Report No 02053
Version I

PORT BOTANY CONTAINER TERMINAL EXPANSION

NOISE ASSESSMENT

JUNE 2003

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June 2003

Prepared for

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EXECUTIVE SUMMARY

Wilkinson Murray Pty Limited have conducted an assessment of noise from a proposed expansion of the container terminal facilities at Port Botany. The assessment was conducted with due consideration of the *"NSW Industrial Noise Policy"*, the *"Environmental Criteria for Road Traffic Noise"*, *"Environmental Noise Control Manual"*, the *"City of Botany Bay Noise Policy"* and the Director General's requirements.

The noise level predictions were conducted using the ENM Environmental Noise Model and the UK Department of Transport's Calculation of Road Traffic Noise.

Based on measurements of existing container terminal operations and estimates of a 90^{th} percentile activity level for the proposed terminal, noise levels were predicted at residential and non residential receivers predominantly to the north of the site. It is concluded that, incorporating a 4m high noise barrier along the northern edge of the proposed terminal combined with noise controls to individual machines proposed for the new container terminal, predicted noise levels at certain locations to the north of the terminal would be up to 5dBA above EPA *INP* night time noise criteria during certain meteorological conditions. These noise levels however, when combined with future noise of existing operations would be below existing ambient levels of noise due to traffic in these areas and would increase existing industrial noise levels by 1dBA, an increase which is imperceptible to the human ear.

Besides the noise controls mentioned above to mitigate the predicted impacts it is recommended that a Noise Management Plan outlining Environmental Management procedures to assess and reduce noise levels (where possible) be developed for the operation of the proposal. This Noise Management Plan would include:

- Options for equipment alarm operation
- Machinery noise control
- Operator awareness and training
- Complaints handling and
- Noise monitoring.

Noise levels from potential increases in truck movements due to the proposed expansion of the Port Botany container terminal are small and would comply with EPA Traffic Noise Criteria. In addition, the contribution to overall noise levels from all port traffic at future capacity would comply with EPA traffic noise criteria and would be up to 2dBA in some night time hours.

A Port Traffic Noise Management Plan should be produced which considers noise reduction options such as:

- Re routing of trucks
- Traffic clustering
- Truck movement rescheduling.

During construction, relatively high noise levels will be generated on the site during certain phases of the work. Although dredging would occur on a 24 hour basis, it is anticipated that noise levels from this operation will not exceed the night time noise criteria. During daytime, some of the noisier activities will generate noise levels which will exceed the appropriate noise criteria at the nearby residences. However, given the distance from the proposed construction activities to the nearest residences, noise levels from construction will be less than those which often occur for major construction projects in metropolitan areas.

It is recommended that a Construction Noise Management Plan be developed at the time of construction Tender. This Plan would investigate quiet construction methods, noise controls to machines, operator awareness programs, programming to reduce noise impact, complaints handling, and monitoring requirements.

1. INTRODUCTION

Wilkinson Murray were commissioned to conduct a noise and vibration assessment of a proposed expansion of the container terminal facilities at Port Botany. This report presents the results of that assessment.

The assessment has been conducted with due consideration of the NSW EPA *Industrial Noise Policy (INP)* and *Environmental Criteria for Road Traffic Noise (ECRTN)*, *Environmental Noise Control Manual (ENCM)*, the *City of Botany Bay Noise Policy* and the Director General's Requirements.

2. SITE DESCRIPTION AND PROPOSAL

2.1 Operations

The existing Patrick container terminal is situated on the southern side of Foreshore Road, Botany Road, Banksmeadow and north of Brotherson Dock. The P & O Ports container terminal is situated on the southern side of Brotherson Dock

It is proposed to construct the additional terminal facilities on the western side of the existing Patrick terminal extending northward towards Foreshore Road as shown in Figure 1A. It is proposed that road trucks would enter and depart via Foreshore Road across a bridge constructed between the terminal and Foreshore Road.

A new rail link will be constructed to enter the site from the north. This will be achieved by a rail line which approaches from the existing lines to the northeast of the existing Patrick container terminal and runs parallel to Foreshore Road and onto the eastern side of the proposed expansion.

The rail line will be at grade except where it crosses Springvale Drain, Floodvale Drain and the channel between the new terminal and Foreshore Beach. In these areas concrete bridges or culverts would be constructed.

It is proposed that the new terminal will operate 24 hours per day. The expansion will comprise ten new quay cranes, eight on the western side of the site and two on the southern side of the new terminal. Seven new rail mounted gantries will be situated on the eastern side of the site adjacent to the proposed rail siding. These cranes and gantries will be serviced by forty new straddle carriers and four reach stackers which will operate between them. The truck queuing area will be situated at the northern edge of the site.

Table 2-1 provides a summary of equipment proposed for the site.

Table 2-1 Summary of Additional Equipment

Equipment	Total
Straddle Carriers	40
Rail Mounted Gantries	7
Quay Cranes	10
Reach Stackers	4

Note: This equipment is estimated by SPC for modelling purposes.
Actual equipment selection will be determined by the terminal operator.

The proposed site layout is shown in Figure 1A.

It is forecast that at capacity on an average day there will be 1,882 two-way truck trips generated by 941 trucks. These trucks would enter and leave on a 24 hour basis but will generally be concentrated during daytime as shown in Table 2-2.

Table 2-2 Hourly Truck Flows for New Terminal, At Capacity

Hour	Truck Trips (Two-Way)
0100	38
0200	38
0300	38
0400	38
0500	76
0600	94
0700	113
0800	189
0900	132
1000	132
1100	113
1200	94
1300	94
1400	94
1500	94
1600	94
1700	94
1800	56

Hour	Truck Trips (Two-Way)
1900	56
2000	56
2100	38
2200	38
2300	38
2400-0100	38
All day	1882

Note: Hourly figures are averages rounded to a whole number.
The sum of the average hourly figures may not match the total exactly.

It is also forecast that at capacity an average of 18 trains per day would enter the proposed new terminal. The average hourly distribution of trains is given below in Table 2-3.

Table 2-3 Hourly Rail Flows for New Terminal, At Capacity

Hour	Rail Trips (Two-Way)
0100	2
0200	2
0300	2
0400	2
0500	2
0600	2
0700	2
0800	2
0900	2
1000	2
1100	1
1200	1
1300	1
1400	1
1500	1
1600	1
1700	2
1800	2
1900	2
2000	2

Hour	Rail Trips (Two-Way)
2100	2
2200	1
2300	1
2400	1
All day	36

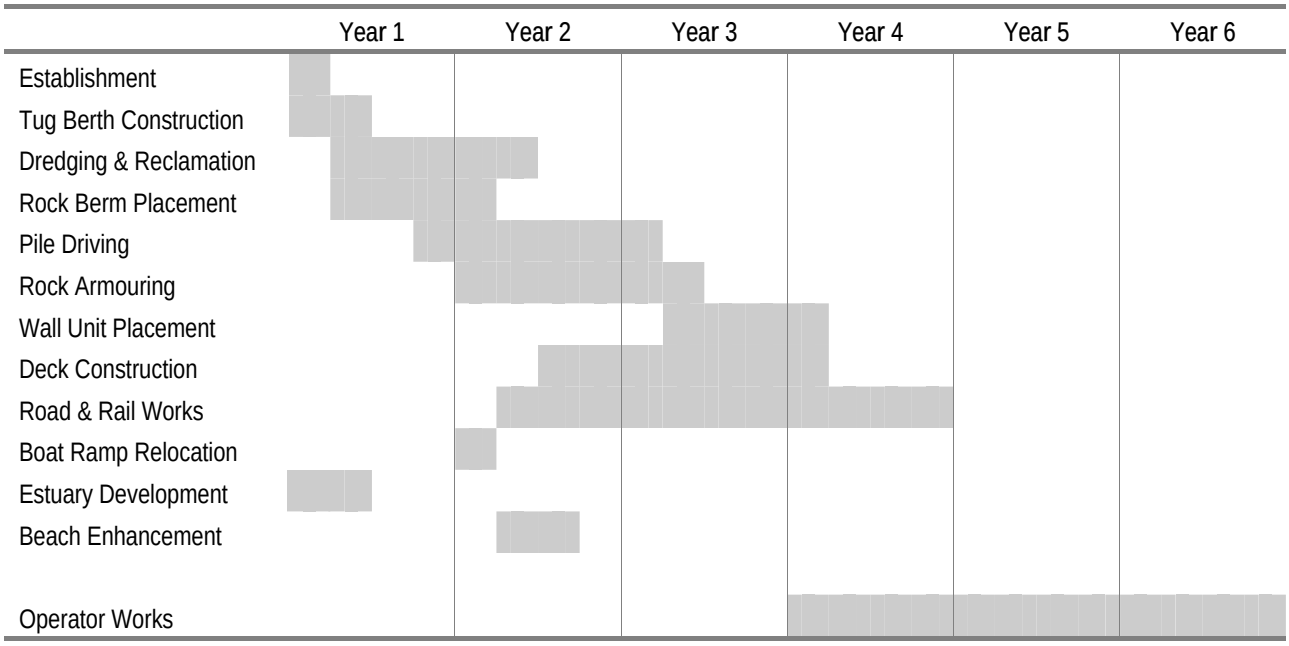
Note: Hourly figures are averages rounded to a whole number.
The average daily total is 36 train movements.
The sum of the average hourly figures may not match the total exactly.

2.2 Construction Schedule

There are a number of methods that could be employed to construct the proposed expansion of the Port Botany facilities. The method ultimately selected would be determined through a competitive tendering process and would be governed by circumstances prevailing at the time. A rock embankment and piled wharf structure has been assumed for the purposes of noise assessment.

Staging and duration of the principal construction activities are summarised below in Table 2-4.

Table 2-4 Construction Schedule



It can be seen from this Table that it would take at least six years to complete the construction and to bring the first berth at the new terminal into operation. The existing facilities at Port Botany would continue operations throughout construction of the new terminal.

A more detailed construction program for the proposed works is provided in construction methodology described in the Environmental Impact Statement. The basic activities which will be involved are:

- underwater works, including dredging, underwater bund construction and infilling behind the retaining wall with dredged material; and

- above water works, including:
  - surface trimming, site compaction pre-loading and temporary sealing / stabilisation works;

  - construction of marine structures and each berth, including pile driving, construction of a hard rock berm, placement of retaining wall, infilling behind retaining wall above water level, rear rail crane beam, ship fendering and mooring units and tug berth wharf/quay face;

  - construction of terminal facilities such as Administration building;

  - construction of rail line and road and rail bridge;

  - construction of beach, and recreational facilities to the north west and Penrhyn Estuary enhancement. This will involve some construction works (mainly sand and sediment relocation) to create habitat.

Noise level predictions have been conducted based on the likely construction plant given in Table 2-5 below:

Table 2-5 Proposed Construction Plant

Phase of Works	Equipment List	Number	Activity
Dredging & Reclamation – construction of embankment	Trucks	100 / day	Delivery of rock bund material and piles
	Front End Loader	2	Loading of rock bund materials onto shuttle barge
	Cutter-suction Dredge Rig	1	Dredging
	Bobcat / Front End Loader	2	Moving rock bund materials into chute on fixed barges
	Tugs	4	Towing rock transport barges
	Barges	4	Rock transport
	Hopper Barges	2	Placing bund material
	Work Boats	2	Servicing dredging operation and general duties
Dredging & Reclamation – Site trimming and stabilisation	Dozer	1-2	Level finished (bulk fill) surface
	Water Truck	1	Aid in compaction and also for dust control
	Grader	1	Level finished (bulk fill) surface
	Rollers (Sheepsfoot & Steel Drum)	1-2	Compaction / Completion of finished surface
	Excavator	1-2	Trenching, trimming of embankments and placing temporary armour
Dredging & Reclamation - preloading	Scraper	6	Profile finished surface
	Water Truck	1	Aid in compaction and also for dust control
	Grader	1	Levelling finished surface
	Dozer / Compactor	1	Level finished surface and compaction
	Roller (Sheepsfoot)	1	Compaction / Completion of finished surface
Wharf Construction	Trucks	Up to 60 / day	Delivery of piles and hardrock berm material
	Piling Rig / Diesel Hammers	2-3	Install steel piles
	Large Crane	1-2	Placement of precast units during wharf construction
	Dozer	1-2	Moving stockpiled sand to fill behind precast retaining wall
	Grader	1	Level finished infilling area behind retaining wall
	Roller (vibratory)	1-2	Compaction / Completion of finished surface
	Road making equipment –		Temporary Sealing
	Bitumen Spray Truck	1	
	Rollers	2	
	Trucks	3	
	Concrete trucks	20 / day	Construction of wharf, bridges, drainage works, buildings etc
	Barges	3-4	Pile transport and driving
	Mobile Crane	1-2	Moving piles and pile sections for joining

Phase of Works	Equipment List	Number	Activity
Beach, Recreational Area and Penrhyn Estuary Enhancement	Trucks	Up to 30 / day	Delivery of hard rock for revetment and boat ramp, and later for extra beach sand and material as required
	Excavator	1	Placing and forming of rock revetment
	Dozer	1	Landscaping and spreading material for beach and estuary enhancement
	Front End Loader	1	Landscaping and spreading material for beach and estuary enhancement
	Dozer / Compactor	1	Profile finished beach area
Terminal Facilities	Trucks	80 / day	Delivery of construction materials
	Heavy Compacting Roller	2	Initial compaction of sub-grade
	Roller (Sheepsfoot)	2	Compaction of sub-grade/base/sub-base materials
	Dozer	2	Grading, profiling and spreading cement
	Asphalt Paving Machine	2	Levelling surface of asphalt
	Bitumen Spray Truck	1	Spraying asphalt over surface
	Roller (Steel Drum)	2	Compaction / Completion of finished surface
	Grader	1	Levelling surface
	Water Truck	1	Dust control
	Excavator	1-2	Excavation to install building foundations
	Backhoe	1	Excavation to install services, fencing and lighting
	Crane	1	Erecting lights, building assemblage and terminal equipment
	Concrete Truck	5 / day	Pouring of concrete for building foundations
Delivery of Terminal Facilities	Crane Transport Vessel	1	Delivery of fully assembled quay cranes
	Large Trucks	5	Delivery of partially assembled RMG sections
	Mobile Cranes	1	Erection of RMGs
	Transport Vessel	1	Delivery of Straddle Carriers/RTGs

2.3 Construction Hours

Construction activities, including deliveries on-site would generally be restricted to daylight hours (7.00am - 6.00pm), 6 days a week. Dredging works would continue 24 hours, 7 days a week. Some activities e.g. works on Foreshore Road and rail extensions may occur occasionally outside these times to minimise disruption to external users.

3. NOISE MEASUREMENTS

Measurements of noise from existing Port Botany container terminal and ambient noise levels have been conducted.

Ambient noise measurements have been conducted at the nearest potentially affected residential receivers which are situated on Chelmsford Avenue, Dent Street, Botany Road Banksmeadow, Australia Avenue to the north and Jennings Street to the east. The purpose of these noise measurements was to determine the background noise on which EPA noise criteria, as given in the *NSW Industrial Noise Policy (INP)*, are based and to determine the existing industrial noise levels.

Predicted noise levels have been compared with this policy.

3.1 Background Noise Levels

Ambient noise levels have been measured at the following locations which will potentially be affected by port noise as shown in Figure 1B:

- Location 1 Chelmsford Avenue - eastern edge of disused bowling green
- Location 2 34 Dent Street - rear boundary fence
- Location 3 42 Jennings Street - centre of rear lawn
- Location 4 The northern boundary of Botany Golf Course
- Location 5 74 Australia Avenue - centre of front lawn
- Location 6 Eastern Suburbs Crematorium Military Road - Northwestern boundary

Measurements were also carried out at other locations potentially affected by port transportation in order to ascertain existing levels of traffic noise on these roads. These were used in setting noise criteria for truck movements to and from the container terminal.

- Location 7 36 Beauchamp Road - garden in front of house
- Location 8 1424 Botany Road - edge of verandah
- Location 9 44 Denison Street - lawn in front of house

In accordance with the Director General's Requirements, these locations were selected to be representative of the most noise affected location in each area as defined by Section 3.1.2 of the NSW *INP*. They were chosen to represent areas closest to or unshielded from the proposed new container terminal and with the lowest background levels such that they represent the areas where the noise levels from the proposed port expansion would have the greatest impact.

These measurements were carried out between 11 April 2002 and 26 April 2002. The noise monitoring equipment used for these measurements consisted of environmental noise loggers set to A weighted, fast response continuously monitoring over 15 minute sampling periods. The 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 occurred.

A glossary of acoustic terminology is shown in Appendix A.

The results of ambient monitoring are shown in Appendix B.

EPA noise criteria are based on the Rating Background Noise Level (RBL). The Rating Background Level has been determined in accordance with the Environment Protection Authority *NSW Industrial Noise Policy (INP)* (wind and rain affected data have been excluded). (See Appendix A for a description of RBL).

The RBL values for each of the time periods (Day/Evening/Night) defined in the *INP* are given in Table 3-1 below.

Table 3-1 Rating Background L_{A90} Level

Time Period	Rating Background L_{A90} Levels (dBA)			Dominant Noise Sources
	Daytime * (7.00am – 6.00pm)	Evening (6.00pm – 10.00pm)	Night Time (10.00pm – 7.00am)	
Location 1 Chelmsford Avenue	49	45	36	Traffic
Location 2 Dent Street	47	43	36	Traffic
Location 3 Jennings Street	40	39	40	Traffic/Industrial
Location 4 North of Golf Course	57	50	43	Traffic
Location 5 Australia Avenue	42	40	42	Industrial
Location 6 Military Road	46	46	45	Industrial/Traffic
Location 7 36 Beauchamp Road	50	43	42	Traffic
Location 81424 Botany Road	56	45	37	Traffic
Location 9 44 Denison Street	52	50	47	Traffic

* These values are based on less data than required by the *INP* for the assessment of background noise levels due to weather exclusions. The approach used here is to make use of all valid data, since insufficient data were available to derive background noise levels in accordance with the policy.

Individual Assessment Background Level (ABL) values for each day are shown in Appendix C.

The amenity criteria, to be discussed in the next section, are based on the ambient L_{Aeq} levels. The measured ambient L_{Aeq} levels are given in Table 3-2 below.

Table 3-2 Ambient L_{Aeq} Level

Time Period	Ambient L_{Aeq} Levels (dBA)		
	Daytime (7.00am – 6.00pm)	Evening (6.00pm – 10.00pm)	Night Time (10.00pm – 7.00am)
Location 1 Chelmsford Avenue	57	55	51
Location 2 Dent Street	61	58	57
Location 3 Jennings Street	53	48	51
Location 4 North of Golf Course	63	60	58
Location 5 Australia Avenue	59	53	49
Location 6 Military Road	65	57	58
Location 7 36 Beauchamp Road	65	62	59
Location 8 1424 Botany Road	70	65	64
Location 9 44 Denison Street	69	65	62

3.2 Existing Container Terminal Noise

Attended noise measurements of existing container terminal activities were conducted on the night / morning of 23/24 April 2002 by an experienced Wilkinson Murray acoustical engineer. During this period two ships were being unloaded by four quay cranes and attendant straddle carriers. Measurements were conducted at each of the long term monitoring locations and also on Foreshore Road and at the Boat Ramp.

These measurements were conducted using a Bruel & Kjaer Type 2231 Integrating Sound Level Meter. The calibration was checked immediately prior to and subsequent to the survey and no significant drift occurred. Measurements were conducted in terms of the same parameters as used for long term unattended monitoring.

While the statistical noise measurement parameters across each 15 minute measurement period were recorded by the meter, the instantaneous sound pressure level for individual noise events heard on site were noted, as shown in Table 3-3. These can be considered equivalent to L_{A1} levels for these noise events and are relevant to the sleep disturbance assessment discussed in Section 5.3.

The results of the attended monitoring are shown in Table 3-3.

Table 3-3 Attended Noise Measurements

Location	Time	Overall Noise Environment (dBA)				Comments on Noise Sources**
		L_{Aeq}	L_{A90}	L_{A10}	L_{A1}	
1 Chelmsford Avenue	11.45	47	40	50	56	Traffic on Botany Road and Foreshore Road, Trucks on Foreshore Road 41 to 50dBA, Insects, Turbo Prop take off from Kingsford Smith 57. PA system or CB radio from the west, Port inaudible.
2 Dent Street	12.10	48	42	50	53	Traffic on Foreshore Road, Beepers and siren audible from container terminal. Aircraft 46, Traffic 51,52,49, Alarm and metallic boom (low frequency impact noise) audible from container terminal- neither measurable, aircraft 54dBA, boom, trucks, boom, alarm.
3 Jennings Street	12.40	44	43	45	48	Steady 43 to 44 from engine hum and beepers from the Port, Container bangs 45, 45, 49, crash 51, crane winching 44, aircraft 44, Beepers and alarms clearly audible but don't raise the overall level.
3a Solander Street*	00.55	44	42	44	53	Steady 43 from engines and beepers from Port, some contribution from fan on nearby factory, bang 45, beepers 44, horn 45, alarms, bang 45, car 52, after 10 mins steady 42, bang 49 train horn 54.
4 Golf Course	01.35	51	42	55	59	Trucks 57,60, Bang 44, Cars 46, 50 truck on foreshore 54, car47, Background dropped to 38dBA. Port was inaudible.
5 Australia Avenue	01.15	49	47	50	56	Steady 48 from Port, bangs 50, alarm 49, 50, bang 56, alarm 49, 51, 54,55,57,53,59,65 alarm 49, bangs 62,51,56,60,57

Notes: *Near Jennings Street
**All noise sources described in dBA

During the survey weather conditions were cool cloudless and very still.

At some of the monitoring locations noise levels from sources other than the existing container terminal dominated the noise environment. At these locations it is therefore difficult to estimate the L_{Aeq} level due to the existing container terminal.

To the extent possible these measurements of port noise were used to calibrate the noise prediction model to allow a prediction of the existing noise levels. This was done by setting the model conditions to those found on site during the survey and predicting noise levels at the measurement locations. These predicted noise levels were then compared to the measured noise levels (see Section 5.2.1 for discussion of model calibration).

