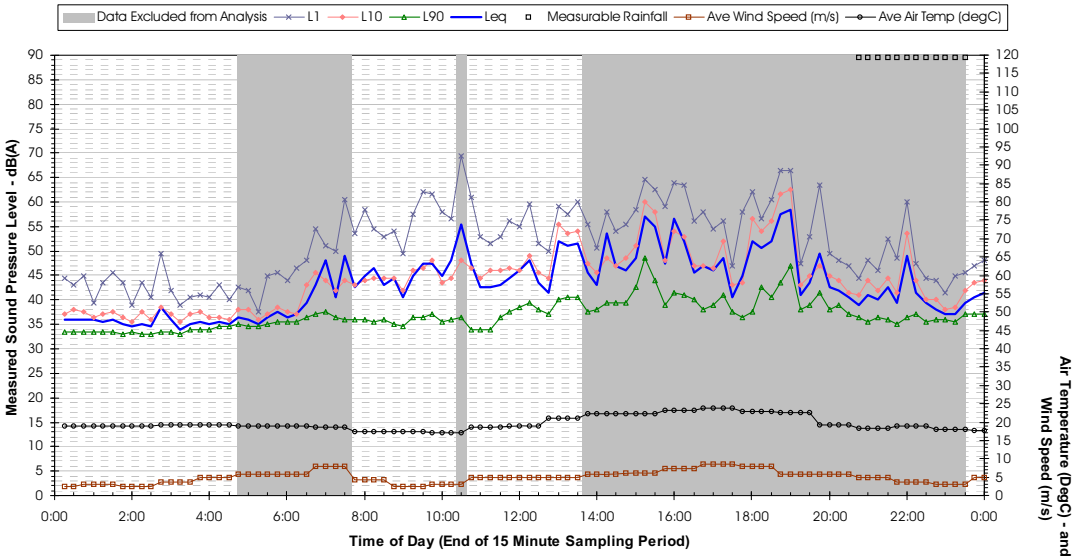
Profile of Noise Environment - Wyndarra Way, Koonawarra
Sunday 4 March 2007



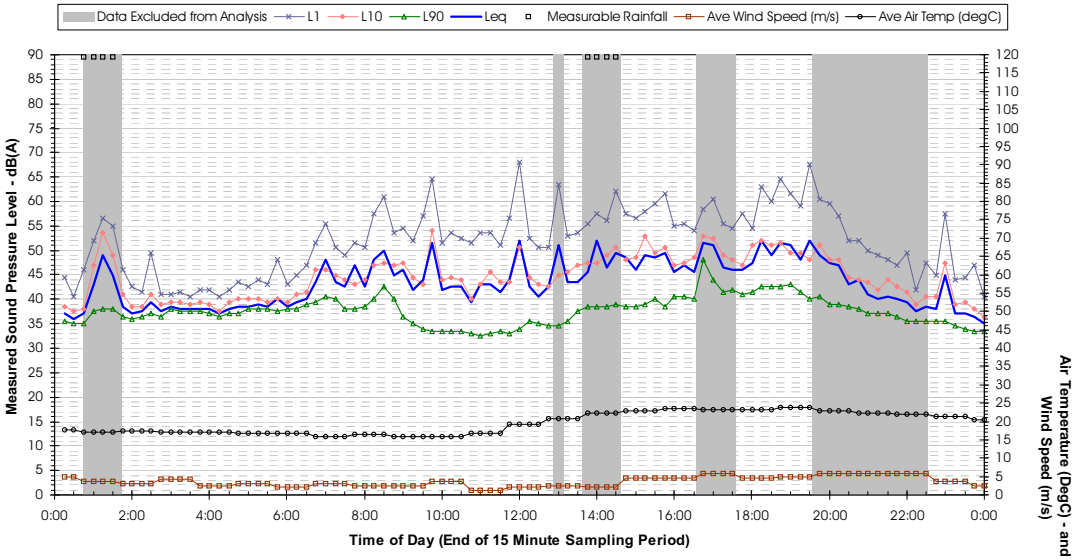
Profile of Noise Environment - Wyndarra Way, Koonawarra
Monday 5 March 2007