4. NOISE AND VIBRATION CRITERIA

The EPA provide noise criteria for both operational noise and construction noise. These are discussed below.

4.1 Operational Noise Criteria for Residences

The EPA in its *Industrial Noise Policy (INP)* sets two noise criteria with the intent to control noise emissions from premises. These are Intrusiveness Criteria and the Amenity Criteria.

4.1.1 *INP* Intrusiveness Criteria

Firstly to avoid annoyance from intrusive noise, the L_{Aeq} at the nearest residential boundary should not exceed the rating background L_{A90} level (Table 3-1) by more than 5dBA. Table 4-1 shows Level L_{Aeq} intrusiveness noise criteria for the proposed development which are derived by adding 5dBA to the rating background L_{A90} levels in Table 3-1.

Table 4-1 EPA Intrusiveness Criteria

Time Period	Intrusiveness Criteria $L_{Aeq,15minute}$ Levels (dBA)		
	Daytime (7.00am – 6.00pm)	Evening (6.00pm – 10.00pm)	Night Time (10.00pm – 7.00am)
Location 1 Chelmsford Avenue	54	50	41
Location 2 Dent Street	52	48	41
Location 3 Jennings Street	45	44	45
Location 4 North of Golf Course	62	55	48
Location 5 Australia Avenue	47	45	47
Location 6 Military Road	51	51	50

4.1.2 *INP* Amenity Criteria

The second aim of the EPA noise policy is to protect amenity. The total industrial ambient noise level should not creep above the planning levels in the EPA *INP*. The recommended L_{Aeq} noise levels for residential properties in a suburban area are:

- $L_{Aeq,11hour}$ 55dBA during daytime (7.00am – 6.00pm)
- $L_{Aeq,4hour}$ 45dBA during evening (6.00pm – 10.00pm)
- $L_{Aeq,9hour}$ 40dBA during night time (10.00pm – 7.00am)

The recommended L_{Aeq} noise levels for residential properties in an urban area are:

- $L_{Aeq,11hour}$ 60dBA during daytime (7.00am – 6.00pm)
- $L_{Aeq,4hour}$ 50dBA during evening (6.00pm – 10.00pm)
- $L_{Aeq,9hour}$ 45dBA during night time (10.00pm – 7.00am)

In this instance residential areas to the west of the golf club are considered suburban while houses close to the golf club and those to the east of Beauchamp Road are considered to be urban based on the definitions contained in the *INP*. This distinction is made because those areas to the west of Beauchamp Road are generally not affected by industrial noise, but are affected by relatively distant road traffic noise. In contrast, those areas to the east of Beauchamp Road are significantly affected by noise from the existing port operations and other heavy industry.

The aim of the amenity criteria is to ensure that overall levels of industrial noise do not creep above these recommended levels. When the existing levels of industrial noise are above the recommended L_{Aeq} levels, the *INP* achieves this by setting the amenity criteria for a new development at 10dBA below these existing levels. This is the case which exists near the port, particularly east of Beauchamp Road.

When a new industrial noise source of a level 10dBA below the existing level is added to the existing noise environment a noise level increase of 0.4dBA is the result. The aim of this is to restrict any noise level increase to that which is imperceptible to the human ear. A noise level increase of 2dBA is considered barely perceptible.

In instances where existing levels of transportation are the dominant noise source and transportation noise exceeds the recommended L_{Aeq} levels by more than 10dBA and future levels of traffic noise are not likely to reduce then the acceptable noise level (ANL) becomes the existing traffic noise level minus 10dBA. This criterion applies to all industrial noise. The project specific criterion is then derived from using Table 2.2 of the *INP* such that when the new noise source is added to the existing industrial noise the overall industrial noise level does not exceed the Acceptable Noise Level.

4.1.3 Council Minimum Acoustical Requirements

The City of Botany Bay has published *Minimum Acoustical Requirements for New Developments* in November 2000. This document requires use of the *INP* for the assessment of noise associated with such developments. This document therefore adds no requirements other than those discussed in Sections 4.1.1 and 4.1.2 above.

4.1.4 Council Standard Noise Criteria

The City of Botany Bay has also published *Standard Noise Criteria* on 23 May 2001. For residential receivers, the noise criteria, applying to the L_{Aeq} level, are:

- Background noise level +5dBA
- 40dBA at night time (10.00pm – 7.00am)

These criteria are no more stringent than the *INP* recommended noise levels discussed in Sections 4.1.1 and 4.1.2 above of 40dBA and 45dBA for suburban and urban areas respectively.

4.1.5 Overall L_{Aeq} Noise Criteria for Port Botany Expansion

The noise criteria at the locations around the proposed Port expansion have been determined in accordance with Section 4.1.1 and 4.1.2.

Since the port operations are expected to be carried out on a 24 hour basis, the most stringent criteria apply at night time. The night time criteria are shown in Table 4-2 below.

In all cases, the appropriate night time criteria are the amenity criteria and therefore they apply to the $L_{Aeq,9hr}$ measure for the night time period from 10.00pm to 7.00am. In the cases of Jennings Street, Golf Club, Australia Avenue and Military Road, the amenity criteria represent an amount below the existing industrial noise levels. In the case of the Golf Club, Australia Avenue and Military Road, the high traffic noise approach has been adopted in accordance with the *INP*. However, despite the fact that the traffic noise levels from Foreshore Road measured at Chelmsford Avenue and Dent Street were observed to be high, there are other houses in the area which are shielded to a greater degree from Foreshore Road. Accordingly, the high traffic noise approach was not used for these locations. At each location, the level of industrial noise was estimated by on-site noise measurement and observation allowing other noise sources to be visually filtered.

Table 4-2 Adopted Noise Criteria

Location	Level of Existing Industrial Noise	Amenity Criterion L_{Aeq} For the new development only
Location 1 – Chelmsford Avenue	Not Measurable	40dBA
Location 2 - Dent Street	Not Measurable	40dBA
Location 3 – Jennings Street	44dBA	39dBA
Location 4 - North of Golf Club	48dBA	40dBA
Location 5 – Australia Avenue	48dBA	38dBA
Location 6 - Military Road	48dBA	40dBA

It should be noted that these amenity criteria apply to the proposed expansion and not to the existing terminals. The criteria for the proposed new development at most locations are 10dBA below the existing level of industrial noise, such that, when noise levels from the expansion are added to existing noise levels, no increase in noise level occurs.

It can be seen from Tables 4-1 and 4-2 that the intrusiveness criteria, which relate to $L_{Aeq,15min}$ are in all cases at least 1dBA higher than the amenity criteria which relate to $L_{Aeq,period}$. The calculations presented later show that at night the predicted $L_{Aeq,15min}$ is only 0.7dBA higher than the predicted $L_{Aeq,9hr}$. Therefore the amenity criterion is more stringent at all locations. This becomes the project specific noise criterion at each location.

4.1.6 Sleep Disturbance Noise Criteria

Between 10.00pm and 7.00am sleep disturbance from individual transient noise events such as container impacts from the proposed expansion should be considered.

To avoid sleep disturbance from industrial operations the EPA recommends in its *Environmental Noise Control Manual (ENCM)* that the $L_{A1,1min}$ of the intruding noise should not exceed the background noise level by more than 15dBA. The $L_{A1,1min}$ represents the typical maximum noise level of transient events such as container impacts and horns etc.

As a result of a more recent review of the latest research into sleep disturbance, the EPA recognises that the current *ENCM* criterion is not ideal. Nevertheless, as there is insufficient evidence to conclude what should replace it, the EPA recommend that this approach be used as a guide. Where the criterion in the *ENCM* is likely to be exceeded, more detailed analysis is required. This analysis generally involves determining the extent to which the criterion is exceeded and how many noise events are likely to occur during each night.

Based on the measured background L_{A90} levels (Rating Background Level values in Table 3-1) the *ENCM* night time sleep disturbance criteria at the residential locations are given in Table 4-3.

Table 4-3 L_{A1} Sleep Disturbance Criteria

Time Period	L_{A1} Sleep Disturbance Criteria (dBA) Night time (10.00pm – 7.00am)
Location 1 - Chelmsford Avenue	51
Location 2 - Dent Street	51
Location 3 - Jennings Street	55
Location 4 - North of Golf Course	58
Location 5 - Australia Avenue	57
Location 6 - Military Road	60

It should be noted that some researchers (Greifahn 1992) presented in the NSW EPA *Environmental Criteria for Road Traffic Noise* (ECRTN) claim that internal noise levels of 50-55dBA (corresponding to external noise levels of 60 to 65dBA with windows open) are unlikely to cause awakening reactions. Research by Bullen (1996) also presented in the ECRTN however presents data which suggests that the probability of awakening reaction becomes 0% at internal noise levels of 45dBA (external 55dBA). The ECRTN cause-effect relationship for noisy events and awakening reactions in the home are not fully understood and more research is required. It is considered however, that the background +15dBA criteria given in Table 4-3 are conservative.

4.2 Operational Noise Criteria for Non Residential Receivers

The NSW *INP* also provides noise criteria for non residential noise sensitive receivers such as schools, churches and recreational areas. These criteria are reproduced in Table 4-4 below.

Table 4-4 Noise Criteria for Non Residential Noise Sensitive Receivers

Receiver	Acceptable L_{Aeq}
School Classroom (Internal)	35 (1) (2)
Places of Worship	40 (1)
Passive Recreation Area (National Parks)	50
Active Recreational Area (School Playground, Golf Course)	55

Notes:
(1) With windows open this corresponds to an external criterion 10dB higher.
(2) Where existing school classrooms are affected by existing industrial noise, the acceptable level may be increased to 40dBA.

4.3 Construction Noise Criteria for Residences

The EPA provides guidelines for the control of construction noise in the *Environmental Noise Control Manual (ENCM).* The EPA recognise people accept to a greater degree noise levels of a finite duration and known end date at a higher level than continuous noise. They therefore propose a trade off between duration and noise level and the usual EPA construction noise goals are as given below:

- For a construction period of four weeks or less the L_{A10} level measured over a period of not less than 15 minutes when the construction site is in operation shall not exceed the background level by more than 20dBA.

- For a construction period of greater than four weeks but less than 26 weeks the L_{A10} level measured over a period of not less than 15 minutes when the construction site is in operation shall not exceed the background level by more than 10dBA.

Construction periods of greater than 26 weeks are considered to be similar in nature to long term industrial noise. The noise criterion which apply in this case are that the L_{A10} levels measured over a period of not less than 15 minutes when the construction site is in operation shall not exceed the background levels by more than 5dBA. This is the case which applies to the proposed port construction where a lengthy construction process is anticipated.

Although the *ENCM* recommends that construction operations occur during daytime only, construction at night time is possible providing that the noise levels meet the long term criteria of background noise level +5dBA. The resulting construction noise criteria, based on the measured RBL values, are shown in Table 4-5.

Table 4-5 L_{A10} Construction Noise Criteria for Long-Term Construction

Time Period	L_{A10} Construction Noise Criteria (dBA)		
	Daytime (7am - 6pm)	Evening (6pm - 10pm)	Night Time (10pm - 7am)
Location 1 - Chelmsford Avenue	54	50	41
Location 2 - Dent Street	52	48	41
Location 3 - Jennings Street	45	44	45
Location 4 - North of Golf Course	62	55	48
Location 5 - Australia Avenue	47	45	47
Location 6 - Military Road	51	51	50

4.4 Road Transport Noise Criteria for Residences

4.4.1 Overall Traffic Noise

The EPA sets noise criteria for various types of roads and developments in its *NSW Environmental Criteria for Road Traffic Noise (ECRTN).*

For *land use developments with the potential to create additional traffic on existing freeways/arterial roads* the policy sets base criteria of daytime $L_{Aeq,15hour}$ of 60dBA (7.00am-10.00pm) and night time $L_{Aeq,9hour}$ of 55dBA (10.00pm-7.00am).

Where these criteria are already exceeded by existing traffic noise levels the document recommends the following:

> *"Where feasible, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using 'quiet' vehicles; using barriers and acoustic treatments.*
>
> *In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2dB."*

For *land use developments with the potential to create additional traffic on collector roads* the base criteria are $L_{Aeq,1hour}$ 60dBA during daytime (7.00am – 10.00pm) and $L_{Aeq,1hour}$ 55dBA during night time (10.00pm – 7.00am).

Again where these levels are already exceeded noise mitigation is recommended and the traffic arising from the development should not lead to an increase in existing noise levels of more than 2dB.

From ambient traffic noise measurements conducted, it is clear that the base criteria (even for arterial roads) are exceeded at all traffic noise monitoring locations. The noise criterion which applies to all roads is therefore that additional trucks as a result of the proposed Port Botany expansion should not increase noise levels by more than 2dB. This criterion has also been applied to assess construction traffic noise through the construction period.

The *ECRTN* also provides criteria for sensitive land uses. These are reproduced below in Table 4.6.

Table 4.6 Road Traffic Noise Criteria For Sensitive Land Uses

Sensitive Land use	Criteria	
	Day 7.00am - 10.00pm dB(A)	Night 10.00pm - 7.00am dB(A)
School Classrooms	$L_{Aeq(1hr)}$ 45 (Internal)	-
Hospital wards	$L_{Aeq(1hr)}$ 35 (Internal)	$L_{Aeq(1hr)}$ 35 (Internal)
Places of worship	$L_{Aeq(1hr)}$ 40 (Internal)	$L_{Aeq(1hr)}$ 40 (Internal)
Active recreation (for example, golf courses)	Collector and local roads: $L_{Aeq(1hr)}$ 60 Freeway/arterial roads: $L_{Aeq(15hr)}$ 60	-
Passive recreation and school playgrounds	Collector and local roads: $L_{Aeq(1hr)}$ 55 Freeway/arterial roads: $L_{Aeq(15hr)}$ 55	-

4.4.2 Sleep Disturbance due to Truck Movements

The EPA's *Environmental Criteria for Road Traffic Noise* also considers the potential for sleep disturbance. It is recognised that transient events from traffic have different characteristics than other transient events in that they have a slower rise time or less sudden onset. The *Environmental Criteria For Road Traffic Noise* at the conclusion of its discussion of sleep disturbance concludes:

- *Maximum internal noise levels of 50 to 55dBA are unlikely to cause awakening reactions.* This corresponds to 60 to 65dBA externally with windows open ie the building fabric attenuates noise levels by 10dBA.

- *One or two noise events per night, with maximum internal noise levels of 65 to 70dBA are not likely to affect health and well being significantly.*

4.5 Vibration Criteria

There are generally two concerns in relation to vibration. Vibration limits have been set to protect buildings against damage and to protect human comfort within buildings. The human comfort limits are the more stringent limits.

British Standard BS6472:1992 sets the following vibration limits for human comfort (above 8Hz):

- 0.28mm/s peak velocity within residences during daytime
- 0.56mm/s peak velocity within offices during daytime

In regard to potential building damage, the German Standard DIN4150 suggests a limit of 10mm/s peak particle velocity (ppv) within any normal building and the British Standard BS7385:Part 2 - 1993 sets a limit within buildings which depends upon the vibration frequency and varies from 7.5mm/s ppv at 4Hz to 25mm/s at 40hz and above. Given that the bulk of the vibration energy from construction activity will fall in the range 10-100Hz, it is reasonable to adopt an overall vibration limit of 10mm/s ppv.

DIN4150 also sets a vibration limit of 3mm/s (ppv) at the foundation of heritage buildings and sensitive structures.

5. SITE OPERATIONAL NOISE AND VIBRATION ASSESSMENT

5.1 Operational Noise Sources

Predictions of operational noise from the proposed new container terminal have been made based on measurements conducted of the existing container terminal plant/operations combined with estimated noise levels for new items of plant. Plant noise measurements were conducted on Friday, 23 November 2001 between 2.00pm and 7.00pm. L_{Aeq} noise levels for various activities at the container terminal were measured. These included:

- Unloading of ship at each berth by two quay cranes combined with transfer of containers from the quay crane to the container stacking area by four straddle carriers.
- Loading and unloading of trucks in the truck exchange area by straddle carriers.
- General straddle carrier and reach stacker activity within the container stacking area.
- Truck traffic on access Road.
- Arrival of train in the rail siding.
- Train idling while containers are unloaded by reach stacker.
- Ship auxiliary power units (Ships typically run auxiliary power units while berthed. This is the dominant noise source from the ship during this time).
- Tugs (engine exhaust noise).

The measurements in each area included typical activity in that area. For example in the region of the quay crane the L_{Aeq} level measured included long travel alarms, spreader movement alarms, container impacts and noise levels from straddle carrier movements.

Based on these noise levels each activity area within the proposed container terminal has been assigned an L_{Aeq} sound power level and each activity has been assigned a geographical acoustic centre. Predictions at the nearest residential receivers have been based on the source L_{Aeq} level for all sources combined, the distance from each source acoustic centre to the residential receiver, intervening acoustic shielding due to buildings and terrain etc and atmospheric absorption.

In the absence of noise level data for train/truck loading/unloading by Rail Mounted Gantries (RMG) it has been assumed that activity for each RMG would be similar to that of a quay crane. This is because the main noise sources associated with RMG operations would be container impacts, alarms and engine noise from the straddle carriers. The noise level produced by the RMG power units would be secondary as is the case for the quay cranes. Therefore the sound power level for RMG loading activities would be similar to that of a quay crane. The $L_{Aeq,15min}$ for one RMG crane and

two attendant straddle carriers has been assumed to be 3dBA less than that used for two quay cranes unloading a ship with four attendant straddle carriers.

The sound power level for ship loading/unloading activity (comprising two quay cranes and four straddle carriers) was derived from on site measurements of L_{Aeq} across a 15 minute unloading period.

The sound power levels determined for each activity are shown in Table 5-1.

Table 5-1 Octave Band Sound Power Levels for Port Activities

Activity	A - Weighted	Octave Band Centre Frequency (Hz) (dB)							
		63	125	250	500	1K	2K	4K	8K
Ship Loading/Unloading	111	111	109	111	107	106	103	95	83
Straddle Carrier	108	113	109	108	105	103	101	95	87
Rail Loco Idle	94	100	96	91	89	89	87	82	75
Truck Processing Area	108	118	115	115	112	109	107	103	96
Truck/Train Loading/Unloading Area	108	108	106	108	104	103	100	92	80
Ship Auxiliary Power Units	106	118	110	107	103	102	94	83	83
Tugs	93	116	111	103	95	87	85	83	78

Alarms are included in these sound power levels where they were measured in typical loading/unloading activities, ie the sound power level used for the portainer crane unloading activities includes a contribution from ship lid alarms, long travel alarms and straddle carrier reverse alarms.

Other alarms are considered to be of limited duration and sporadic occurrence such that they have not been included in noise modelling of overall noise levels. Their potential for annoyance due to their tone and character is however recognised and the potential for annoyance for all alarms are considered in the noise mitigation measures discussed in Section 5.8.

Preliminary estimates of noise levels from the proposed operations have revealed that the noise criteria will probably be exceeded by operational noise levels from the port expansion. Accordingly, it was proposed to install noise control kits on all mobile plant to be operated at the port. These kits would include high performance exhaust silencers, internally lined engine enclosures or partial enclosures and attenuation on ventilation openings. The attenuation expected from these kits is 6dBA applying to all operations and equipment, except the ships, trains and road trucks. The reduced sound power levels have been assumed in the calculation of noise levels for the noise mitigated situation shown and discussed in this report. It is considered reasonable that at the time machinery for the new terminal is purchased it will either be fitted with noise control

kits or be designed such that the overall noise levels emitted would be similar to machinery treated with noise control kits.

It has been assumed that all noise source heights are 2m above ground level except for ship auxiliary power units which it has been assumed are 6m above ground level, tugs which are 1m above water level and locomotives which are assumed to be 4m above ground. This has been based on observations made on the existing container terminals. While cranes and straddle carriers are significantly greater than 2m in height, the majority of noise from the unloading process is emitted from activities close to the ground, eg straddle carrier engines, container impacts on the ground, and alarms.

5.2 Operational L_{Aeq} Noise Calculation Model

Based on the above assumption noise levels at the nominated receiver locations have been calculated using the Environmental Noise Model (ENM). This computer program has been endorsed by the EPA.

5.2.1 Calibration of ENM

Firstly the model was calibrated by modelling the conditions found on the night of the attended survey and on the night of a previous attended survey of port noise.

On the first night one ship was being unloaded by two quay cranes at the Patrick terminal and the wind was blowing from the southeast at approximately 2m/s. The predicted noise level at the north side of the golf course was 47.5dBA. This is very good agreement with the measured noise level at this point when unloading activity was occurring of 48dBA.

On the second survey, conditions were cool and clear with no wind. Mist formed in the lower areas later in the night indicating the presence of a temperature inversion. At this time a noise level of 44dBA was measured at Jennings Street. The predicted noise level of 42dBA at this location is in relatively good agreement with this measured level.

5.2.2 Port Calculations

The model was then used to calculate future noise levels from the Port Botany site operations. Noise levels were firstly calculated for the proposed new terminal. This was then followed by calculation of noise levels from all port facilities in the future, at capacity, being the proposed expansion, Patrick and P & O Ports. This provided an overall noise level for the operation of all three container terminals at Port Botany.

As noted above, modelling of noise from all port facilities included the stevedoring facilities only. As container terminal noise is the dominant noise generated from the

port facilities, it was considered that other port related operations would not affect the model significantly.

Noise levels were calculated for still isothermal conditions, typical of a still warm night or daytime.

The NSW EPA *INP* requires that where a temperature inversion occurs on at least 30% of winter nights then it is a significant weather condition which would have an effect on noise levels in the area. Data from the periods 1 January 1997 and 31 December 1997, and 1 January 2000 and 31 December 2002 shows that inversions occurred on an average of 25% of winter nights. Accordingly, an assessment of noise levels under temperature inversion conditions are not required in accordance with the *INP*. Nevertheless, for information, noise levels for temperature inversion conditions of 3°C/100m are presented in Appendix E. In addition, similar results are presented in the Appendix for a temperature inversion of 3°C/100m coupled with a breeze from the northwest at 2m/s, this wind being determined as the common drainage breeze during winter nights.

The *INP* also requires that noise levels be assessed for prevailing wind conditions when wind is a feature of the area. Wind is regarded as a feature of the area when any wind component occurs for at least 30% of the time in any direction for wind speeds up to 3m/s. An analysis of wind data from Sydney Airport collected over several years indicates that the dominant wind direction in all seasons is northwest. The season with the greatest percentage of winds in this direction is winter and the percentage of time in winter that this wind occurs is just over 30%. No other wind occurs more than 30% of the time from any direction or during any season.

Accordingly, assessment of noise for a northwesterly wind at 3m/s has been included in this report in accordance with the *INP*.

5.3 Modelling Assumptions

Five ship berths are proposed at the port expansion area. However, the five berths would not be taken up for many years and even then, it would be very uncommon that all five berths would be occupied simultaneously. The number of ships in port would vary from none to a maximum of five, but would often be around three or four.

In order to model a typical worst case (90^{th} percentile operational day/night) the following operation has been assumed:

- four vessels would be in port: three at berths along the western edge of the container terminal and one on the southern edge.

- sound power levels of typical ship auxiliary power units would be near the lower end of the range of existing units to allow for technological improvement over time.

- most mobile equipment proposed for the terminal would be operating in loading and unloading operations. All mobile equipment was modelled incorporating noise control kits.

- one train would be located on the terminal, with two locos located at the northern end, during loading/unloading on the new terminal. Note that the proposed development includes the construction of three rail lines on the terminal, however, it is anticipated that only one train would be present on the site at any one time. The model also includes a loco situated on the main access rail loop to the new terminal in Penrhyn Estuary. Locomotives have been modelled as if they are present for the whole night time period. This would be an over-estimate of their time on site and the predictions are slightly conservative in this respect. However, noise levels from locomotives do not dominate overall noise levels and this effect would be insignificant in terms of overall L_{Aeq} level.

- audible alarms would be operating normally. Container terminals typically utilise audible alarms to warn of various activities. These include ship lid alarms, portainer crane long travel alarms, straddle carrier reverse alarms, train movement alarms, etc. Alarms are included in the noise model to the extent they were measured in typical loading/unloading activities, ie the sound power level used for the portainer crane unloading activities includes a contribution from ship lid alarms, long travel alarms and straddle carrier reverse alarms. The alarms have not been included as discreet noise sources. Train movement alarms have not been included in prediction of typical $L_{Aeq,15min}$ levels as they would not occur in all fifteen minute periods.

- the operational L_{eq} has been calculated on the basis that across an 8 hour shift operations would occur for 6.75 hours with 1.25 hours down time incorporating breaks and operator changeover time.

- At the northern end of the site two buildings of 12m and 18m will be constructed. These have not been modelled specifically but will form part of the acoustic barrier at this end of the site (see Section 5.4). The buildings will provide some extra shielding but due to their limited horizontal extent, this is likely to be insignificant over that provided by the barrier.

A list of noise sources and map showing their locations, included in the noise modelling scenario are shown in Appendix D.

Attenuation due to distance, topographical features, air absorption and meteorological conditions have been taken into account.

5.4 Noise Barrier Options

Preliminary estimates of noise levels in the surrounding area indicated that noise levels would exceed the criteria discussed in Section 4. Accordingly, consideration was given to a range of noise control measures which might be able to be incorporated into the port expansion.

The principal practicable form of noise control measure was considered to be the construction of a substantial noise barrier, generally on the northern side of the port expansion. Three suitable locations for the barrier were identified, each with different merits. Accordingly, the noise levels from the proposed terminal were calculated incorporating each of the three barrier options.

These barrier options are:

Option 1 - 4m high barrier on the new terminal along the north and northeastern boundaries as shown in Figure 1C.

Option 2 - 4m high barrier off site situated on the southern side of Foreshore Road.

Option 3 - 4m high barrier off site situated on the northern side of Foreshore Road.

Option 1 is the preferred option for a number of reasons. It is the most effective in attenuating noise from the proposed new container terminal and it would be the least visually intrusive from the viewpoint of residences. Additionally it would be located entirely within Sydney Ports Corporation land.

It will not be possible to construct a solid acoustic barrier on the northern edge of the terminal adjacent to the tug berth as this would restrict the operation of the berth. Combinations of barriers and buildings can be used to form an effective barrier in this area to shield residential areas to the north from activities in the main terminal area. It is proposed that one building in this area would be 12m high and one would be 18m high.

Since the barriers proposed as Options 2 and 3 are a similar distance within the limits of the model from the proposed port operations, these barriers would result in operational noise level reductions which are the same. Accordingly, predicted port noise levels for these two options would be the same. However, it should be noted that Option 3 would have the benefit of reducing noise levels associated with road traffic on Foreshore Road at the residences to the north.

5.5 Results of Noise Calculation

The results of the calculations of port noise (three barrier options and machinery noise controls) are discussed here.

5.5.1 Noise Levels from Proposed Expansion

Firstly, Table 5-2 shows the levels predicted for the port expansion at residential receivers. These are the levels to be compared with the adopted operational noise criteria shown in Table 4-2.

Table 5-2 Predicted L_{Aeq} Levels for Proposed New Container Terminal Operations Only at Residential Receivers

Location		L_{Aeq} Predicted Noise Level (dBA) Barrier Option			
		No barrier (No Noise Controls)	Barrier 1 + Noise controls	Barriers 2 and 3 + Noise Controls	Criterion
Location 1	Isothermal	44	38	39	40
Chelmsford Avenue	3m/s wind from NW	41	35	36	
Location 2	Isothermal	49	43	44	40
Dent Street	3m/s wind from NW	48	41	42	
Livingstone Avenue	Isothermal	46	41	41	40
	3m/s wind from NW	44	38	39	
Tupa Street	Isothermal	47	41	42	40
	3m/s wind from NW	45	39	40	
Waratah Road	Isothermal	47	42	43	40
	3m/s wind from NW	46	40	41	
Location 3	Isothermal	28	27	28	39
Jennings Street	3m/s wind from NW	34	34	34	
Location 4	Isothermal	49	43	44	40
North of Golf Course	3m/s wind from NW	50	45	46	
Location 5	Isothermal	26	25	26	38
Australia Avenue	3m/s wind from NW	36	33	36	
Location 6	Isothermal	32	31	31	40
Military Road	3m/s wind from NW	41	40	40	

The noise level shown in Table 5-2 are for the port expansion operating at typical worst case (90^{th} percentile operational capacity day/night).

Table 5-3 shows noise levels predicted at non residential receivers.

Table 5-3 Predicted L_{Aeq} Levels for the Proposed New Container Terminal Operations at Non Residential Receivers Including Active Recreation Areas

Location		L_{Aeq} Predicted Noise Level (dBA)			
		Barrier Option			
		No barrier No Noise Controls	Barrier 1 +Noise Controls	Barriers 2 and 3 + Noise Controls	Criterion
Church, Hannon	Isothermal	39	38	39	50 (1)
	3m/s Wind	37	35	36	
Church, Rancon Street	Isothermal	45	40	40	50 (1)
	3m/s Wind	44	38	39	
Banksmeadow Primary School	Isothermal	45	41	43	55 (1)
	3m/s Wind	44	40	42	
Matraville Primary School	Isothermal	27	26	27	55 (1)
	3m/s Wind	33	33	33	
Church, Bunnerong Road	Isothermal	26	26	26	50 (1)
	3m/s Wind	33	34	33	
Sir Josephs Banks Park/Golf Course	Isothermal	51	45	45	50 (2)
	3m/s Wind	50	43	44	

Note: (1) External noise criterion
(2) Criterion is 55dBA for golf course

The above noise levels were predicted assuming no containers would be stacked on the site. In reality there will be container stacks in the central part of the site for most of the time. These will have some shielding effect when situated between on site noise sources and sensitive receivers. This situation has been modelled assuming containers would be stacked two high in conjunction with the 4m noise barrier and noise controls to onsite machinery. This had the effect of reducing predicted noise levels as given in table 5-2 and 5-3 above by up to 1dBA at some locations with a reduction of around 0.5dBA being common.

It is evident from Table 5-2 that with no noise mitigation the noise level criteria would be exceeded by the new port operations by up to 10dBA. Installation of a noise barrier and noise mitigation to individual plant items is therefore recommended. The most effective location for this barrier would be close to the terminal boundary on the northeastern and northern sides (Barrier Option 1).

If this barrier were constructed, exceedances of criteria would be up to 5dBA at Botany Road north of the golf course but between 0dBA and 3dBA between Chelmsford Street and Dent Street, respectively. Combined with noise controls to on site machinery reductions in overall noise levels are up to 7dBA at residences to the north (Figures 2 and 3 show noise level contours for the isothermal and 3m/s northwesterly wind conditions).

It should be noted however that reference to Table 3-2 shows even without the noise mitigating barrier L_{Aeq} levels from the proposed expansion will be below existing ambient L_{Aeq} levels at night and well below existing levels during daytime.

If Barrier Option 2 were constructed combined with noise controls to on site machinery (along the southern side of Foreshore Road) the attenuation provided would be up to 6dBA.

Barrier Option 3 (north of Foreshore Road) would again provide up to 6dBA attenuation to the noise levels from the proposed expansion but would significantly reduce traffic noise levels from Foreshore Road by around 10dBA. While this option may be desirable in terms of its reduction of traffic noise levels it may have the effect of making transient noise levels from container impacts etc more prominent above ambient levels.

Construction of Barrier Options 2 and 3 would also need to occur on land which is not owned by Sydney Ports Corporation.

It is therefore recommended that a 4m noise barrier (Option 1) be constructed along the northeastern and northern edge of site as it would be the most feasible and reasonable method to reduce impacts from the proposed expansion for the reasons discussed above.

To construct a combination of noise barrier options would not provide significant additional attenuation to port noise over that of Barrier Option 1.

A combination of Barrier Option 1 and noise controls to machinery on site would achieve compliance at the non residential receivers identified in Table 5-3.

It may be practicable to build a 6m barrier along the northern side of the proposed terminal to the point where the rail siding enters the site with a 4m barrier elsewhere. This would reduce noise levels by between 0.5 and 1.5dBA between Chelmsford Avenue and the golf course more than the 4m barrier. It would have no effect elsewhere. It is not considered that the additional attenuation provided by a 6m wall would provide significant additional benefit, therefore the 4m wall is considered most practical.

Table 5-3 indicates that the EPA criteria will be met for non-residential land uses.

5.5.2 Noise Levels from Combined Port Operations

The noise levels resulting from the proposed port expansion when combined with the existing port facilities have also been calculated. These noise levels have been based on the proposed port operations at capacity as well as the existing port facilities also at capacity.

In the case of P & O existing operations, the noise model includes ships at each berth and associated loading/unloading operations. At the Patrick Terminal, the noise model also includes a ship at each berth with associated loading/unloading operations. In addition, the expansion proposed by Patrick Stevedores has also been included in the model, as indicated in *Upgrade of Patrick Stevedores Port Botany Container Terminal Environmental Impact Statement*, prepared by PPK Environment and Infrastructure. In respect of the expansion at the Patrick terminal, no specific noise control measures have been assumed.

The combined noise levels at residential locations are shown in Table 5-4. This table shows the combined level as well as the level of existing port operations as expanded (without the proposed port expansion which is the subject of this report). In the case of the proposed expansion, the Option 1 barrier and noise controls to machinery have been assumed.

Table 5-4 Predicted L_{Aeq} Levels for Proposed New Container Terminal Operations Compared with Future Existing Port Operations

Location		L_{Aeq} Predicted Noise Level (dBA)				
		Future with Expansion[1]	Future without Expansion	Difference	Existing Ambient Leq Night Time (10.00pm – 7.00am)	Overall change in Leq,9hr Night Time (10.00pm – 7.00am)
Location 1	Isothermal	44	43	1	51	0.8
Chelmsford Avenue	Wind 3m/s from NW	42	41	1		0.5
Location 2	Isothermal	49	48	1	57	0.7
Dent Street	Wind 3m/s from NW	47	46	1		0.4
Livingstone Avenue	Isothermal	46	45	1	57	0.3
	Wind 3m/s from NW	44	43	1		0.2
Tupa Street	Isothermal	47	46	1	57	0.4
	Wind 3m/s from NW	45	44	1		0.3
Waratah Road	Isothermal	48	47	1	57	0.5
	Wind 3m/s from NW	46	45	1		0.3
Location 3	Isothermal	41	41	0	51	0.4
Jennings Street	Wind 3m/s from NW	44	43	1		0.7
Location 4	Isothermal	53	52	1	58	1.1
North of Golf Course	Wind 3m/s from NW	51	50	1		0.8
Location 5	Isothermal	44	44	0	49	0.7
Australia Avenue	Wind 3m/s from NW	46	46	0		1.8
Location 6	Isothermal	47	47	0	58	0
Military Road	Wind 3m/s from NW	54	54	0		1.5

Note: (1) With Option 1 barrier and noise controls to machinery at the new terminal only

It is evident from Table 5-4 that the maximum difference in noise level between the future operation with the expansion and the future existing operations is 1dBA. A noise level difference of 1dBA is considered unnoticeable to the human ear.

5.6 Sleep Disturbance Levels

L_{A1} noise levels from the Port Botany container terminal would be expected to increase at residences to the north of the site due to the proposed expansion in that direction. However, the proposed barrier would reduce these levels down towards current existing levels.

Container impacts from the existing operations were measured north of the golf course at L_{A1} levels of 52-57dBA. This range represents the typical range of level, but higher

levels may result from time to time, particularly as a result of accidental container dropping.

Assuming Option 1 noise barrier is installed, Table 5-5 shows the typical range of L_{A1} levels to be expected from container handling.

Table 5-5 Typical Predicted L_{A1} Noise Levels from Container Handling at Proposed New Container Terminal

Location	Predicted L_{A1} (dBA)	Criterion (dBA)
Location 1		
Chelmsford Avenue	49 - 53	51
Location 2		
Dent Street	53 - 59	51
Livingstone Avenue	52 - 57	51
Tupa Street	52 - 58	51
Waratah Road	52 - 59	51
Location 3		
Jennings Street	33 - 45	55
Location 4		
North of Golf Course	52 - 59	58
Location 5		
Australia Avenue	31 - 43	57
Location 6		
Military Road	18 - 35	60

The upper end of the range of L_{A1} levels expected will exceed the *ENCM* sleep disturbance criteria at a number of locations, particularly to the north and northwest. However, many of these locations are already subjected to industrial noise impacts of levels similar to those to be expected.

Typically, maximum noise levels from container handling will extend from below the criterion at each location to up to 8dBA above the criterion of some locations. In addition to this, during the occasional container drop, even higher levels may result.

These predicted noise levels are below the external level of 65dBA which some researchers consider would not result in awakening reactions.

At the most affected locations, more than half of container handling impacts will be above the criterion, where as at the other locations, more than half of the impact will be below the criteria. The number of audible container handling impacts likely to occur will vary widely from night to night, depending upon the location of the ship being loaded/unloaded and also the accuracy of the crane operator on the particular occasion.

However, generally speaking it is probable that several impacts would occur during any night time hour period.

The frequency of container dropping is substantially less, being in the order of one or two a night. Apart from noise events being generated by existing port operations, local noise sources at all locations, particularly traffic on Foreshore Roads and Botany Road, Bunnerong Road and Military Road, presently result in L_{A1} noise levels which exceed the EPA sleep disturbance criteria. Reduction of transient noises such as container impacts should be specifically addressed by the Noise Management Plan as outlined below in Section 5.8.

The frequency of container impacts is likely to reduce in future due to computerised handling technology.

5.7 Recommended Noise Control Measures

Noise Management Plan

A Noise Management Plan containing environmental management measures to assess and minimise noise from the proposed terminal expansion is recommended. This Plan should address the predicted noise impacts which have been found to exceed night time amenity, and sleep disturbance criteria.

Noise Barriers

One of the most practical forms of noise control was considered to be the construction of a substantial noise barrier, generally on the northern side of the Port Expansion. Three suitable locations for the barrier were identified, each with different merits. Accordingly, the noise levels were calculated for each of the three barrier options with a barrier height of 4m. A 6m barrier has also been considered. This was found to result in between 0.5dBA and 1.5dBA additional reduction between Chelmsford and the golf course. It would have no effect elsewhere. This is not considered a significant increase in attenuation when considered against the practicalities of constructing a 6m barrier and therefore a 4m barrier is considered most appropriate.

Option 1 is the preferred option for a number of reasons. It is the most effective in attenuating noise from the proposed new container terminal; it would be the least visually intrusive from the viewpoint of residences; and it would be entirely within Sydney Ports Corporation land. The preferred barrier location is shown in Figure 1C.

A number of noise controls other than the barriers discussed above may be implemented as part of the noise management plan to reduce noise levels:

Equipment Alarms

Measures include turning audible safety alarms off some of the terminal equipment during night hours (between 10.00pm and 6.00am) and replacing them with visual alarms. Alarms from existing terminal operation were clearly audible at residences on the north side of the golf course during attended measurements and have been identified as a source of noise complaint from port operations.

The alarms which may be turned off include the quay crane ship lid alarm and the train shunt alarm. It is recognised that these alarms have a particularly annoying character and it is expected that removal of some of the alarms will reduce the likelihood of noise complaints and may reduce overall noise levels to some extent.

It is understood that for certain types of equipment e.g. quay cranes (long travel alarm and high wind alarm) alarms are required to remain for safety reasons. In respect of other items of mobile equipment, a safety assessment would be required to ensure that the audible alarms could be replaced with visual alarms without affecting safety. Closed circuit TV systems in mobile machinery may be one possibility for reducing the requirements for safety alarms.

Quay crane ship lid alarm and the train shunt alarms could possibly be turned off during night (as indicated above). Further consideration of these alarms may determine the possibility of turning these off during all night hours.

Machinery Noise Control

Apart from the noise control kits discussed in Section 5.1 and included in the calculations above, selection of new shore based plant for the site should be made with noise level emission in mind. The quietest possible plant within other operational constraints should be selected.

Environmental management measures for assessing and mitigating noise sources from terminal machinery should be considered in addition to regular maintenance of machinery to ensure optimal and efficient operation.

Other noise controls which may be provided are computer controlled spreaders on forklifts and straddle carriers which control the speed and accuracy which the spreaders lock on to containers. This can reduce the impact noise often associated with port facilities.

Shore Power

The noise associated with ships in port results primarily from the exhaust of the on-board diesel generator supplying power to the ship. The diesel generator would not have to run if power were separately supplied from the shore whilst the ship were in port.

Consideration has been given to the supply of shore power at ports in NSW and it is concluded that it is not practicable. Ships that berth at the port are registered at a number of locations around the world and do not include on-board facilities for the connection of shore power. Even if it were possible to have ship owners modify the ships, then difficulties would arise in regard to on-board computer operated equipment at the time of connection to shore power. The design of the new terminal, however, has allowed shore power facilities to be installed should ships be designed to connect to shore power in the future.

Operator Awareness and Training

Operator awareness and training would be regularly conducted. Good training and awareness of noise issues will be implemented such that poor cargo handling operations are minimised.

Complaints

As part of the noise management plan specific provision for a complaints handling mechanism should be made. This should ensure that all complaints are addressed in a timely and effective manner.

Monitoring

It is suggested that a noise monitoring program be instigated as part of the noise management plan. This program should consider locations most likely to be affected by the new terminal operations.

6. ROAD AND RAIL TRAFFIC

6.1 Road Traffic

This section of the report presents the predicted noise level impact of trucks using the proposed container terminal on the various roads in the immediate area of the container terminal. *The NSW Environmental Criteria for Road Traffic Noise* (ECRTN) presents noise criteria both in absolute noise levels and in terms of noise level changes due to developments likely to generate road traffic.

The absolute noise criteria are already exceeded at Locations 7 - 9 and at other locations near Foreshore Road by existing levels of road traffic noise in the area. Accordingly, consideration has been given to the reduction of the existing road traffic noise levels.

As shown in Tables 6-1 and 6-2 below, the contribution of port truck movements to overall road traffic noise levels, including at night time, is very small. Consequently, modifications to port traffic or trucks will not have a significant effect upon existing road traffic noise levels on port transportation routes.

The only other effective form of traffic noise control that could be conceivably practicable in this case is the erection of roadside noise barriers. However, houses on Botany Road rely on access from these roads and noise barriers adjacent to the roads would restrict this access. Such noise barriers are therefore not considered practicable.

In the case of Foreshore Road, the affected residences are north of the road. Option 3 barrier discussed in Section 5.4, being north of Foreshore Road, would provide some traffic noise shielding to these residences. However, this barrier would provide less attenuation to the port noise which is considered more significant and there are practical difficulties in constructing such a barrier on land not controlled by Sydney Ports Corporation. Accordingly, a barrier on the northern side of Foreshore Road is not proposed.

The noise level impact of traffic generated by the proposed port has been viewed in terms of the noise level contribution from trucks using the container terminal and the change in absolute noise level due to the change in the number of trucks resulting from the proposed expansion.

The noise level predictions have been made using the *Calculation of Road Traffic Noise* (CORTN) model developed by the Welsh office of the UK Department of Transport, 1988. Wilkinson Murray has modified this model to reflect Australian conditions, based on research conducted by Stephen Samuels of the Australian Road Research Board to assess its appropriateness for use in Australia. This Noise Prediction Model has been calibrated against field measurements on numerous occasions in the past and no further calibration is considered necessary in this case. This is particularly so

because the *CORTN* model has been used to predict traffic noise level changes, rather than absolute traffic noise levels.

The *CORTN* method calculates the $L_{A10,1\ hour}$ noise level and takes into account the following factors:

- Traffic flow volumes
- Average vehicle speed
- Percentage of heavy vehicles
- Gradient of road
- Type of road pavement
- Distance from receiver location to road
- Shielding from barriers / buildings and intervening topography
- Angle of view
- Building facade reflection correction
- Ground absorption

Noise level predictions have been considered and the contribution of trucks from the proposed new terminal operating at capacity, with respect to overall traffic noise levels has been determined (overall traffic includes trucks plus other vehicles).

The *CORTN* model has been adapted to permit the calculation of hourly $L_{Aeq,1hr}$ levels using the acceptable approximation $L_{Aeq,1hr} = L_{A10,1hr}$ - 3dBA. This method also allows the *CORTN* model to be used at low flows for which it may be inappropriate for prediction of L_{A10} levels.