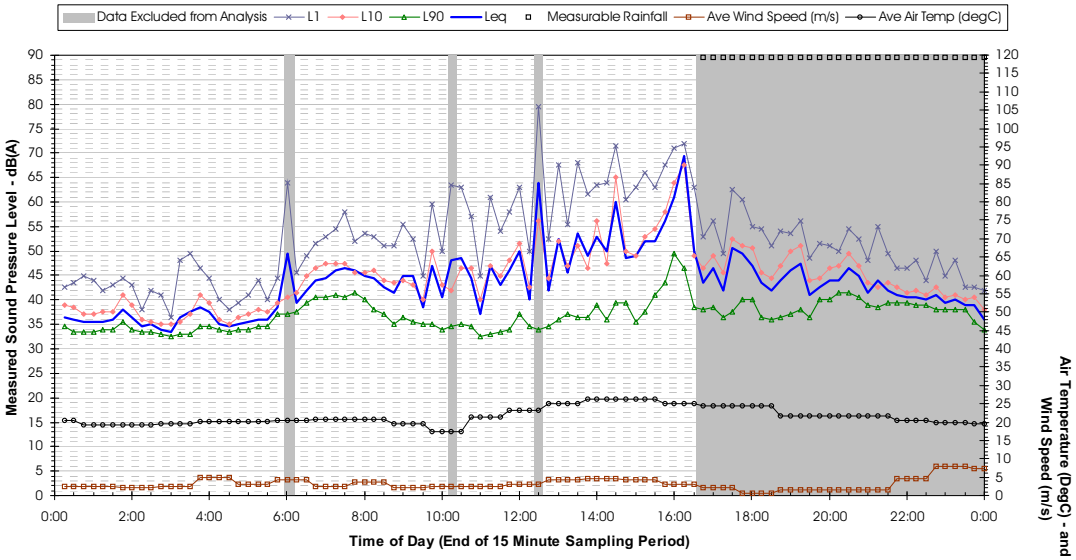
Profile of Noise Environment - Wyndarra Way, Koonawarra
Tuesday 6 March 2007



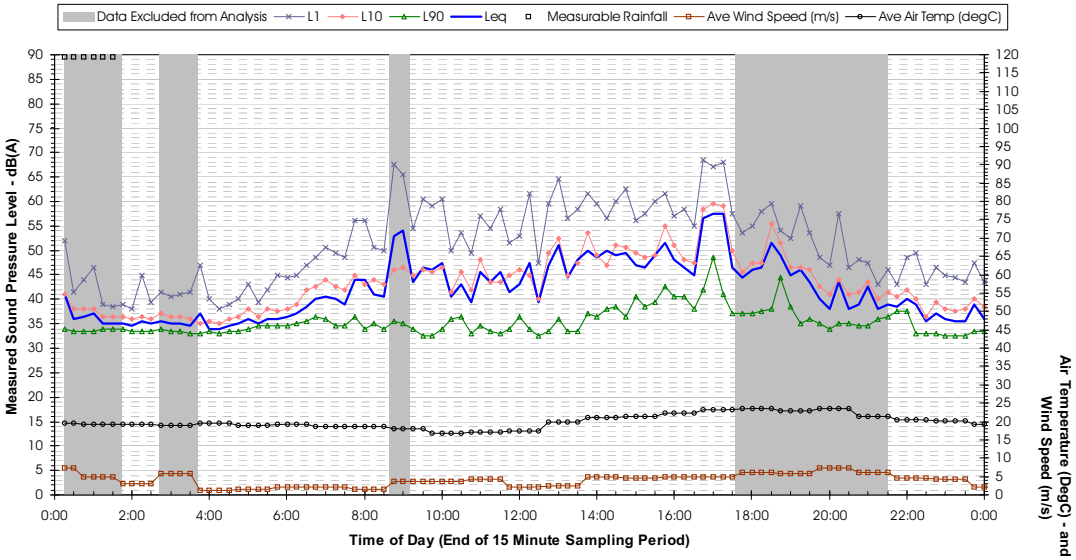
Profile of Noise Environment - Wyndarra Way, Koonawarra
Wednesday 7 March 2007



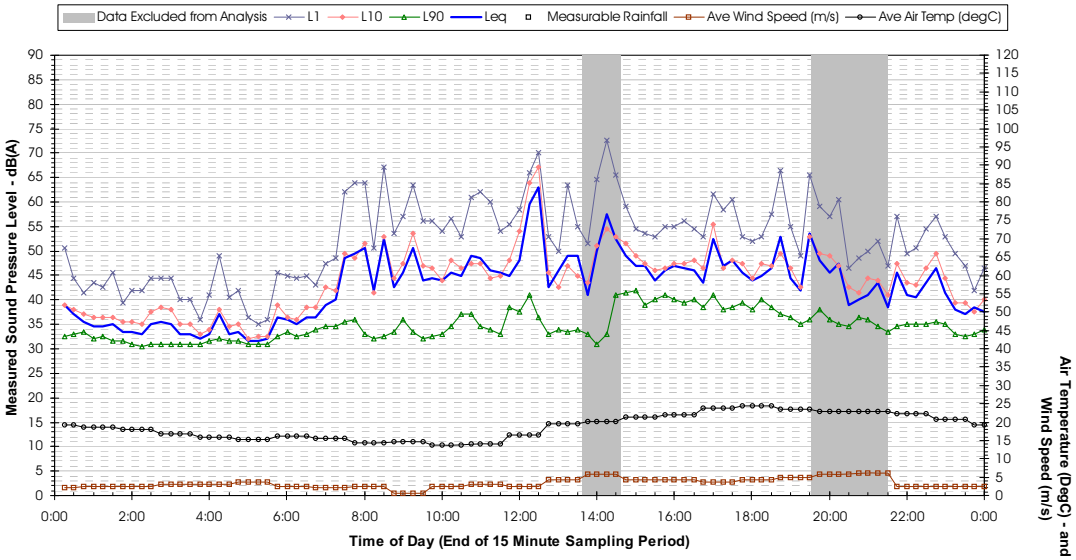
Profile of Noise Environment - Wyndarra Way, Koonawarra
Thursday 8 March 2007