The *CORTN* model has also been adapted to include varying vehicle source sites as follows:

- Light Vehicle and Truck Road / tyre noise 0.5m above road level
- Truck engine 1.5m above road level
- Truck exhaust 3.6m above road level

The traffic flow figures used in the calculations are based on predicted daily traffic flows provided by Maunsell Pty Ltd distributed throughout the 24hr period. Table 6-1 shows the contribution of the truck movements associated with the proposed Port Botany Expansion to overall future road traffic noise levels.

Table 6-2 shows the contribution of the truck movements associated with all container terminal operations at Port Botany (P & O, Patrick and new terminal) to overall future road traffic noise levels.

Note that all traffic noise calculations are made for the terminals operating with predicted traffic flows based on forecast trade demand levels (as provided by Maunsell Pty Ltd).

Table 6-1 Contribution to Overall Noise Level from Trucks using the New Terminal (dBA)

Period	Botany Road East of Beauchamp Road	Foreshore Road	Botany Road North of Foreshore Road	Beauchamp Road
	Increase in Contribution due to Proposal	Increase in Contribution due to Proposal	Increase in Contribution due to Proposal	Increase in Contribution due to Proposal
12. midnight - 1.00am	0.1	0.6	0.5	0.2
1.00am - 2.00am	0.1	0.4	0.5	0.3
2.00am - 3.00am	0.1	0.3	0.4	0.2
3.00am - 4.00am	0.0	0.2	0.3	0.1
4.00am - 5.00am	0.0	0.2	0.2	0.1
5.00am - 6.00am	0.1	0.4	0.3	0.1
6.00am - 7.00am	0.1	0.2	0.1	0.0
7.00am - 8.00am	0.0	0.2	0.1	0.0
8.00am - 9.00am	0.0	0.2	0.1	0.0
9.00am - 10.00am	0.0	0.2	0.1	0.0
10.00am - 11.00am	0.0	0.2	0.1	0.0
11.00am - 12 noon	0.0	0.2	0.1	0.0
12 noon - 1.00pm	0.0	0.2	0.1	0.0
1.00pm - 2.00pm	0.0	0.2	0.1	0.0
2.00pm - 3.00pm	0.0	0.2	0.1	0.0
3.00pm - 4.00pm	0.0	0.1	0.1	0.0
4.00pm - 5.00pm	0.0	0.1	0.1	0.0

Period	Botany Road East of Beauchamp Road	Foreshore Road	Botany Road North of Foreshore Road	Beauchamp Road
	Increase in Contribution due to Proposal	Increase in Contribution due to Proposal	Increase in Contribution due to Proposal	Increase in Contribution due to Proposal
5.00pm - 6.00pm	0.0	0.2	0.1	0.0
6.00pm - 7.00pm	0.1	0.3	0.2	0.0
7.00pm - 8.00pm	0.1	0.4	0.4	0.1
8.00pm - 9.00pm	0.1	0.6	0.6	0.1
9.00pm - 10.00pm	0.1	0.5	0.4	0.1
10.00pm - 11.00pm	0.1	0.5	0.4	0.1
11.00pm - 12 midnight	0.1	0.6	0.5	0.1

Table 6-2 Contribution to Overall Noise Level from Trucks using All Terminals (dBA)

Period	Botany Road East of Beauchamp Road	Foreshore Road	Botany Road North of Foreshore Road	Beauchamp Road
	Contribution due to Port Traffic	Contribution due to Port Traffic	Contribution due to Port Traffic	Contribution due to Port Traffic
12. midnight - 1.00am	1.9	2.0	1.7	0.3
1.00am - 2.00am	1.5	1.5	1.8	0.5
2.00am - 3.00am	0.8	1.2	1.5	0.3
3.00am - 4.00am	0.2	0.6	0.9	0.2
4.00am - 5.00am	0.4	0.6	0.7	0.1
5.00am - 6.00am	0.9	1.2	0.9	0.1
6.00am – 7.00am	0.5	0.7	0.3	0.1
7.00am - 8.00am	0.4	0.6	0.3	0.0

Period	Botany Road East of Beauchamp Road	Foreshore Road	Botany Road North of Foreshore Road	Beauchamp Road
	Increase in Contribution due to Proposal	Increase in Contribution due to Proposal	Increase in Contribution due to Proposal	Increase in Contribution due to Proposal
8.00am - 9.00am	0.4	0.5	0.2	0.0
9.00am - 10.00am	0.3	0.7	0.3	0.0
10.00am - 11.00am	0.4	0.7	0.2	0.1
11.00am - 12 noon	0.4	0.6	0.2	0.0
12 noon - 1.00pm	0.3	0.5	0.2	0.0
1.00pm - 2.00pm	0.3	0.5	0.2	0.0
2.00pm - 3.00pm	0.3	0.5	0.2	0.0
3.00pm - 4.00pm	0.3	0.3	0.2	0.0
4.00pm - 5.00pm	0.3	0.4	0.2	0.0
5.00pm - 6.00pm	0.5	0.5	0.2	0.1
6.00pm - 7.00pm	0.7	0.8	0.6	0.1
7.00pm - 8.00pm	0.8	1.3	1.0	0.1
8.00pm - 9.00pm	1.0	1.7	1.5	0.1
9.00pm - 10.00pm	1.2	1.6	0.9	0.1
10.00pm - 11.00pm	1.4	1.5	1.2	0.1
11.00pm - 12 midnight	1.7	2.0	1.3	0.1

In all cases the increase in truck movements due to the proposed expansion does not cause an increase in overall noise level of more than 0.6dBA. This is an unnoticeable change in noise level to the human ear.

The contribution of all container terminal truck traffic at capacity to overall traffic noise levels however is up to 2dBA during some night time hours.

As the predicted noise increases from the new terminal are less than 2dBA, the noise level contribution of the proposed extension to the Port Botany container terminal complies with the *Environmental Criteria for Road Traffic Noise.*

The contribution to overall noise levels from all port traffic at capacity does not exceed 2dBA. It should also be noted that the small increase is largely due to future truck movements associated with existing port facilities.

It is recommended that a Port Traffic Noise Management Plan be produced involving the operators of the existing terminal and the new terminal. This plan should consider:

- Traffic re routeing – transferring truck movements from other roads to Foreshore Road where there are no dwellings close to the roadside.
- Traffic clustering – this option includes scheduling traffic to occur during periods of higher background noise (however it should be noted that such an option would exacerbate potential for traffic congestion, and therefore is unlikely to be feasible).
- Traffic rescheduling - Night time truck noise levels may also be mitigated by transferring truck movements from night time to day time. However as the proposed port expansion would be a 24 hour operation this is unlikely to be practical.

Noise barriers are a potential alternative however as discussed earlier it is considered noise barriers would be impractical on roads other than Foreshore Road. This location is complicated by the fact that the roadside is not on Sydney Ports Corporation land. The plan should consider the option for noise barriers in consideration of other effects that a barrier may have, such as shadowing or visual impacts.

6.2 Rail Traffic

The Botany Freight Rail Line is a dedicated freight line connecting Port Botany to the Enfield Marshalling Yards and Chullora. Beyond Enfield, the freight line connects to the metropolitan rail network which is a shared freight and passenger line. Passenger trains are much more frequent than freight trains and also take priority. Rail Infrastructure Corporation (RIC) have a program to progressively make improvements and upgrade the freight line. The recent duplication of the single freight line between Marrickville and Cooks River and the proposal to complete the full duplication of the rail line with the duplication of the single line between Cooks River and Botany Yard are part of this upgrading program. As part of the rail duplication between Botany Yard and Marrickville, RIC have undertaken noise impact assessments to assess the impact of future freight rail use on landuses adjoining the rail line between Port Botany and Marrickville. These noise assessments are as follows:

- *Port Botany Freight Rail Project Stage 4 Marrickville Junction to Port Botany Noise Impact Assessment*, Environmental Results, April 2002. This report presents the noise impact for trains travelling between Botany Yard and Cooks River Yard; and
- *Botany Goods Line Marrickville to Alexandra Canal Operational Enhancements Noise Mitigation Assessment*, Richard Heggie Associates, October 2000. This report presents the noise impact for trains travelling between Alexandra Canal (Cooks River) and Marrickville.

There has been no noise assessment undertaken for assessing the future use of the freight rail line between Marrickville and Enfield as this section of the freight line has been duplicated for some time.

Discussion of the predicted future noise impact from the movement of rail freight to and from the proposed Port Botany Expansion has been assessed based on the noise assessments contained in the above reports, and the predicted train numbers using the freight rail line obtained from Maunsell, 2003.

Botany Yard to Cooks River

Noise modeling was undertaken by Environmental Results for RIC in April 2002 to assess noise impact from the proposed duplication of the Botany Freight Rail Line between Cooks River and the Botany Yard. This study was based on a predicted total of 35 trains per day based on a total port throughput of 2.3M TEU. SPC predict an increased capacity of 3.2M TEU for the port, including the proposed new terminal. Based on this throughput, a total of 54 trains per day would visit the port, of which 18 would be to/from the new terminal.

The differences between the predicted number of trains by RIC and SPC is primarily due to different predictions of cargo volume (2.3M predicted by RIC vs 3.2M by SPC);

the fact that RIC has included varied size trains (300-1200m), whilst the SPC predictions are based on 600m trains only; and because SPC has an import:export cargo ratio of 32%:68%, whilst RIC predictions balance import:export, resulting in more trains being generated by the SPC predictions.

The noise report prepared for RIC identifies 23 dwellings (houses and home units) at which noise levels would exceed the EPA criteria for rail noise, as contained in the EPA's *Environmental Noise Control Manual (ENCM).* These criteria are in terms of $L_{Aeq,24hr}$ and L_{Amax} and are:

- 85dBA L_{Amax}
- 60dBA $L_{Aeq,24hr}$

Noise levels were predicted up to 66dBA $L_{Aeq,24hr}$ but generally up to 62dBA. L_{Amax} levels were predicted to be up to 83dBA. It is understood that 6 of the affected dwellings are home units which have acoustic treatment.

This report suggests that the upgraded track and proposed changes to train operations would result in some reductions in certain types of rail noise. The proposed duplication would minimise the need for trains to stop and start at crossings and intersections and therefore would reduce noise levels from locomotives accelerating and bumping noises from wagons. The use report noted the use of locomotive horns will also be reduced.

An increased number of train movements, in accordance with the SPC predictions would have an additional noise impact in terms of frequency of disturbance (and hence the $L_{Aeq,24hr}$), but not the maximum level of noise in each passby (ie L_{Amax}).

On the basis that all the additional trains are assumed to have similar noise characteristics as those assessed for RIC, then the L_{Aeq} noise level adjacent to the rail line will increase in accordance with the number of movements. The increase in L_{Aeq} resulting from the predicted 54 trains per day in comparison to the 35 trains per day modelled by RIC has been calculated as approximately 2dBA. This figure has been derived by calculating 10 times the logarithm of 54 trains divided by 35 trains, the approach being consistent with the energy basis of the L_{Aeq} measure.

An increase of 2dBA in the L_{Aeq} level is expected to be just noticeable to residents living adjacent to the line. Whilst a 2dBA increase is normally not detectable by the human ear, it is expected to be detectable in this case because the increase in the number of movements will be detectable.

Whilst there are no guidelines for the assessment of increased rail movements, equivalent guidelines for the assessment of road traffic (*Environmental Criteria for Road Traffic Noise)* recommend a maximum L_{Aeq} increase of 2dBA for developments

which affect road traffic. It is therefore concluded that the 2dBA increase is generally consistent with an insignificant noise impact.

An increase of 2dBA on the noise contours presented in the noise report prepared for RIC could potentially result in an estimate of up to 10 residences over the 23 identified in the RIC assessment being within the 60-65 dBA noise contour. The estimated additional number of dwellings in this contour bracket is actually estimated to be 6, however difficulty in determining additional dwellings relating to a 2dB increase within a 5dB contour has meant a conservative estimate of 10 has been made.

Cooks River - Marrickville Section

As part of the duplication of this section of the Botany Freight Rail Line, noise impacts along the line were assessed by Richard Heggie Associates in October 2000 for RIC. This assessment was based on a maximum number of 72 trains per day. It is considered by SPC that the 54 trains related to the Port (36 to/from P&O and Patrick and 18 to/from the new terminal) would be included within the assessment of 72 trains per day as there are few other possible destinations of trains on this section of the Line. The remaining 18 trains would include those going to/from Cooks River, without travelling to the Port, however this is a conservatively high estimate of other trains not going to/from the Port.

Hence, the predictions of rail noise impact made in the report can be assumed to be adequate for the assessment of the proposed port expansion.

The noise report prepared for RIC presents a summary of noise mitigation works which would be required to comply with the EPA rail noise criteria at most residences. It suggests that a combination of rail lubricating devices and noise barriers would be necessary. The report shows noise contours which indicate that in the absence of noise controls approximately 90 dwellings in this section would be above EPA rail noise criteria. With noise barriers and other mitigation this number would reduce to approximately 20. Compliance with the $L_{Aeq,24hr}$ criterion is generally achieved with $L_{Aeq,24hr}$ of 54 to 59dBA occurring. The L_{Amax} criterion of 85dBA is however marginally exceeded at 87dBA between Unwins Bridge Road and the Princes Highway.

RIC are undertaking a community consultation process to identify appropriate mitigation measures, together with the EPA. However, the Port Botany Expansion would not change the results in the assessment undertaken by RIC.

The above assessments of train noise between the Botany Yard and Marrickville do not take into account any reduction in noise levels due to improved technology in the future. It would be expected however that improvements in diesel locomotive design and rail wheel interaction technology would result in reductions of overall noise levels.

Marrickville - Enfield Section

This section of the Botany Freight Rail Line (to between Campsie and Belmore) shares the same corridor, although different lines, as the Metropolitan Passenger network. Noise impacts from future freight and passenger movements through this corridor have not been previously assessed by RIC and no information was available on the current noise impacts along this section of the line.

Approximately 90 passenger trains (180 movements) currently travel along the shared Freight / Passenger Rail corridor each weekday, as part of the passenger service between Liverpool and the City. These trains would be significant contributors to noise along the corridor.

Based on information provided by RIC on the future freight movements on this section of the line and the port train estimates from Maunsell 2003, the breakdown of trains per day would be as follows: 36 to/from the existing port; 9 travelling to/from the Cooks River intermodal terminal; 15 relating to grains/minerals/coal/steel trains (travelling to the Illawarra); 5 others (travelling to White Bay for example); plus 18 trains to/from the new terminal. That is, without the new terminal there would be approximately 65 trains per day in the future and with the new terminal there would be total of 83 trains.

The new terminal's contribution of 18 trains to the total freight and passenger trains on this line is small and would not create a perceptible increase in noise levels. Notwithstanding this, some attempt has been made to quantify the future change in freight noise associated with the new terminal. Note that the change will in reality be much smaller between Marrickville and Belmore/Campsie as the noise contribution by the passenger trains is not included in this assessment.

The difference in noise due to train movements with and without the new terminal is calculated to be up to 1dB, using the method outlined above, which is considered to be barely perceptible to the human ear.

Note that if it had been assumed that more trains (unrelated to the new terminal) would use this section of the rail line in the future, then the change due to the new terminal would be even less than that calculated.

Beyond Enfield

Beyond Enfield the freight rail line joins and shares the track with passenger trains. Assuming that all 18 trains from the new terminal travel beyond Enfield (which is conservative as trains also could go to White Bay or travel on the Illawarra line to the South Coast), and considering the predicted breakdown of destinations from Enfield, approximately 50% of the 18 trains would travel on the western line, 25% on the northern line and 25% on the south-western line. It is considered that the impact of the

additional 18 trains from the new terminal, spread over the western, northern and south-western lines, and entering into the passenger network, would be sufficiently 'diluted' within the system such that the effects would not be considered significant.

Rail Noise from New Terminal Operations

The noise modelling undertaken as part of the assessment of the port expansion as shown in Section 5.5 for site operations takes into account noise levels from diesel locomotives idling while being loaded and unloaded.

The rail line into the proposed container expansion will be constructed on concrete viaduct over the estuary area. This will be sufficiently damped to ensure noise levels from regenerated noise caused by vibration of the viaduct will be significantly below noise levels from the train itself and will not therefore control rail noise levels at the nearest residential areas.

Based on noise levels from trains entering the existing container terminal it is predicted that noise levels from a diesel locomotive entering the proposed expansion will be 46dBA L_{A1} at the nearest residences on the north side of the golf course. This is below the night time sleep disturbance criterion and below existing L_{A1} levels due to road traffic at this area.

7. PREDICTED NOISE LEVELS DURING CONSTRUCTION

7.1 Construction Noise Impacts

Table 7-1 contains the Sound Power Levels (L_{A10}) of plant likely to be used for the various phases of construction. Noise levels have been predicted by grouping together typical types of noise sources for a particular section and construction phase and by taking into account relevant acoustic factors such as distance attenuation, shielding effects and ground effects.

Predictions have been made for the noisiest construction stages only and these are shown in Table 7-2. It should be noted that construction stages may overlap as shown in the proposed construction staging program (Table 2-4).

The predicted noise levels shown in Table 7-2 are expected to occur during normal daytime construction hours, with the exception of dredging which will occur on a 24 hour basis.

Table 7-1 Typical L_{A10} Sound Power Levels from Construction Plant

Plant Item	Sound Power Level (dBA)
Backhoe	107
Excavator	107
Dump Truck	109
Compactor	112
Bulldozer	119
Scraper	117
Vibrating Roller	106
Water cart	109
Grader	109
Front End Loader	109
Asphalt Paver	100
Bored Piling Rig	111
Dredge	108
Tug	93
Diesel Hammer	141

Table 7-2 Noise Levels from Construction

Time Period	Predicted Construction L_{A10} Levels (dBA)							LA10 Construction Noise Criteria (dBA)		
	Construction of Embankment	Site Trimming and Stabilisation	Preloading	Wharf Construction	Beach Construction (incl. recreation area and Penrhyn Estuary works)	Night Time [1] Dredging	Terminal Facilities	Daytime (7am-6pm)	Evening [2] (6pm-10pm)	Night Time [2] (10pm-7am)
Location 1						34				
Chelmsford Ave	49	50	53	62	58	34	48	54	50	41
Location 2						38				
Dent St	51	57	60	67	49	40	55	52	48	41
						37				
Livingston Ave	51	53	57	65	57	38	52	52	48	41
						38				
Tupa St	51	54	58	65	51	39	53	52	48	41
						36				
Waratah Rd	51	55	59	67	54	39	53	52	48	41
Location 3						8				
Jennings St	28	32	35	47	25	18	29	45	44	45
Location 4						38				
North of Golf Course	50	57	60	67	45	41	54	62	55	48
Location 5						13			45	50
Australia Ave	27	28	33	49	27	25	28	47		

Notes: (1) For isothermal (first row) and temperature inversion conditions (second row).
(2) Relevant to night time dredging works only.

The noise levels expected from night time dredging will comply with the night time noise criteria. During daytime, much of the construction will result in noise levels which will comply with the daytime criteria. However, some of the activities will produce noise levels above the noise criteria, particularly wharf construction.

It is likely that some activities may overlap. In the worst case where two activities are of similar noise level this would result in noise levels 3dBA higher than the nosiest individual activity. Where one activity is significantly noisier than the other the louder activity will dominate and the increase would be between 0 and 1dBA. If one activity is 10dBA quieter than the other then the overall noise level will be that of the noisier activity.

7.2 Construction Traffic

During construction it is expected that approximately 100 trucks per day may enter the site during the second year of construction. It has been assumed that all of these would travel along Foreshore Road. The distribution of these truck movements throughout the day cannot be predicted at this stage. However, assuming an even distribution across an 11 hour working day and based on existing traffic flows, the maximum contribution to existing traffic noise levels from construction traffic would be 0.3dBA in any one hour on Foreshore Road.

This is a moderately conservative estimate as it is based on existing non construction traffic flows. In the future construction years, non construction traffic will be greater and the contribution of construction traffic to noise levels will be less. Also reference to the construction methodology shows that for most of the construction period, construction traffic will be significantly less than 100 trucks per day.

This noise level contribution complies with the *Environmental Criteria for Road Traffic Noise*.

7.3 Vibration Assessment

Groundborne vibration levels generated by typical construction activities associated with the Terminal expansion site will depend upon the response of the ground at that site. The greatest vibration levels likely to arise from activities associated with the construction will result from impact piling.

Only approximate predictions of vibration levels can be made due to variations in ground conditions etc. There are a number of sources of measurements of vibration levels generated by impact piling and those in *Construction Vibrations,* Charles H Dowding, 1996 are some of the most appropriate. For piling into unusually resistant materials, this text advises that a vibration level of approximately 0.3mm/s would result

at a distance of 100m. At 300m, which is the approximate distance to sensitive receivers, the nearest piling location would be approximately 0.05mm/s.

In respect of potential damage, at the closest building the most stringent limit of 3mm/s for heritage buildings and sensitive structures will be comfortably complied with. The vibration comfort criteria are also likely to be comfortably complied with.

The effects of vibration will therefore be insignificant.

7.4 Summary of Construction Recommendations

Construction Noise Management Plan

In view of the predicted noise impacts and the possibility that other construction methodologies may be employed for actual construction of the container terminal, a detailed Construction Noise Management Plan should be provided at the time of construction. Although construction noise levels exceed EPA construction noise criteria, predicted noise levels are significantly lower than many construction projects in urban/suburban areas.

Highest noise levels occur during pile driving. Impact pile driving is significantly noisier than other construction activities and other forms of piling, bored piles or vibro piling, could be used where possible.

Piling Noise

Where impact piling cannot be avoided, all efforts should be made to reduce noise levels from the piling hammers. Resilient dollies may be placed in between the pile and the hammer and the hammer may be shrouded to provide acoustic attenuation. The exact degree of attenuation depends on hammer design and therefore cannot be predicted accurately at this stage.

Machinery Noise Control

Noise levels from diesel powered machinery may be reduced by fitting noise control kits to machinery, where practical. These are discussed for container terminal machinery in Section 5.7.

In view of the small exceedances of construction noise criteria which would occur when impact piling is not occurring, it is not considered appropriate to fit this type of noise control to moving diesel construction plant.

Awareness and Training

The Noise Management Plan should provide for a training regime to ensure construction workers are aware of the noise created during construction and are appropriately trained in order to minimise noise where possible.

Complaints

A noise complaints handling mechanism should also form part of the Construction Noise Management Plan. This mechanism should ensure all complaints are assessed and responded to in a quick and effective manner.

Monitoring

Noise monitoring should be conducted to assess impacts from construction noise at monthly intervals and in response to any complaints which may be received.

8. CONCLUSIONS

Noise level predictions for the proposed expansion of the Port Botany container terminal in the absence of noise controls show that the proposed expansion would result in noise levels which will significantly exceed noise level criteria at residential locations to the north. Since exceedances of noise criteria would be up to 10dBA without mitigation measures, it is recommended that a 4m noise barrier be constructed to mitigate noise levels. Barrier options from this barrier are discussed in Section 5. Using the preferred option of a noise barrier located along the terminal boundary and noise controls to machinery, the predicted noise levels would be between 0 and 5dBA above the criteria.

With the proposed barrier and noise controls to machinery, total noise levels from all future port facilities (including the expansion) would be no more than 1dBA higher than noise levels from existing port operations operating at future capacity.

To mitigate the predicted impacts, it is recommended that a Noise Management Plan, outlining environmental management measures to assess and reduce noise levels (where possible), be developed for the operation of the proposal. The Noise Management Plan should include descriptions of:

- Options for equipment alarm operation
- Machinery noise control
- Operator awareness and training
- Complaints handling
- Noise monitoring

Noise levels from potential increases in truck movements from the proposed expansion of the Port Botany container terminal only will comply with EPA traffic noise criteria.

The contribution to overall traffic noise levels from all port trucks however would be up to approximately 2dBA during some night time hours at capacity. This also complies with EPA criteria. It is recommended that a Port Traffic Noise Management Plan be produced. This plan should consider:

- Traffic re routeing
- Traffic clustering
- Traffic rescheduling

During construction, relatively high noise levels will be generated on the site during certain phases of the work. Although dredging would occur on a 24 hour basis, it is anticipated that noise levels from this operation will not exceed the night time noise criteria. During daytime, some of the noisier activities will generate noise levels which will exceed the appropriate noise criteria at the nearby residences. However, given the

distance from the proposed construction activities to the nearest residences, noise levels from construction will be less than those which often occur for major construction projects in metropolitan areas.

It is recommended that a Construction Noise Management Plan be developed at the time of construction Tender. This Plan would investigate quiet construction methods, noise controls to machines, operator awareness programs, programming to reduce noise impact, complaints handling, and monitoring requirements.

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
Wilkinson Murray Pty Limited is committed to and has implemented AS/NZS ISO 9001 : 1994 "Quality Systems – Model for quality assurance in design, development, production, installation and servicing". This management system has been externally certified and Certificate 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	Date	Status	Prepared by	Checked by
A	19 November 2002	Draft	Roger Roper	Barry Murray
B	December 2002	Draft	Roger Roper	Barry Murray
C	January 2003	Draft	Roger Roper	Barry Murray
D	4 March 2003	Draft	Roger Roper	Barry Murray
E	13 March 2003	Draft	Roger Roper	Barry Murray
F	24 March 2003	Draft	Roger Roper	Barry Murray
G	14 April 2003	Draft	Roger Roper	Barry Murray
H	20 May 2003	Draft	Roger Roper	Barry Murray
I	30 May 2003	Draft	Roger Roper	Barry Murray

References:

Port Botany Freight Rail Project Stage 4, Marrickville Junction to Port Botany, Noise Impact assessment (noise data and mapping), 2002. Environmental Results

Calculation of Road Traffic Noise (CORTN), 1988. Welsh Office of the UK Department of Transport

Environmental Noise Control Manual (ENCM), 1994. New South Wales, Environment Protection Authority

Environmental Criteria for Road Traffic Noise (ECRTN), 1999. New South Wales, Environment Protection Authority

NSW Industrial Noise Policy (INP), 2000. New South Wales, Environment Protection Authority

Construction Vibrations, 1996. Charles H Dowding

An evaluation of the UK DoE Traffic Noise Prediction Method, 1983. Australian Road Research Board Research Report

Botany Goods Line, Marrickville to Alexandria Canal Operational Enhancements, Noise Mitigation Assessment 2000. Richard Heggie Associates

Figure 1A: Proposed Site Layout

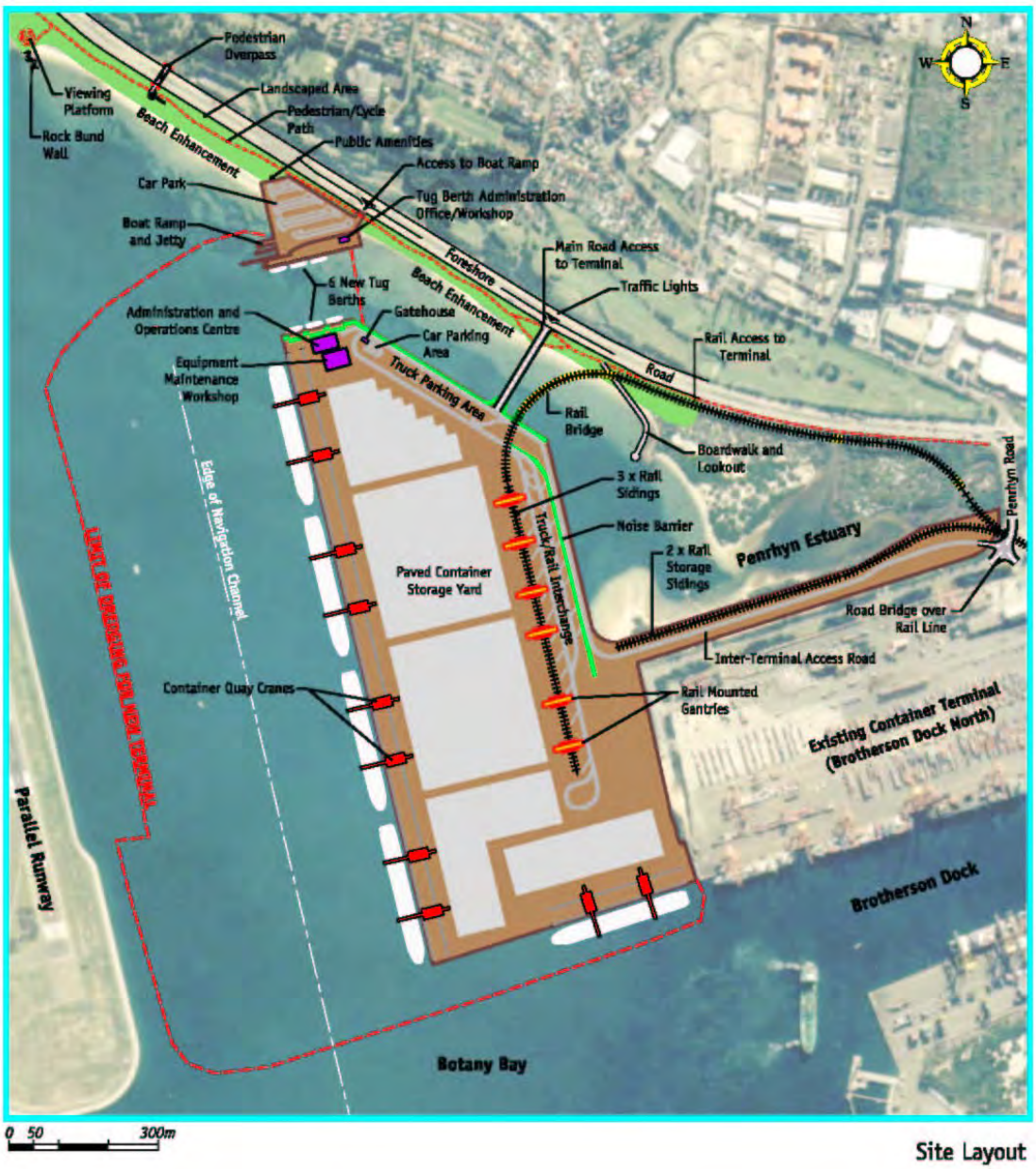


Figure 1B: Ambient Noise Monitoring Locations

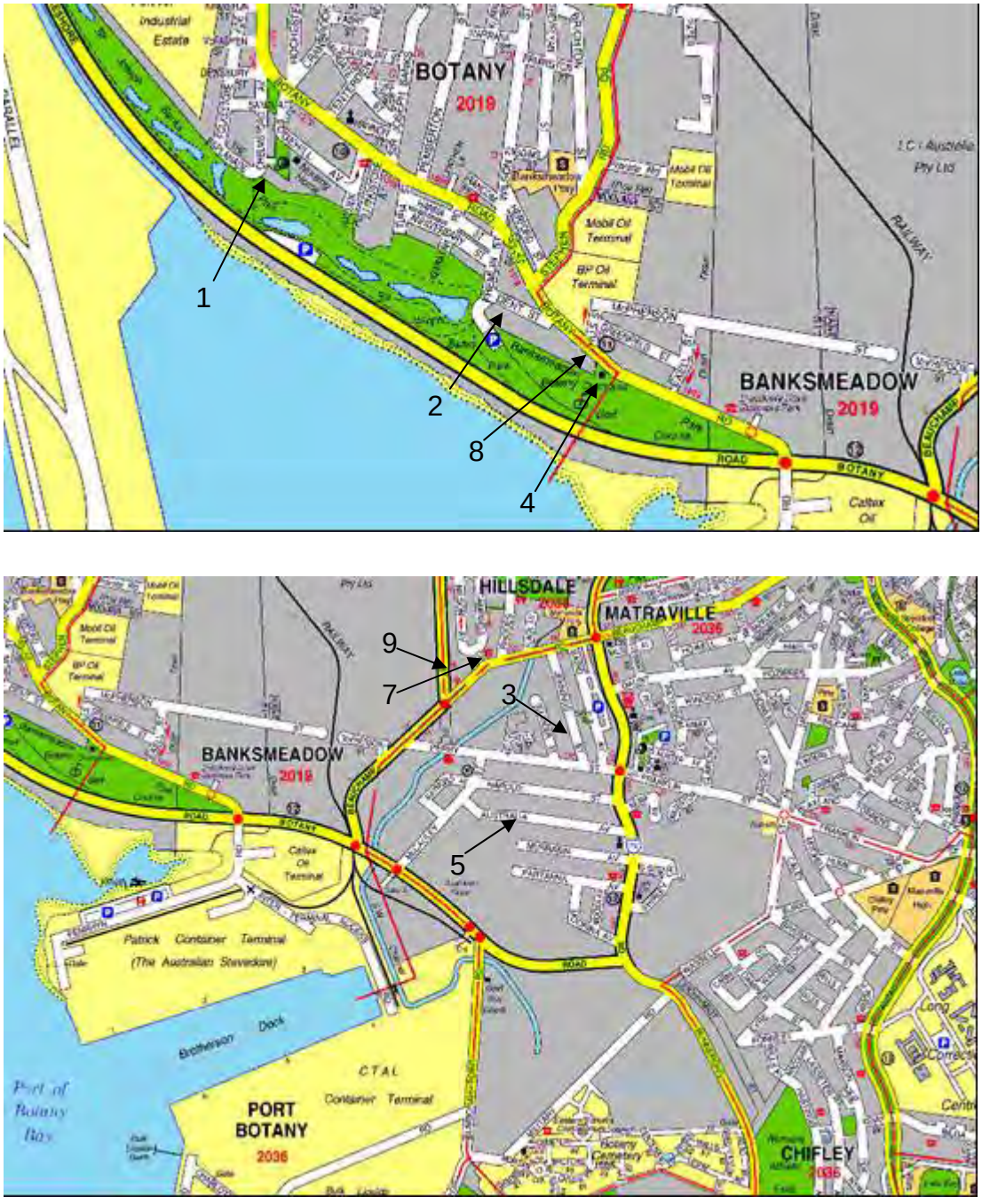


Figure 1C: Proposed Noise Barrier Location

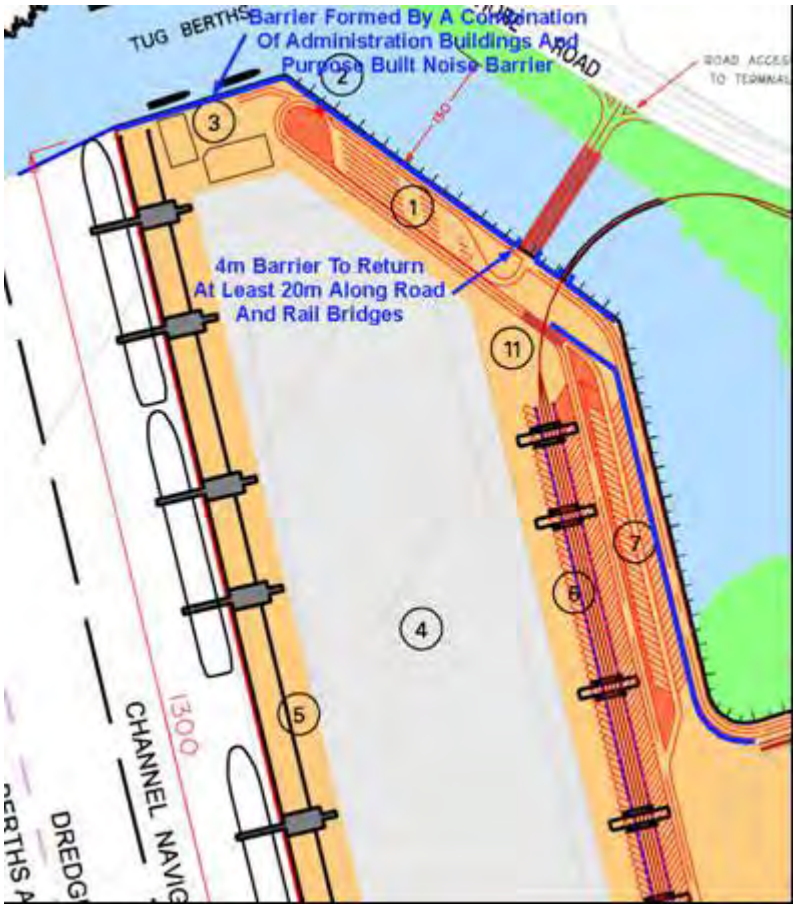


Figure 2: Predicted L_{Aeq} Noise Levels For Neutral Conditions

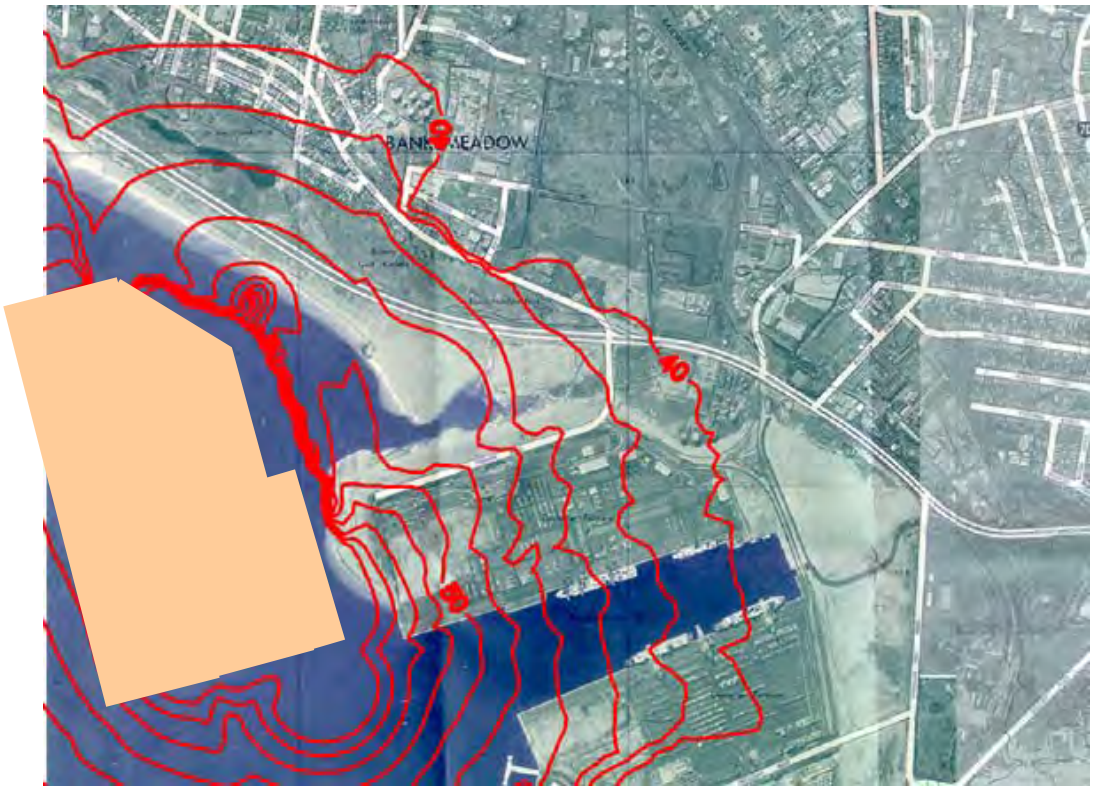
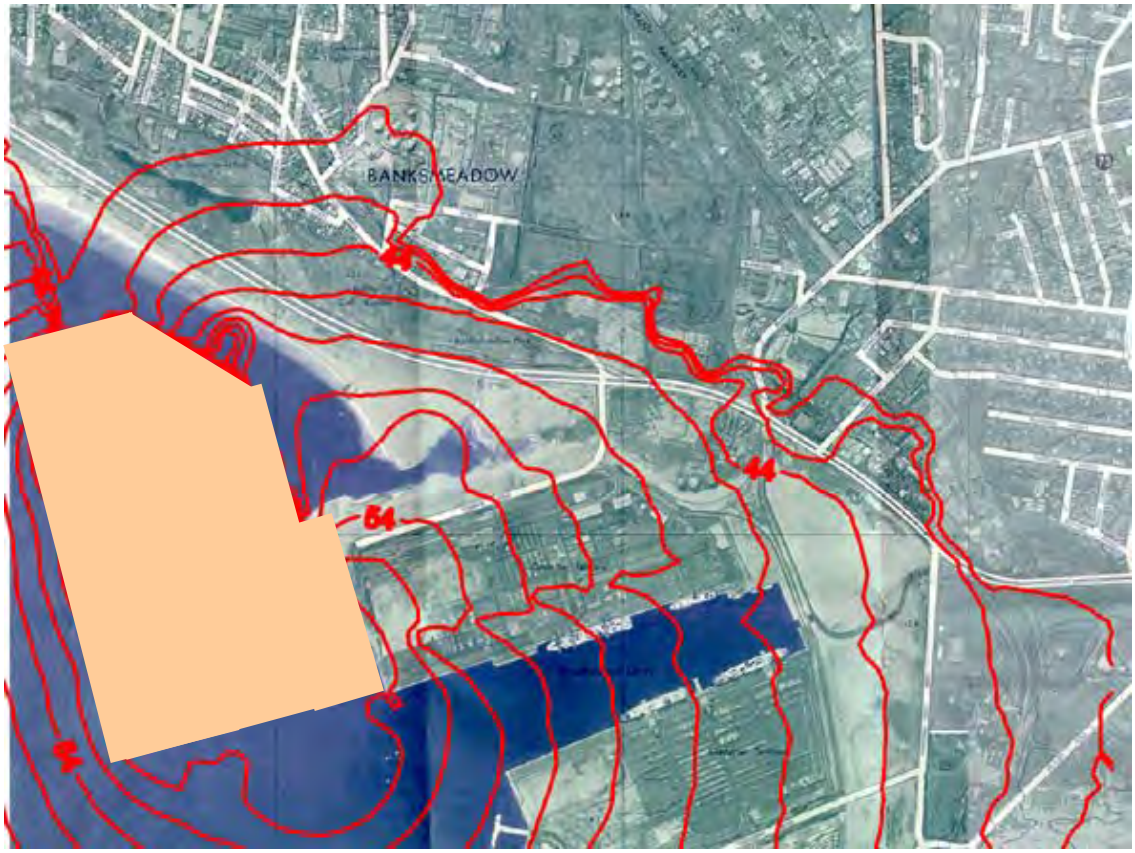


Figure 3: Predicted L_{Aeq} Noise Levels For 3m Wind from NW



APPENDIX A

NOISE DESCRIPTORS

NOISE DESCRIPTORS

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 below, 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.

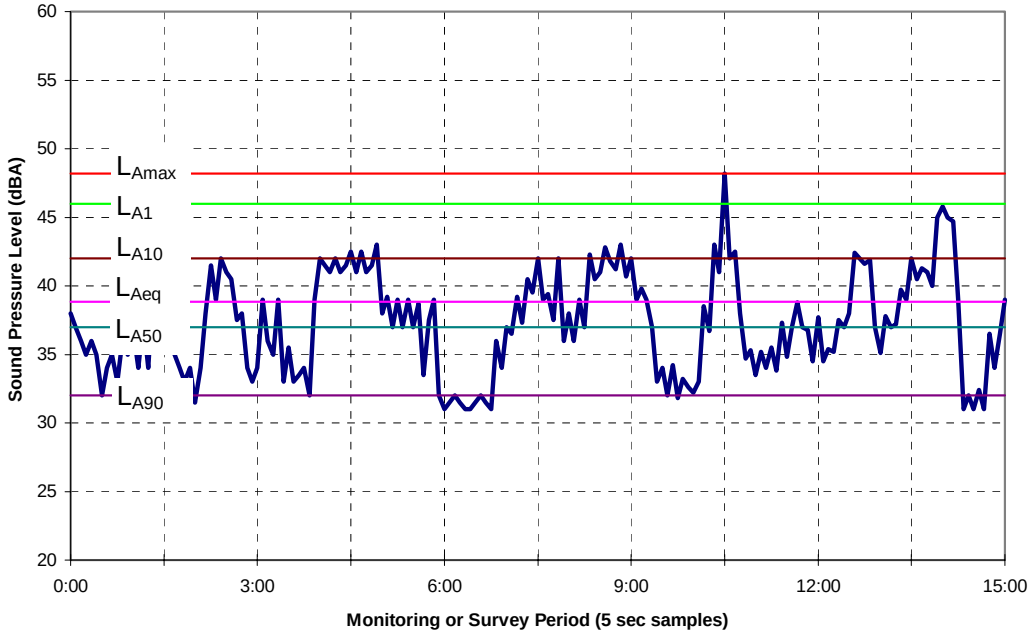
L_{Aeq}. The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and 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 (day, evening and night) 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 medium value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period, day, evening and night.