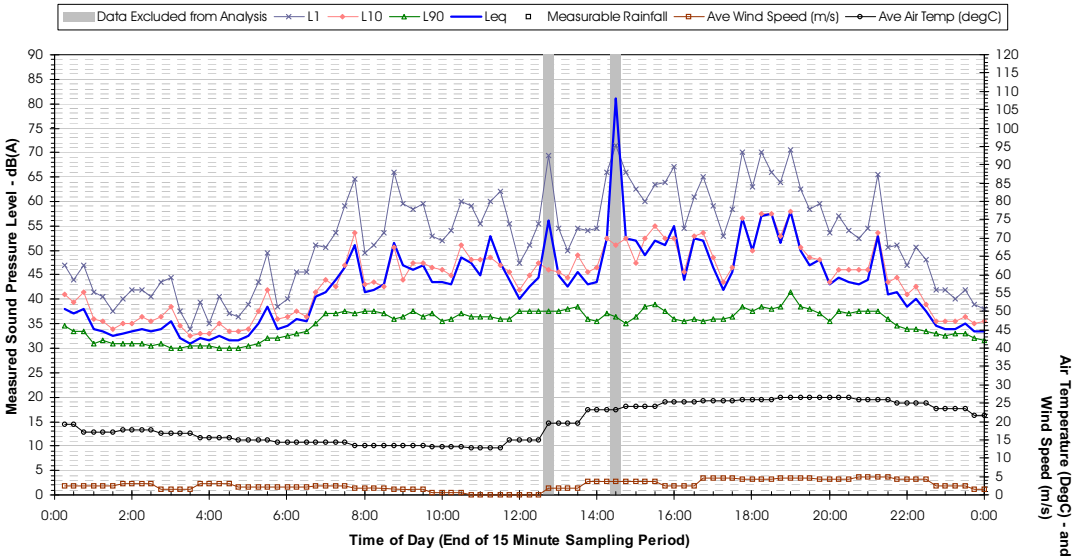
Profile of Noise Environment - Wyndarra Way, Koonawarra
Friday 9 March 2007



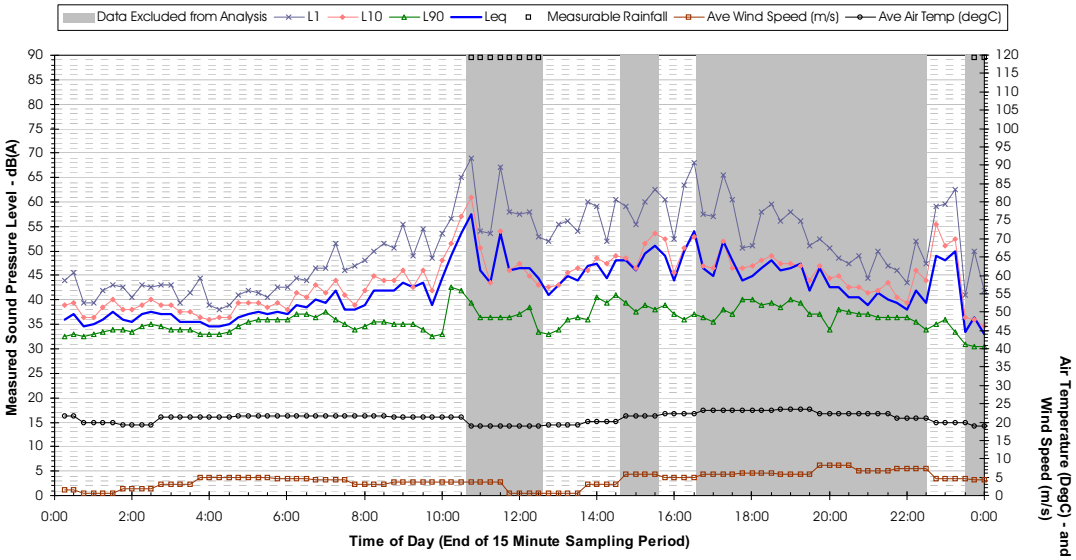
Profile of Noise Environment - Wyndarra Way, Koonawarra
Saturday 10 March 2007



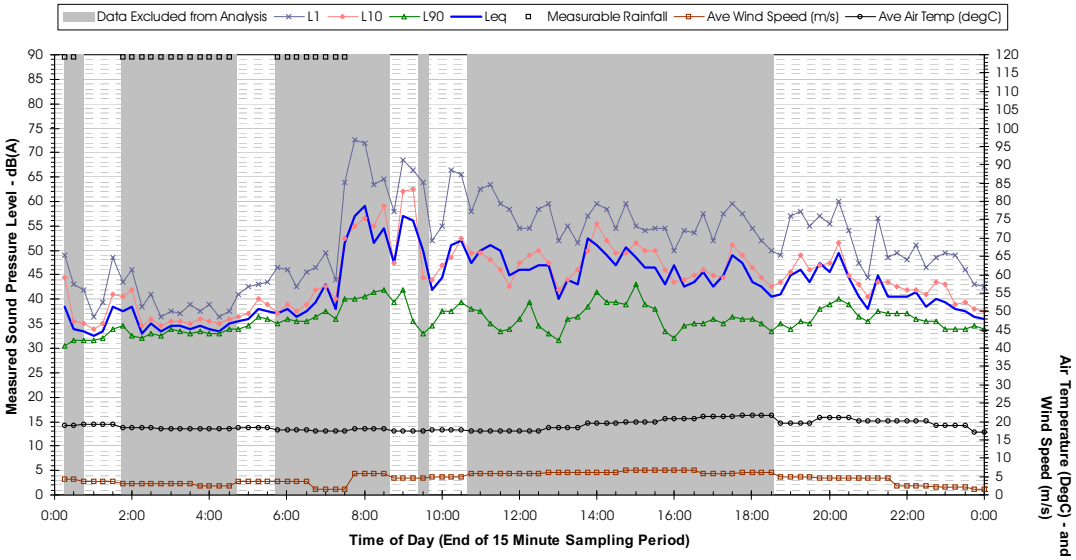
Profile of Noise Environment - Wyndarra Way, Koonawarra
Sunday 11 March 2007



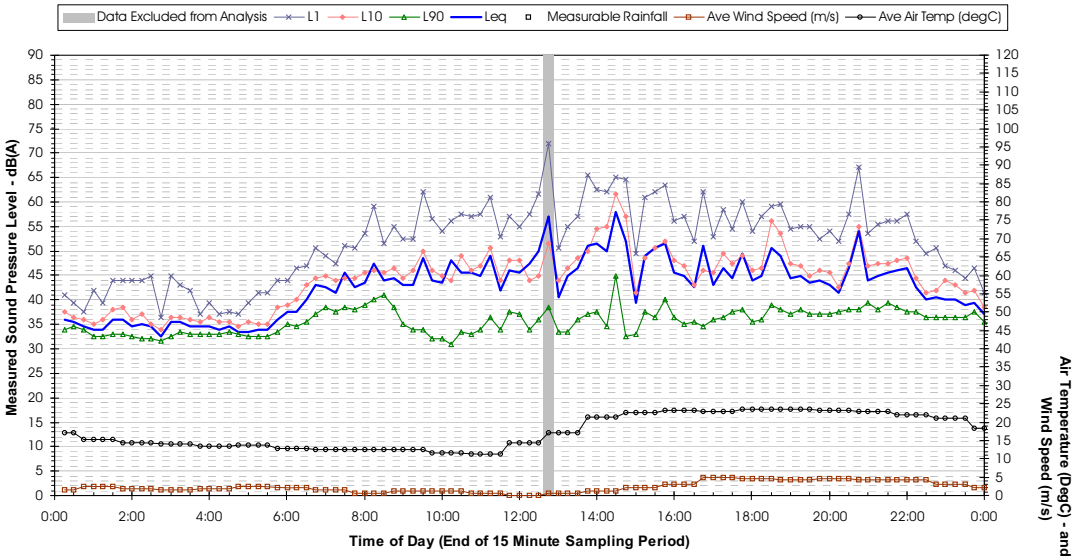
Profile of Noise Environment - Wyndarra Way, Koonawarra
Monday 12 March 2007