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)

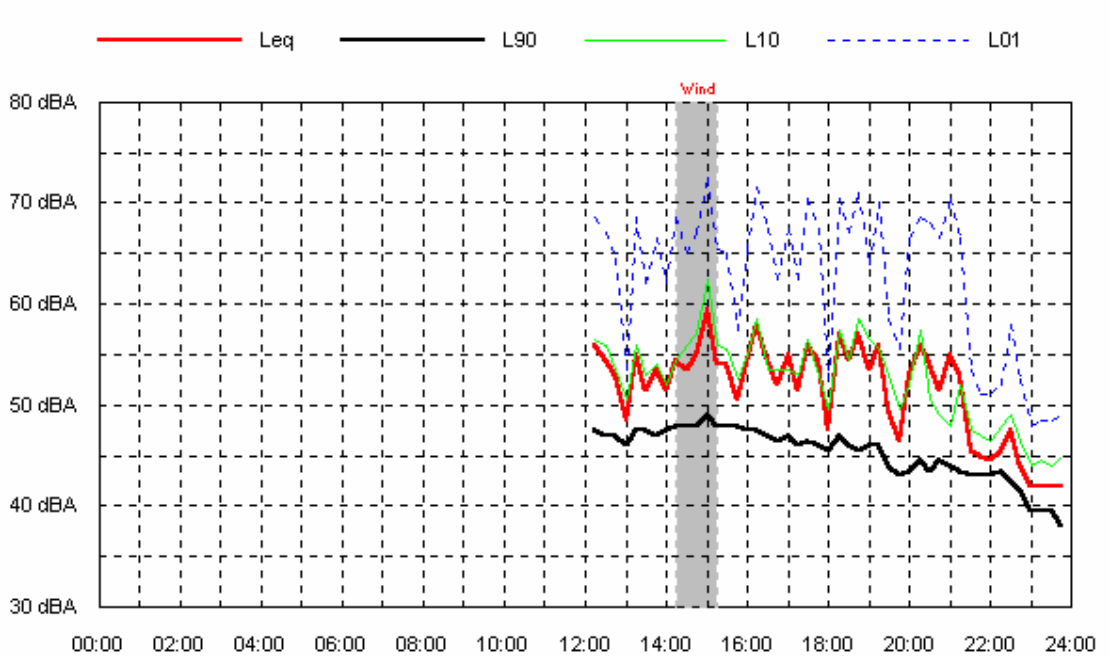
APPENDIX B

AMBIENT NOISE LEVELS

Location: Chelmsford Avenue

Data shaded: Wind; Rain

Wed 10 Apr 02



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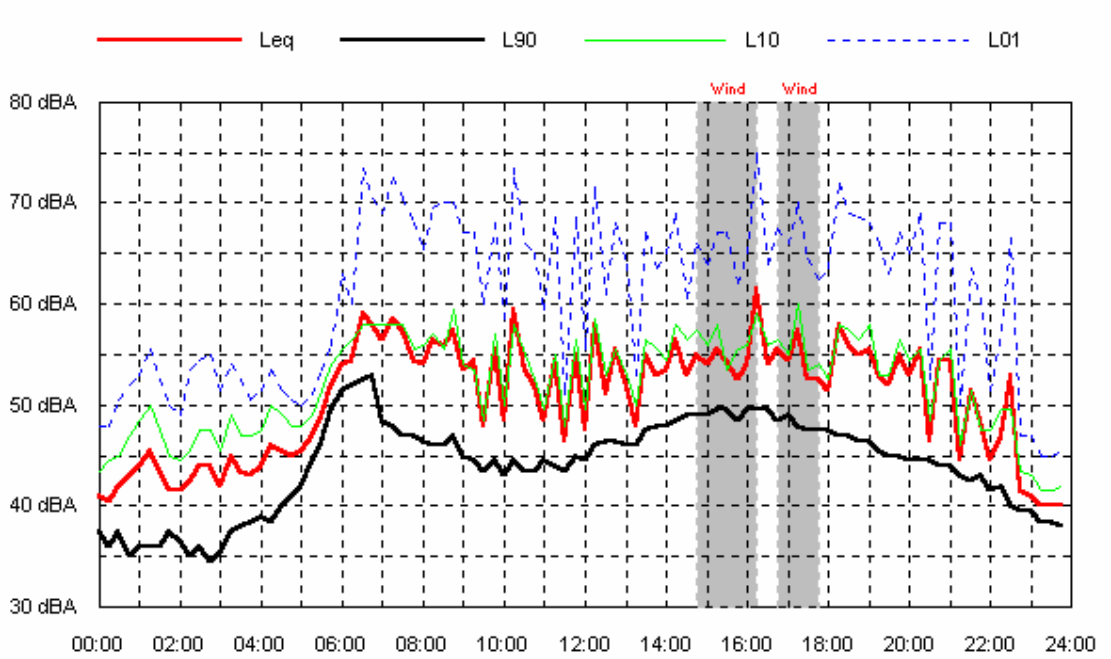

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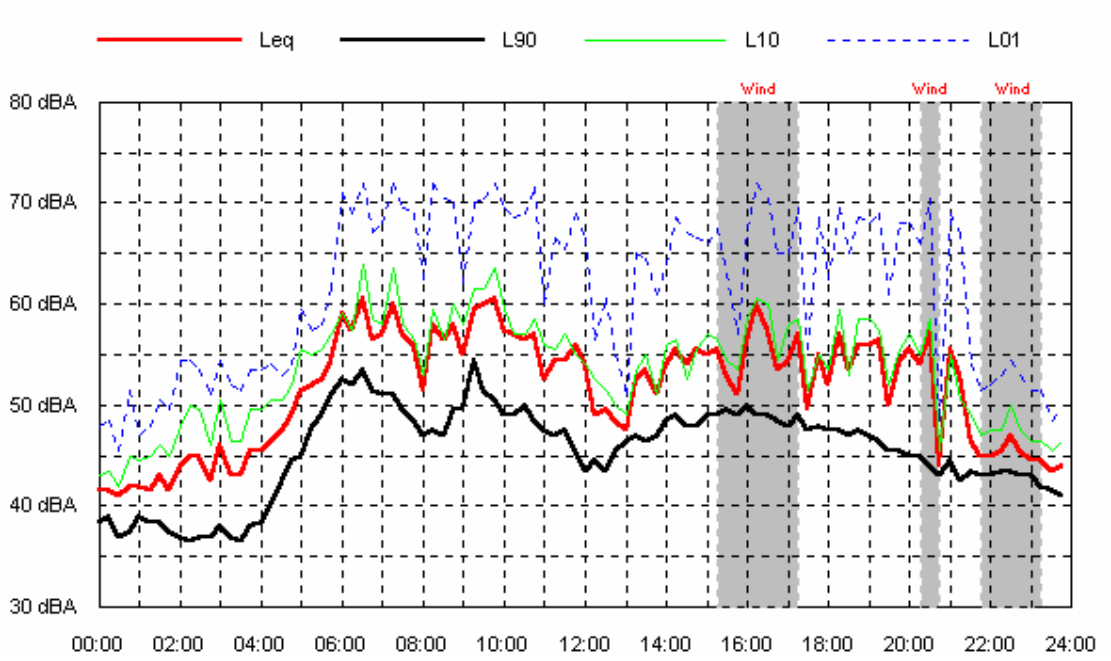

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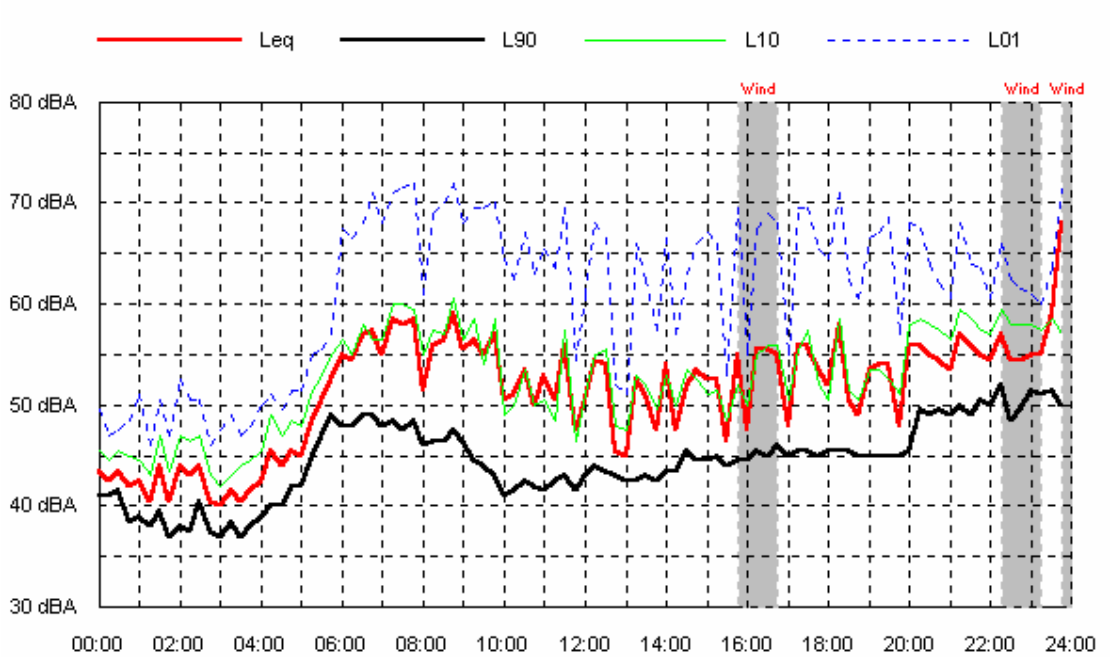

Location: Chelmsford Avenue

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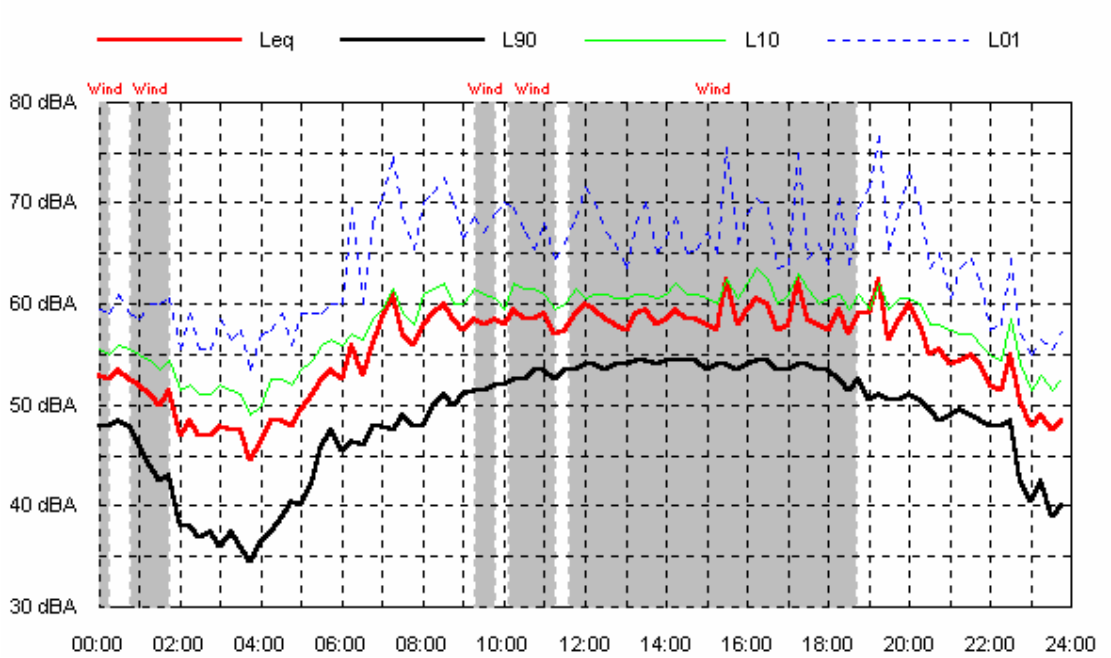

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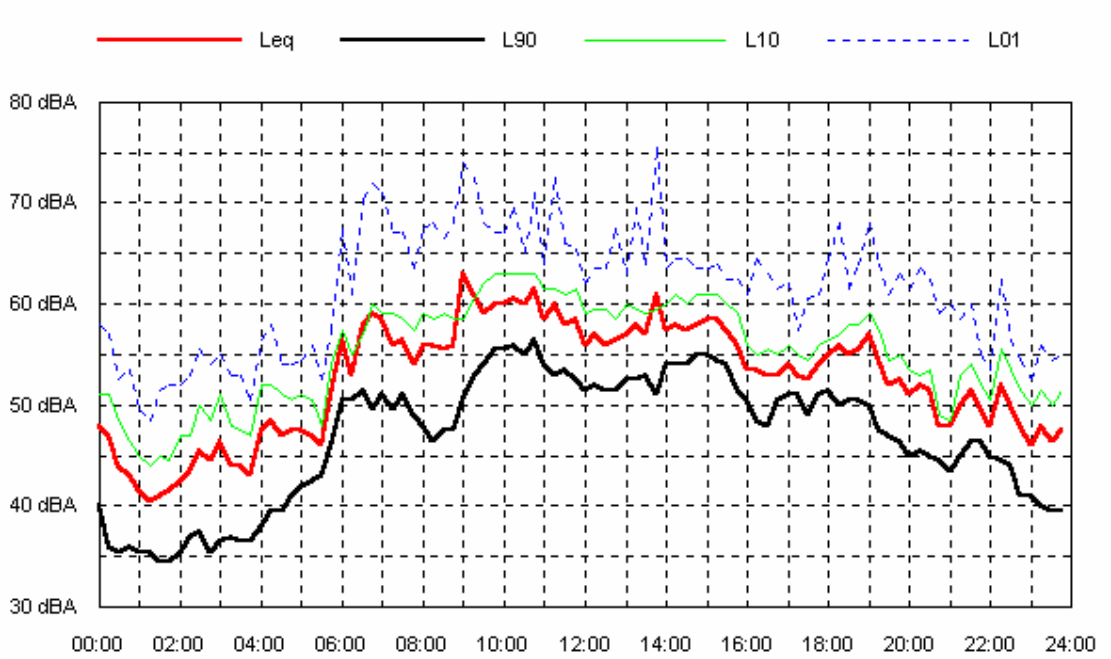

Location: Chelmsford Avenue

Data shaded: Wind; Rain

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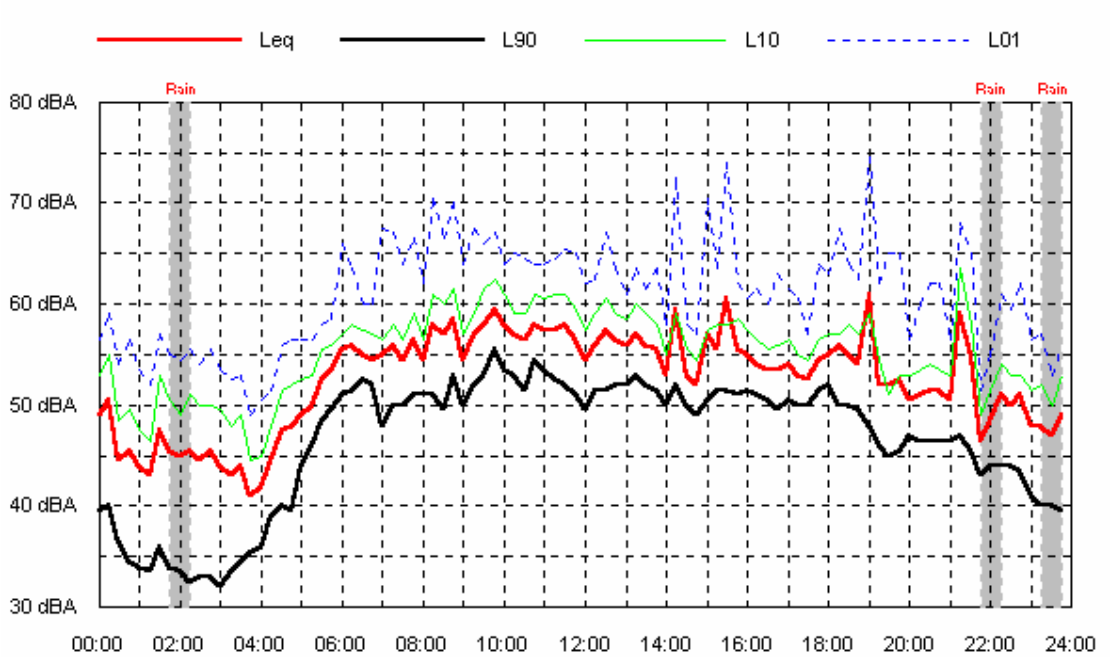

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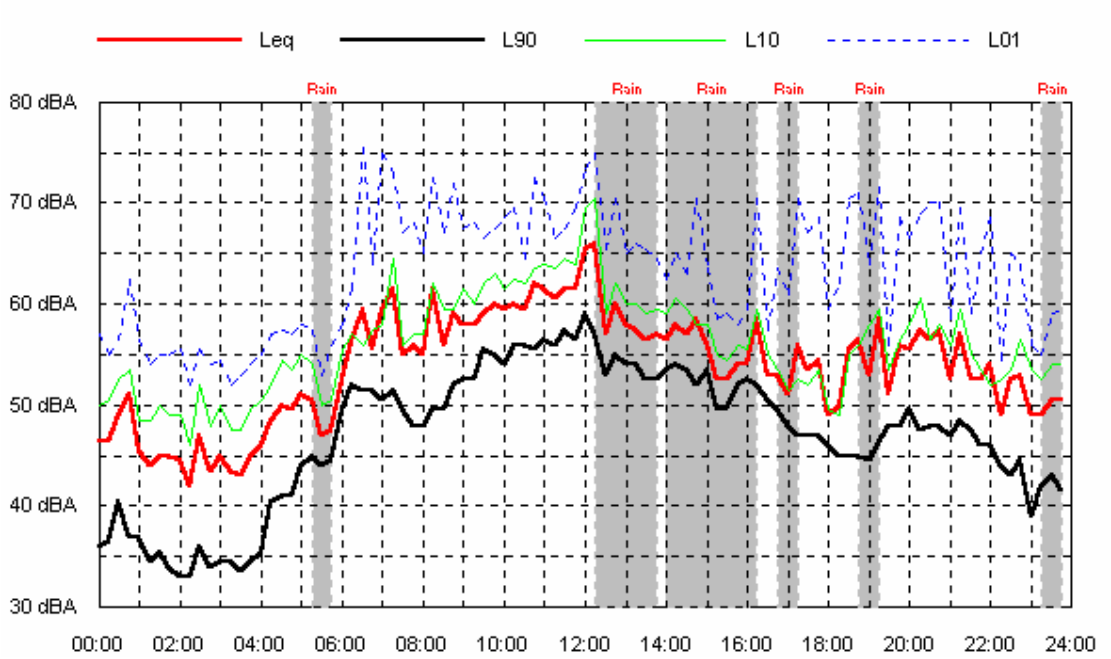

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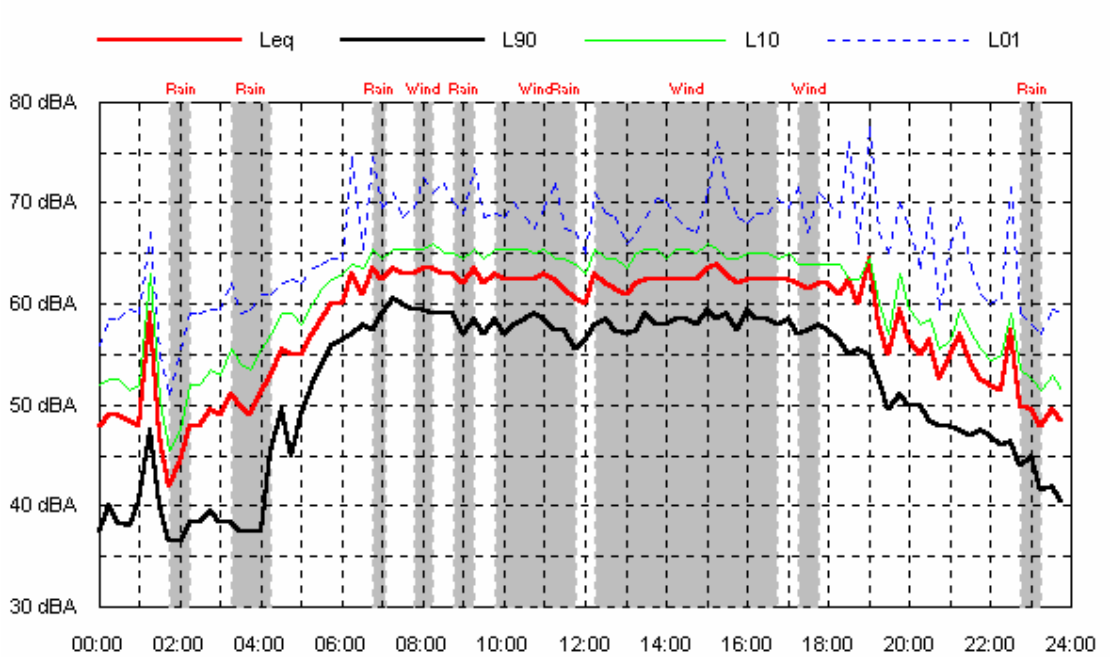