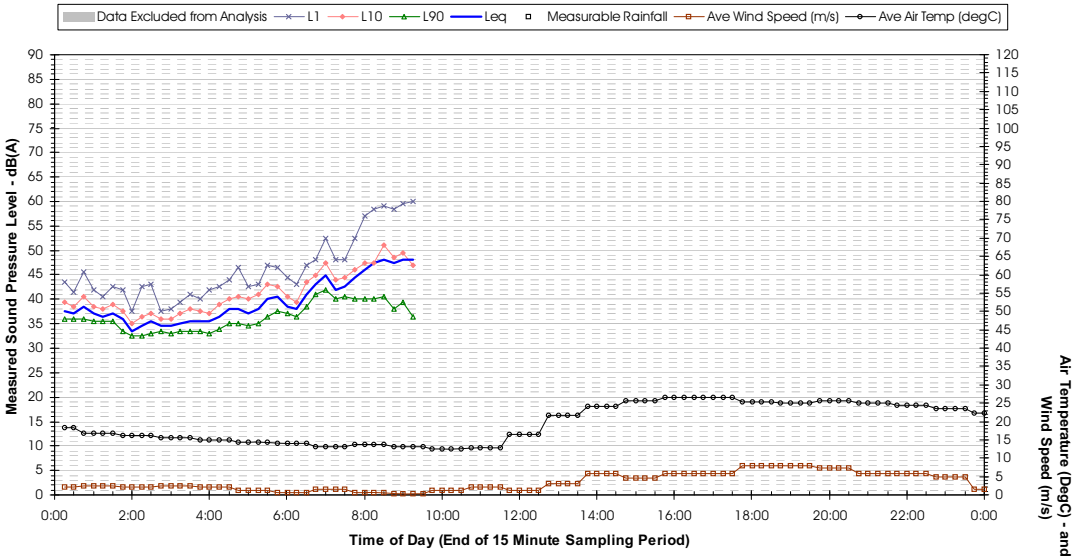
Profile of Noise Environment - Wyndarra Way, Koonawarra
Tuesday 13 March 2007



Profile of Noise Environment - Wyndarra Way, Koonawarra
Wednesday 14 March 2007

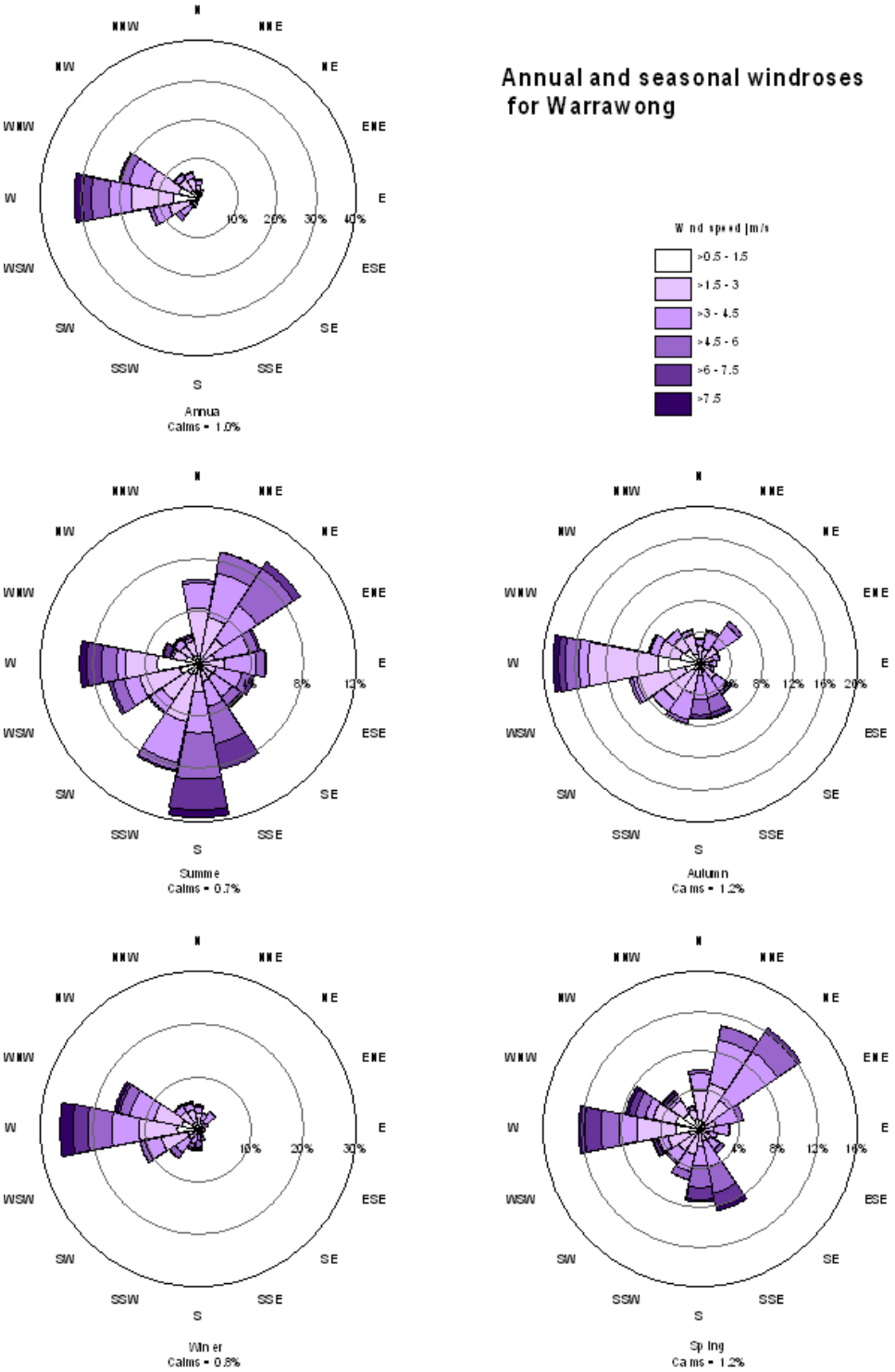


Profile of Noise Environment - Wyndarra Way, Koonawarra
Thursday 15 March 2007



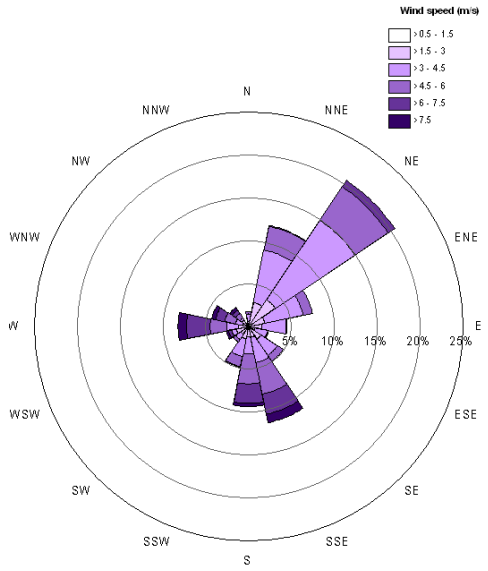
Appendix B Meteorological data

Annual and Seasonal – All Hours



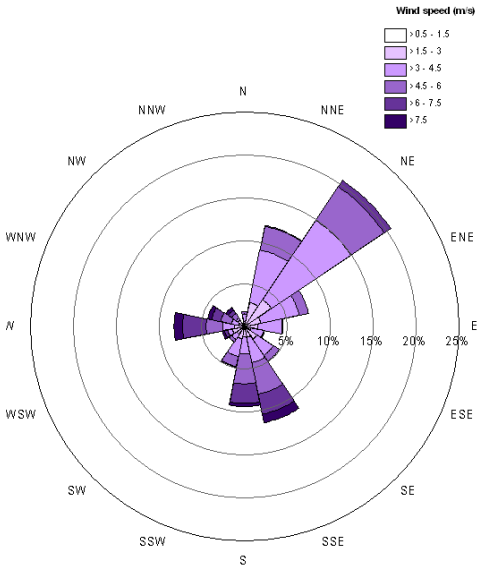
Seasonal Daytime – 7am – 6pm

Spring



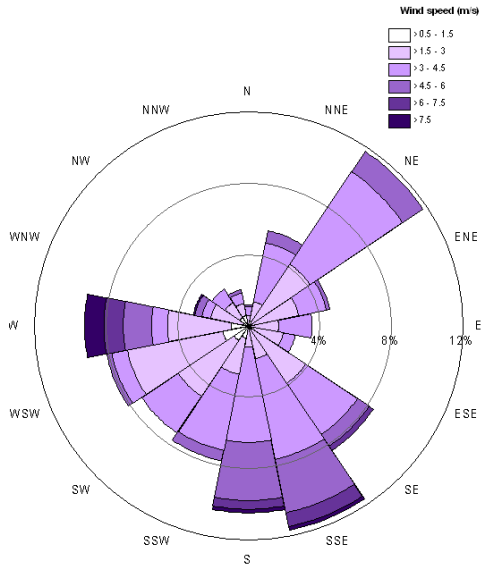
Calms = 0.3%

Summer



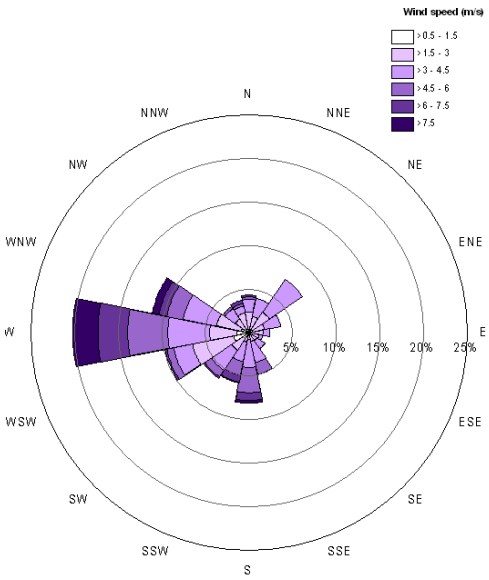