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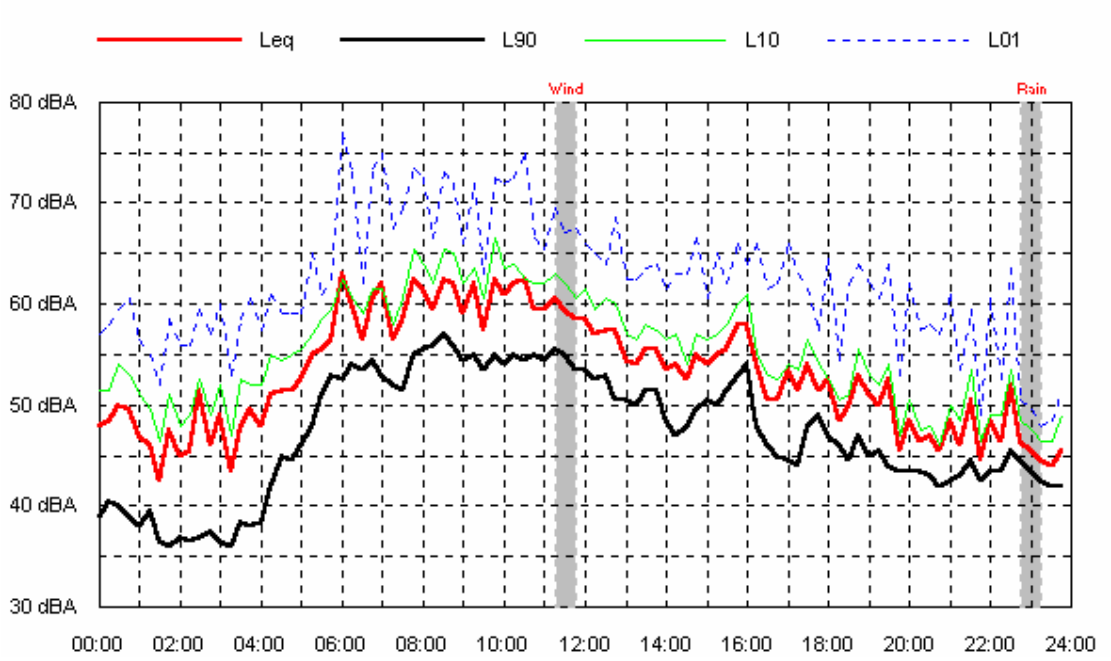

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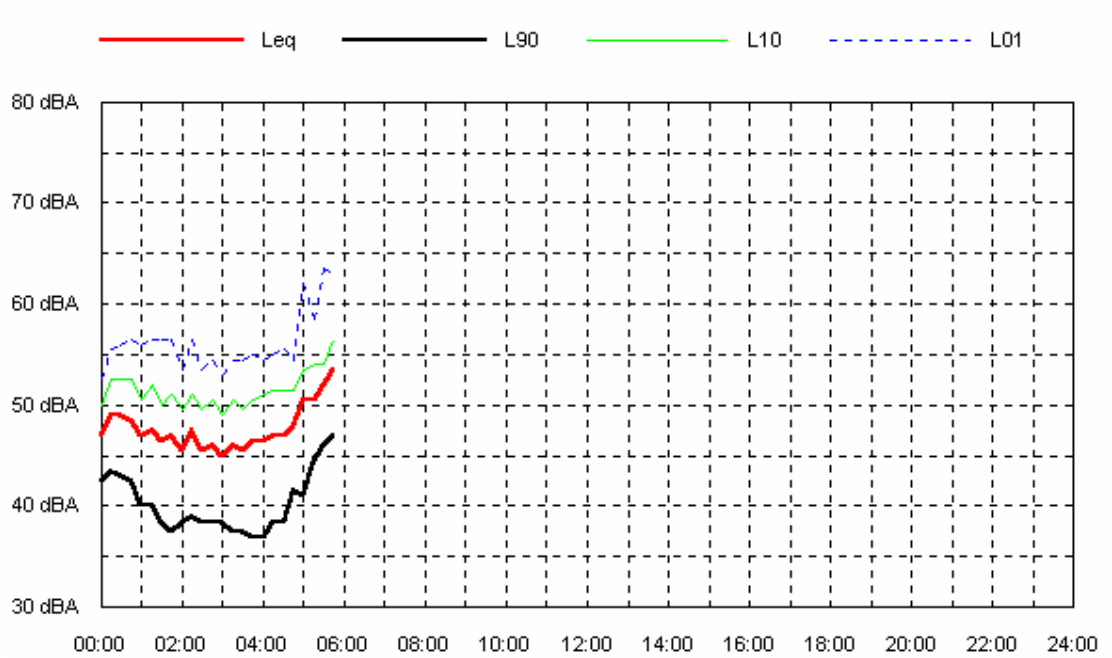

Location: 34 Dent Street

Data shaded: Wind; Rain

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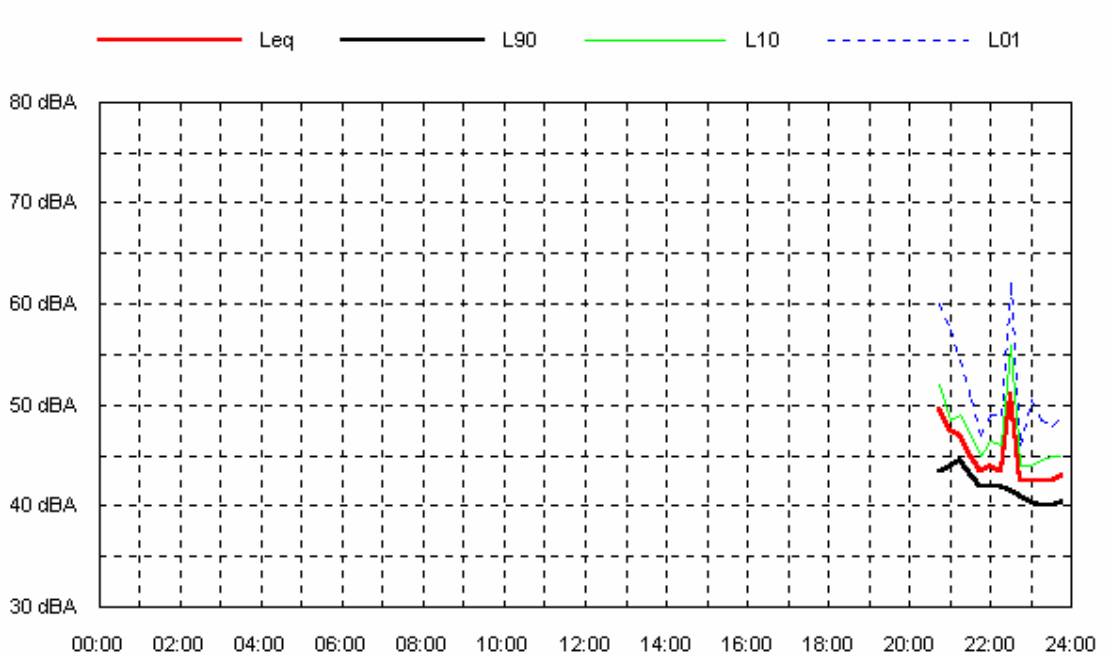

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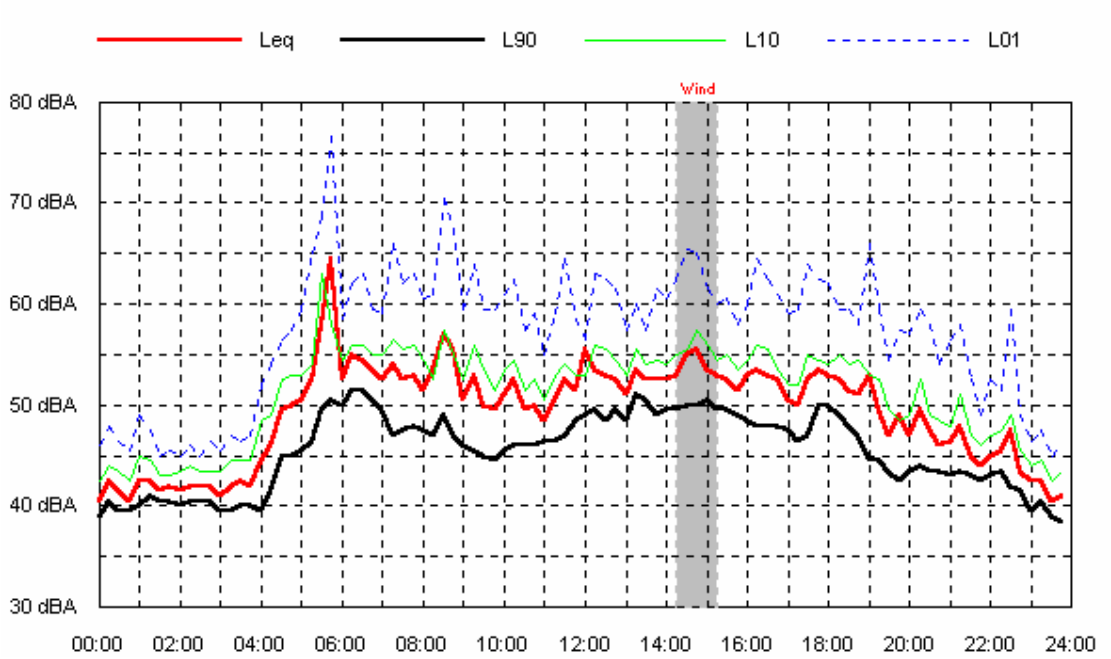

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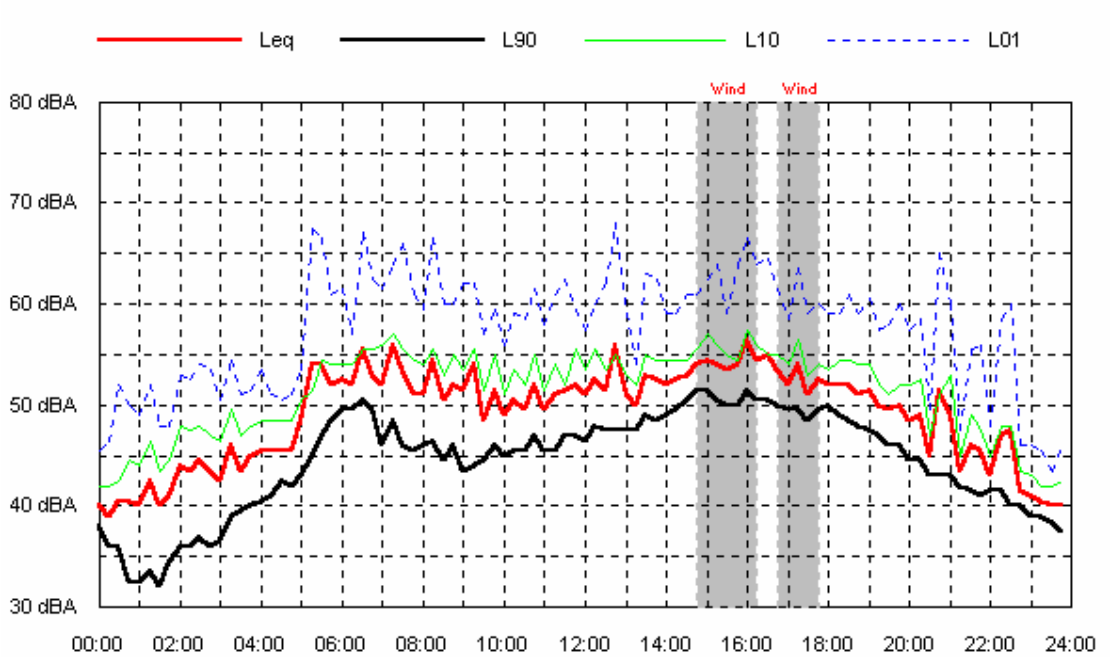

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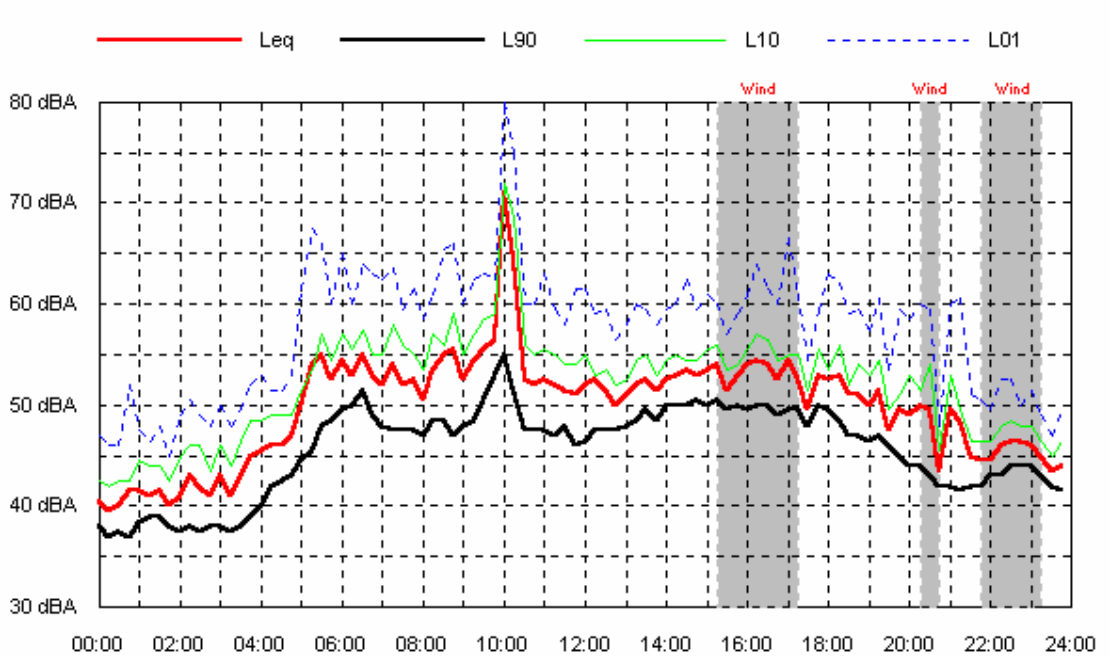

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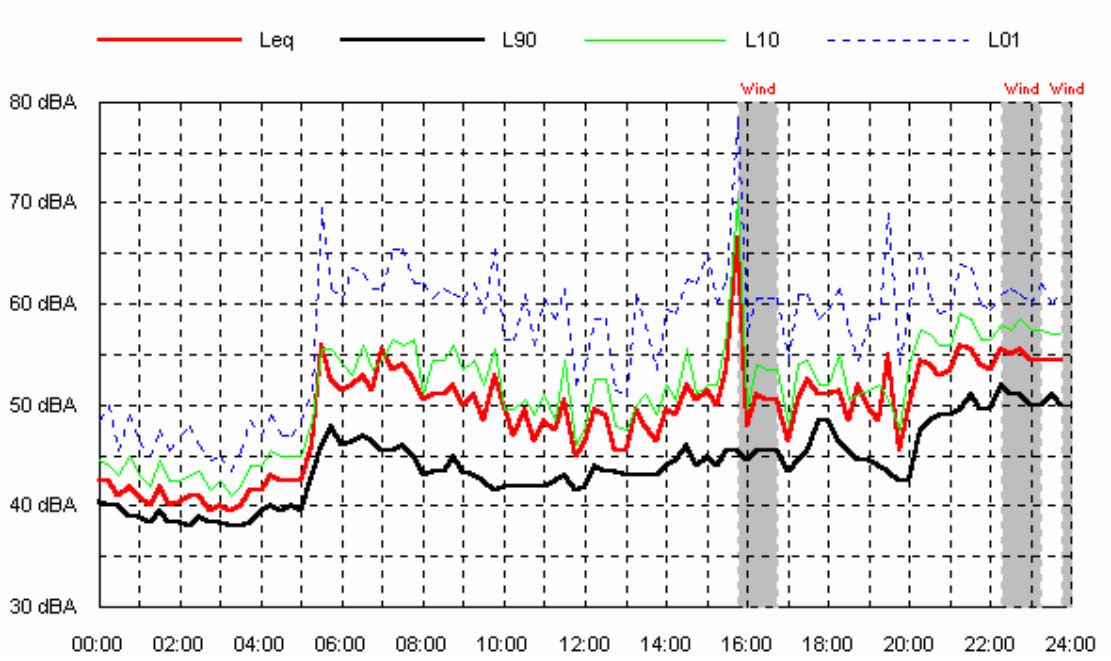

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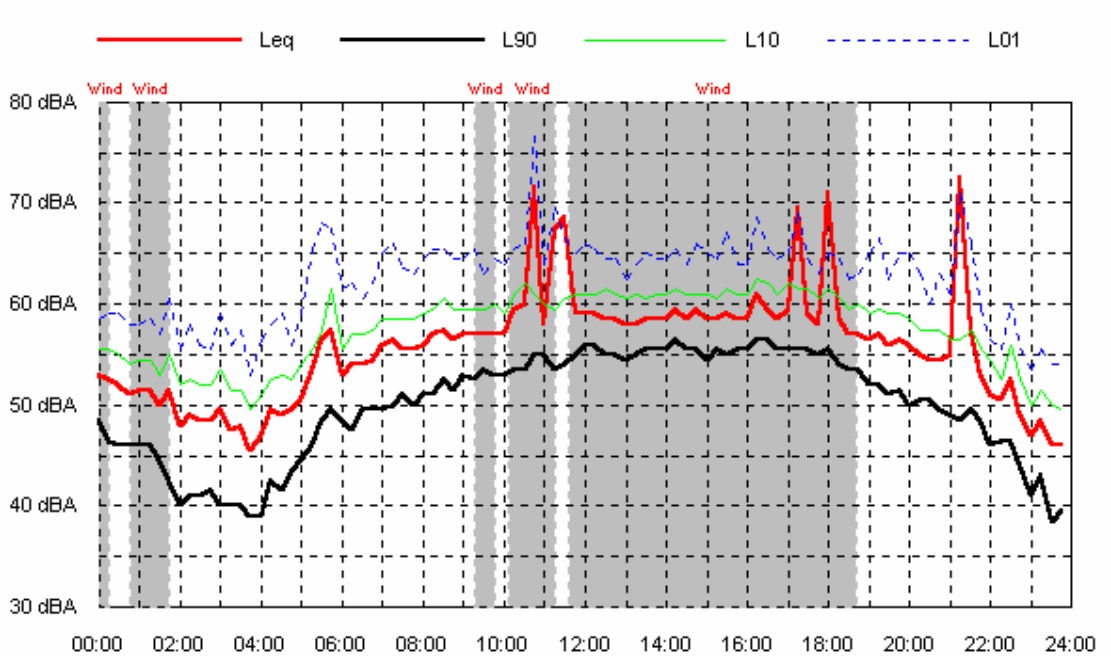

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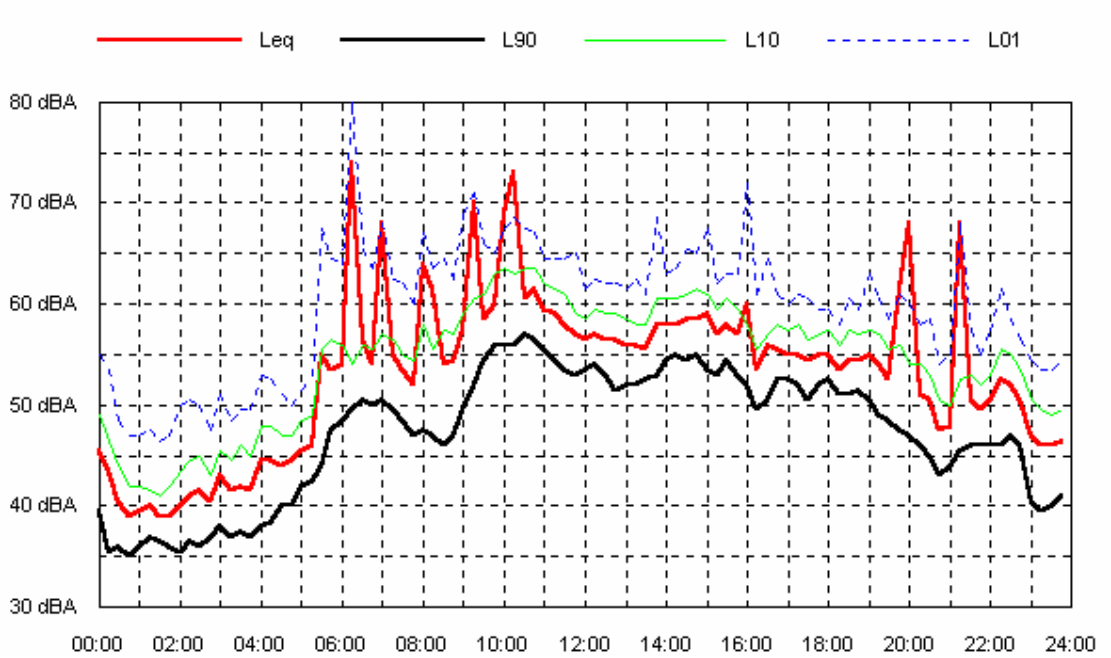

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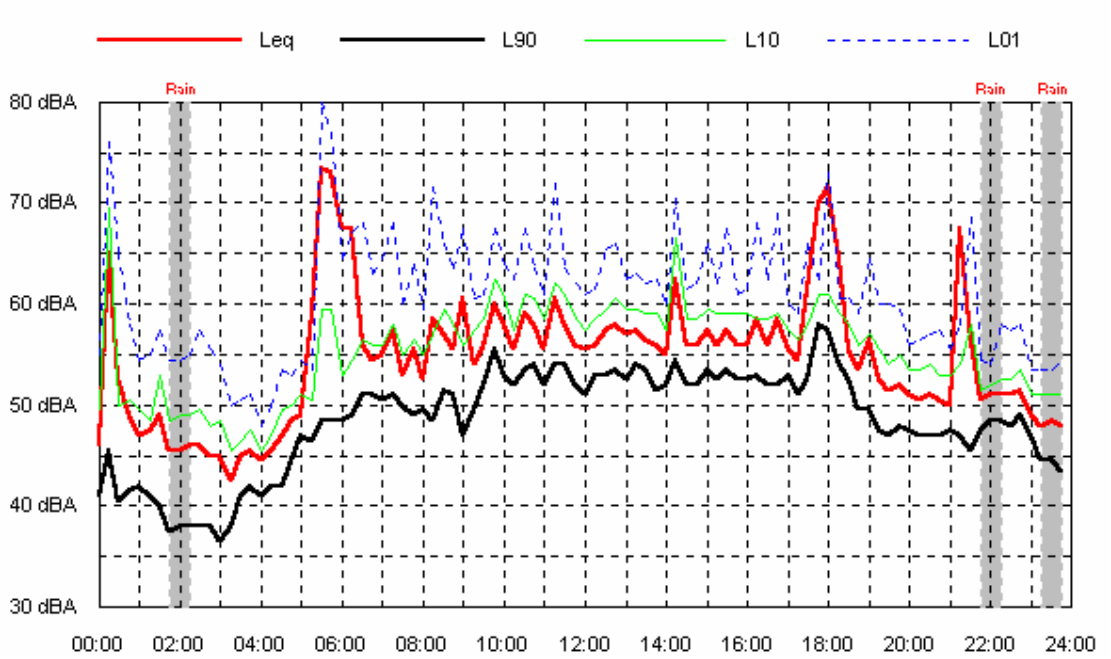