Calms = 0.3%

Autumn



Calms = 0.3%

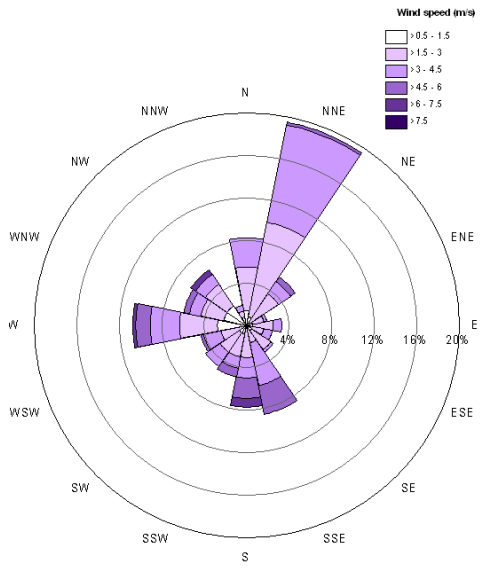
Winter



Calms = 0.5%

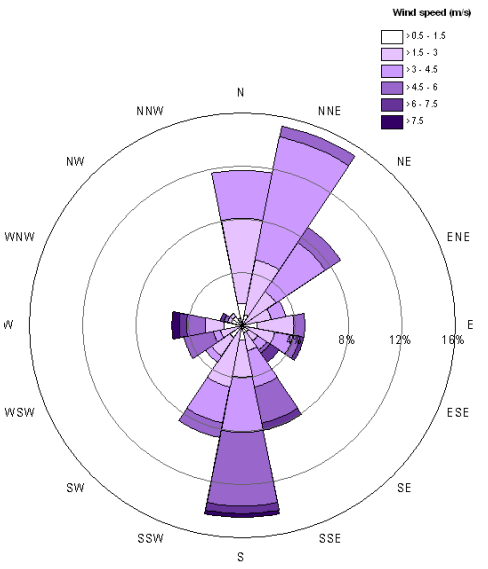
Seasonal Evening – 6pm – 10pm

Spring



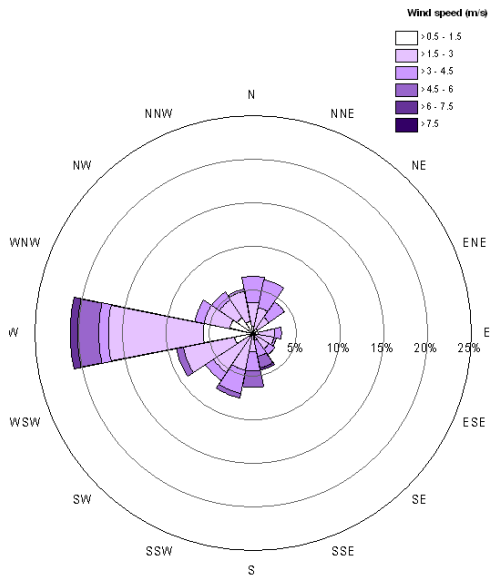
Calms = 0.8%

Summer



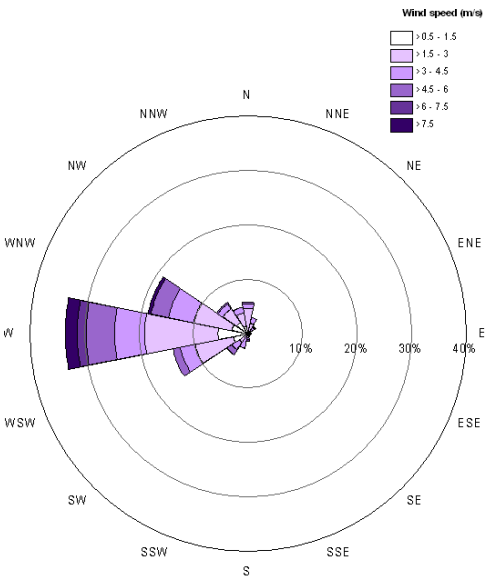
Calms = 0.6%

Autumn



Calms = 1.1%

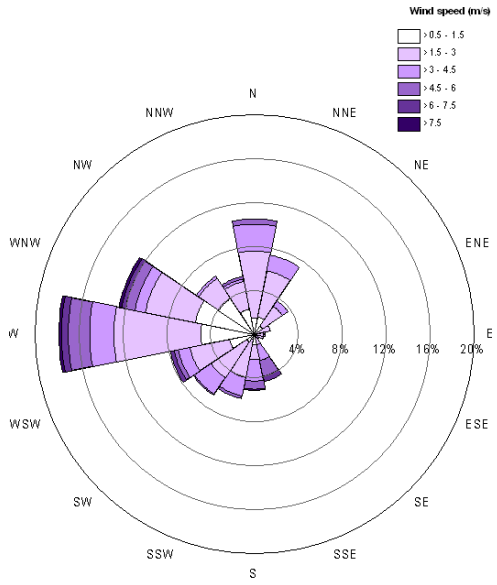
Winter



Calms = 0.5%

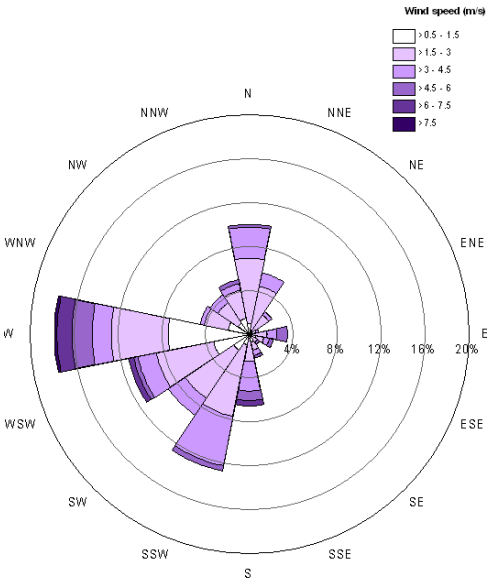
Seasonal Night Time – 10pm – 7am

Spring



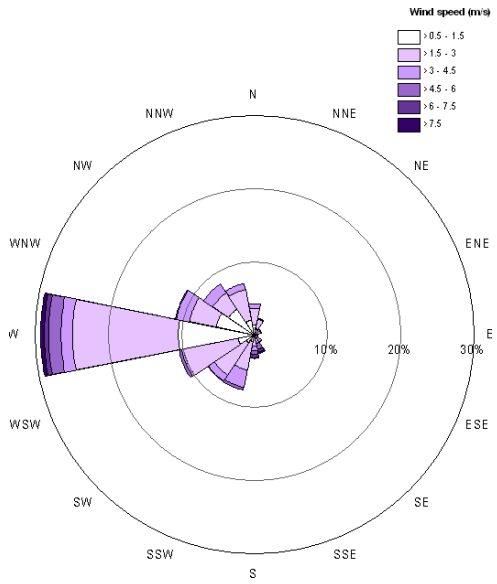
Calms = 2.6%

Summer



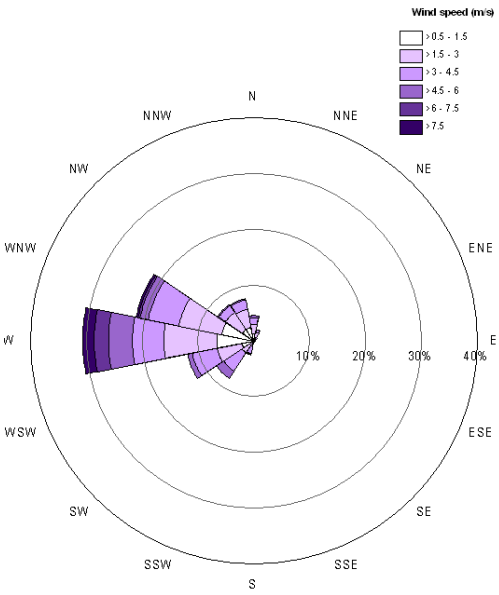
Calms = 0.9%

Autumn



Calms = 2.3%

Winter



Calms = 1.2%

Stability Class by Hour of Day (Winter 6pm-6am)

Hour	Stability Class					
	A	B	C	D	E	F
1	0	0	0	43	12	36
2	0	0	0	40	18	33
3	0	0	0	38	19	34
4	0	0	0	41	17	33
5	0	0	0	41	16	34
6	0	0	0	39	14	38
19	0	0	0	38	17	36
20	0	0	0	36	18	37
21	0	0	0	35	19	37
22	0	0	0	41	19	31
23	0	0	0	49	11	31
24	0	0	0	43	14	34