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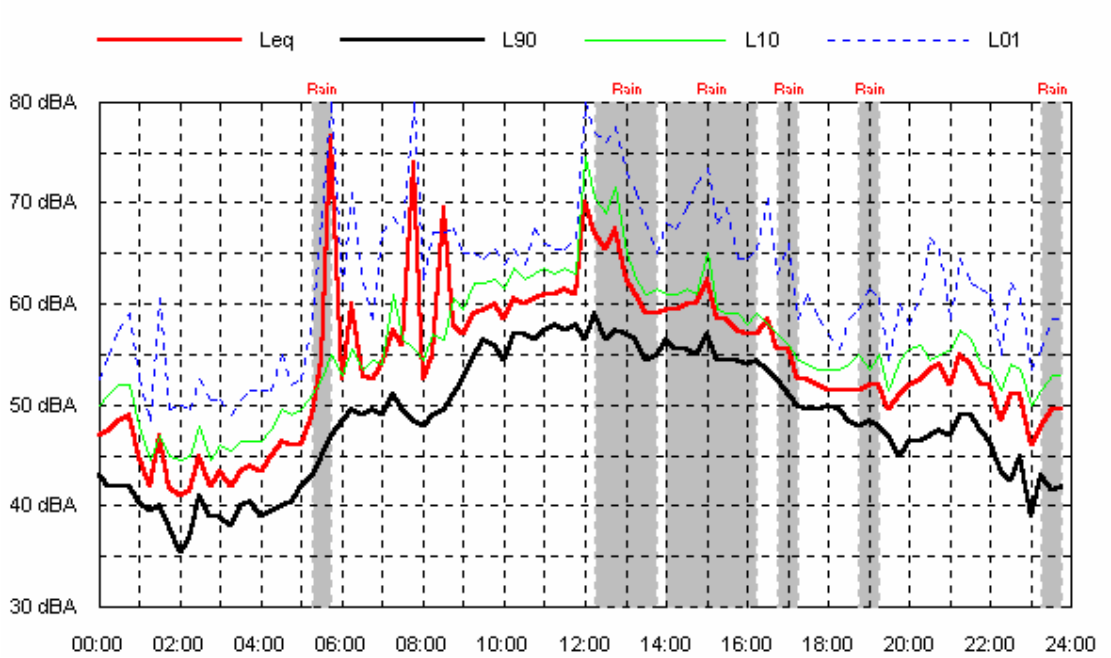

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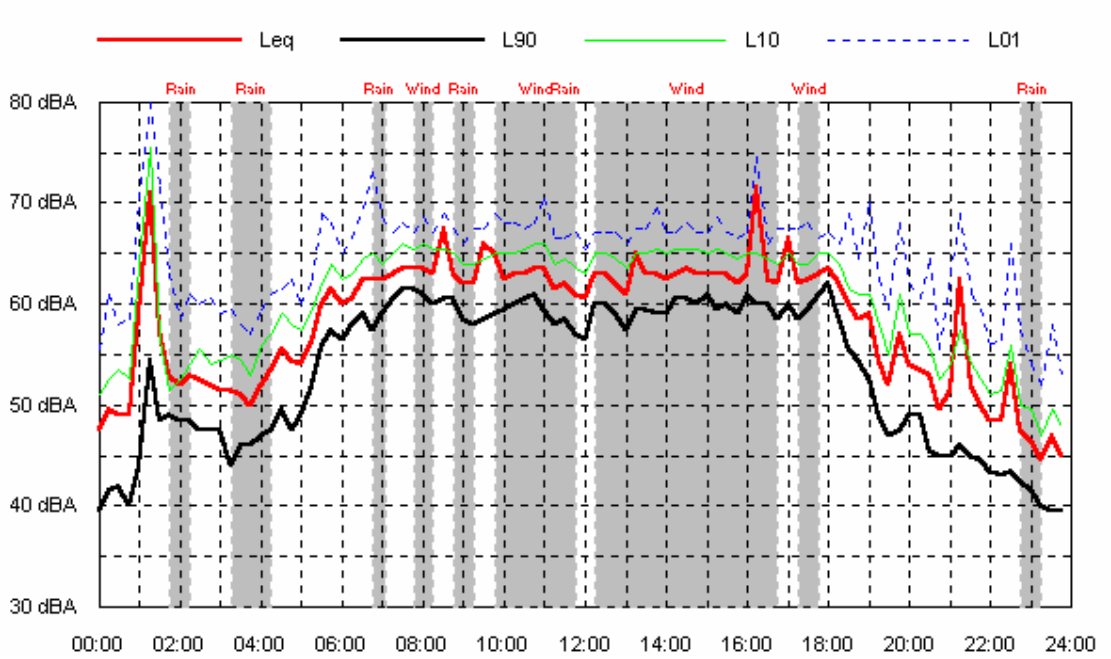

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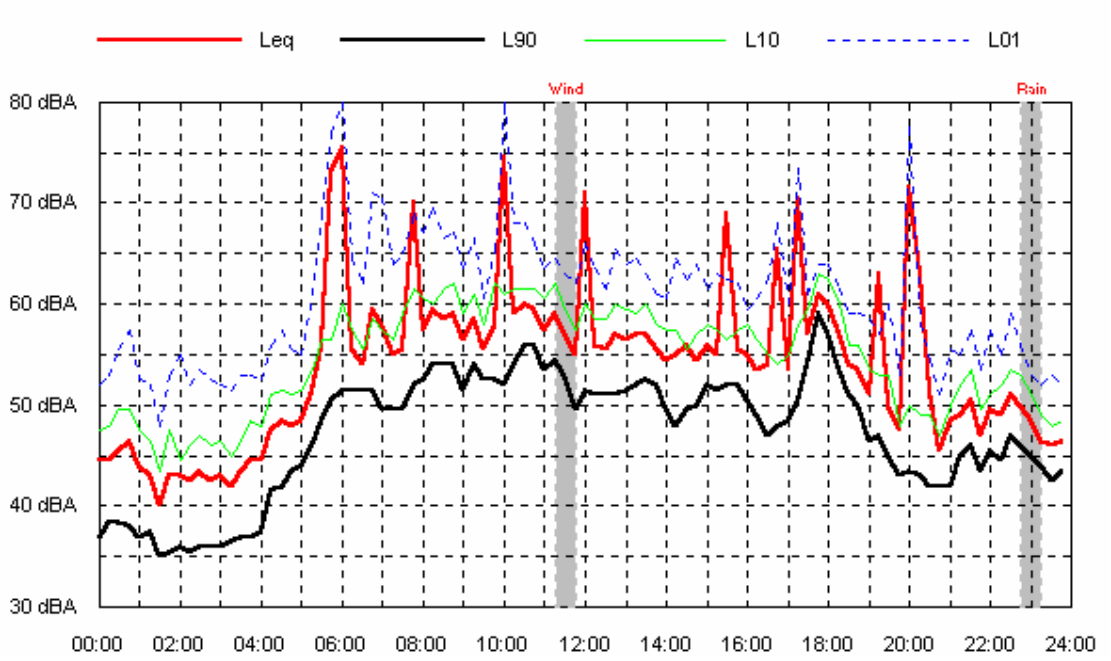

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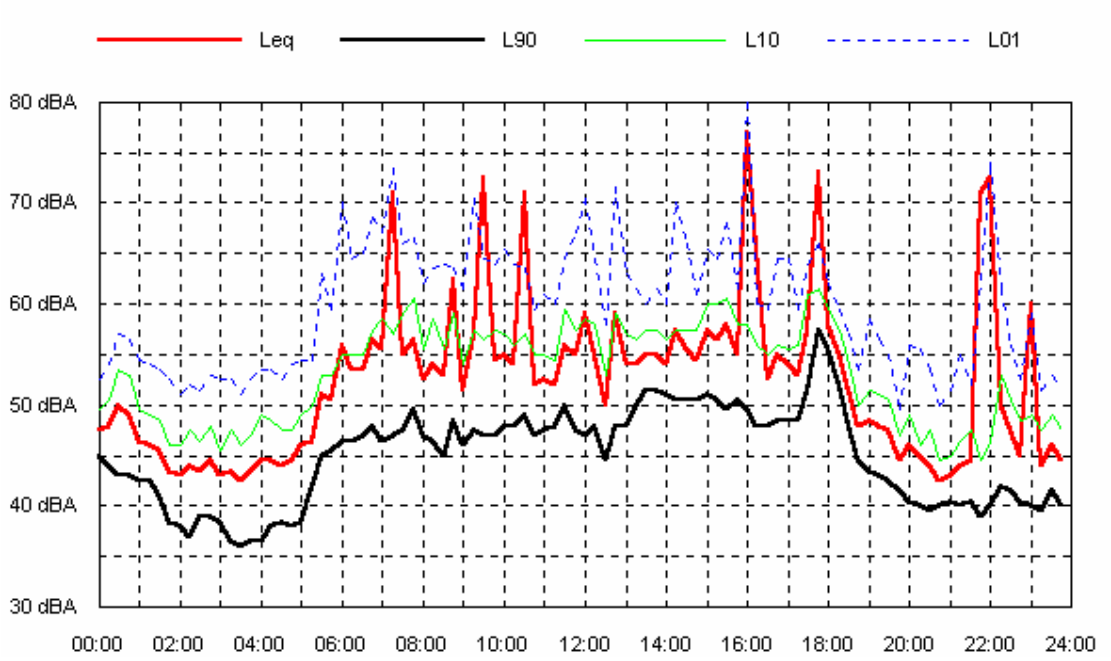

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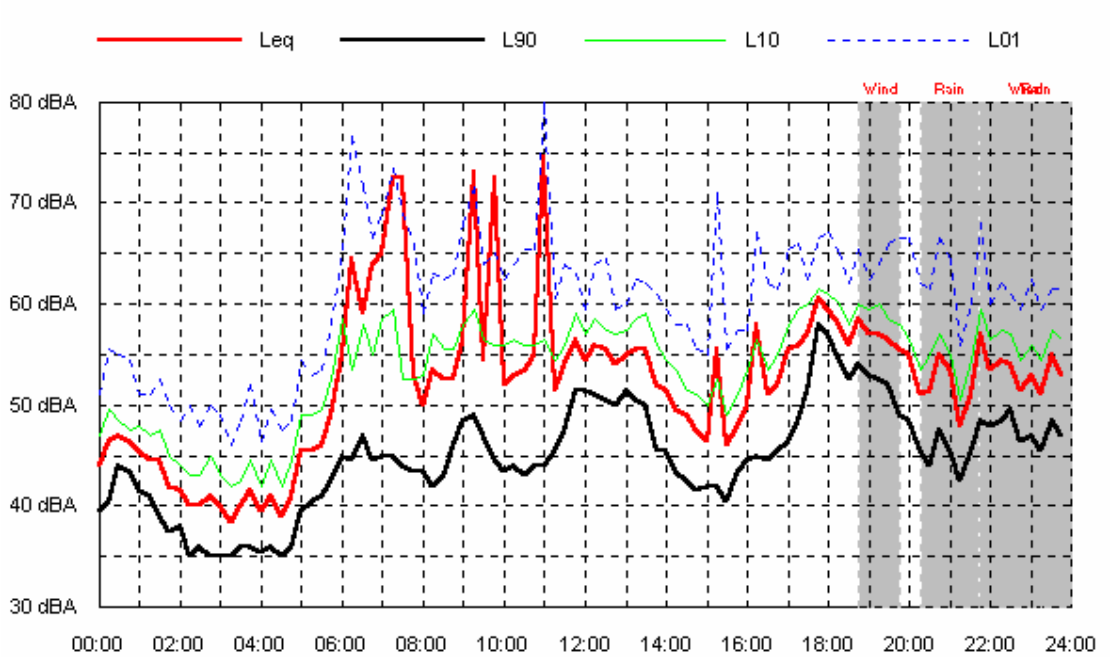

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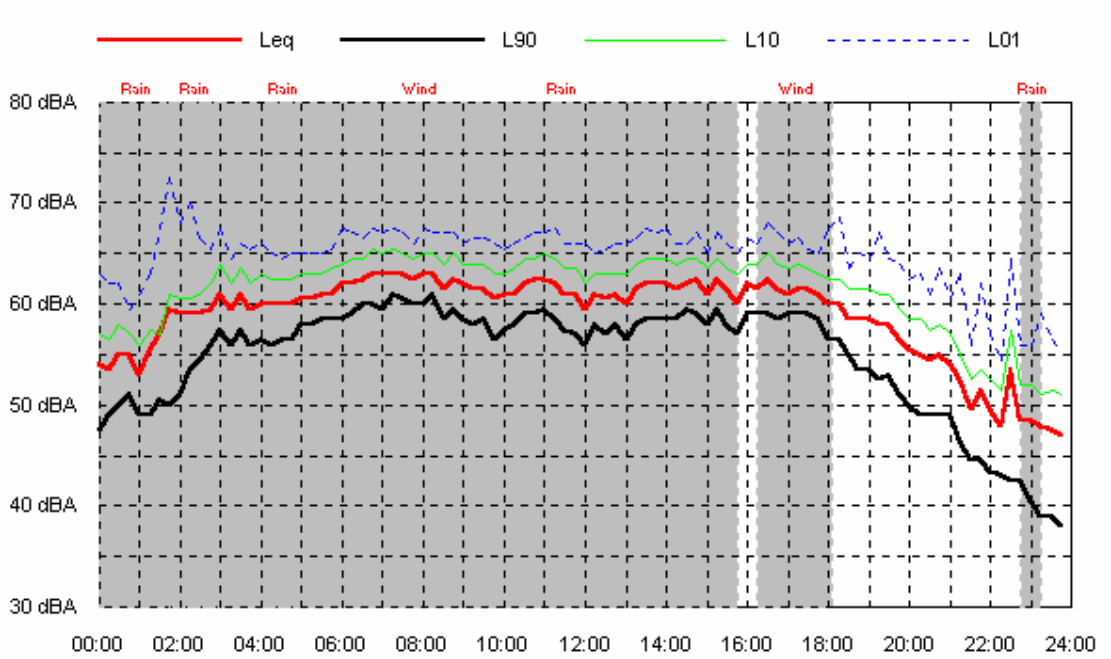

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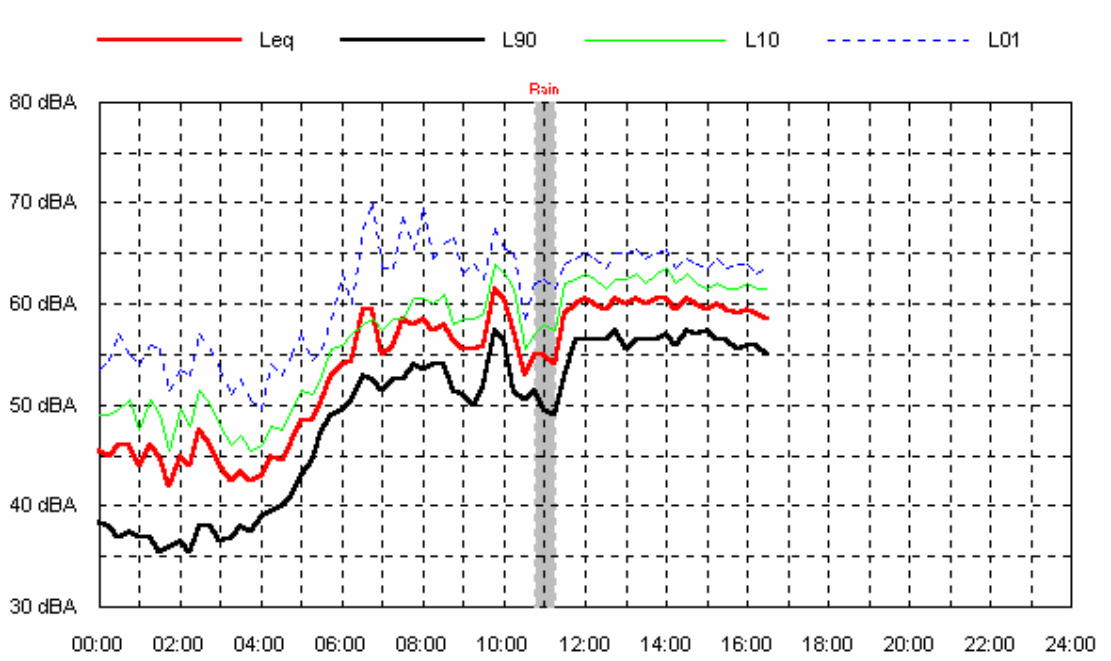

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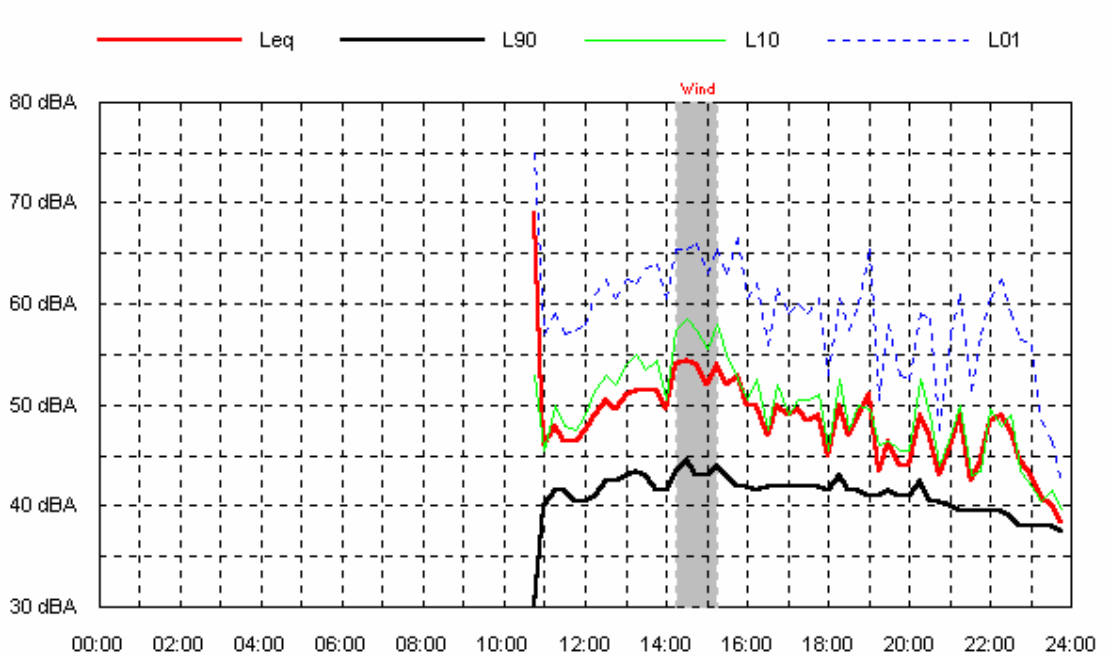

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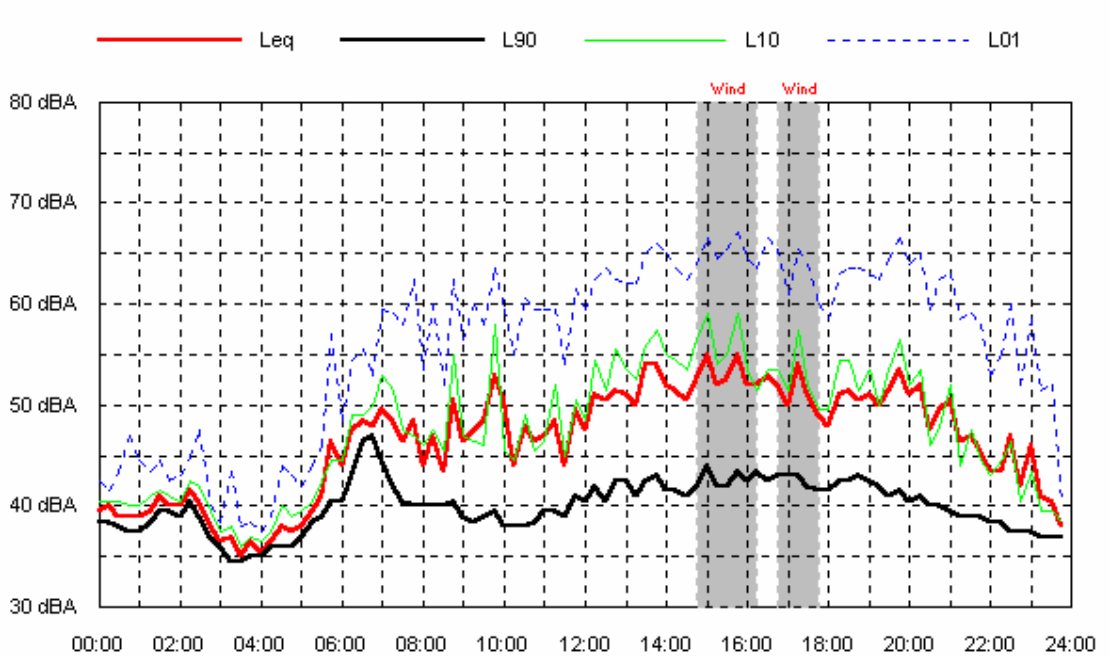

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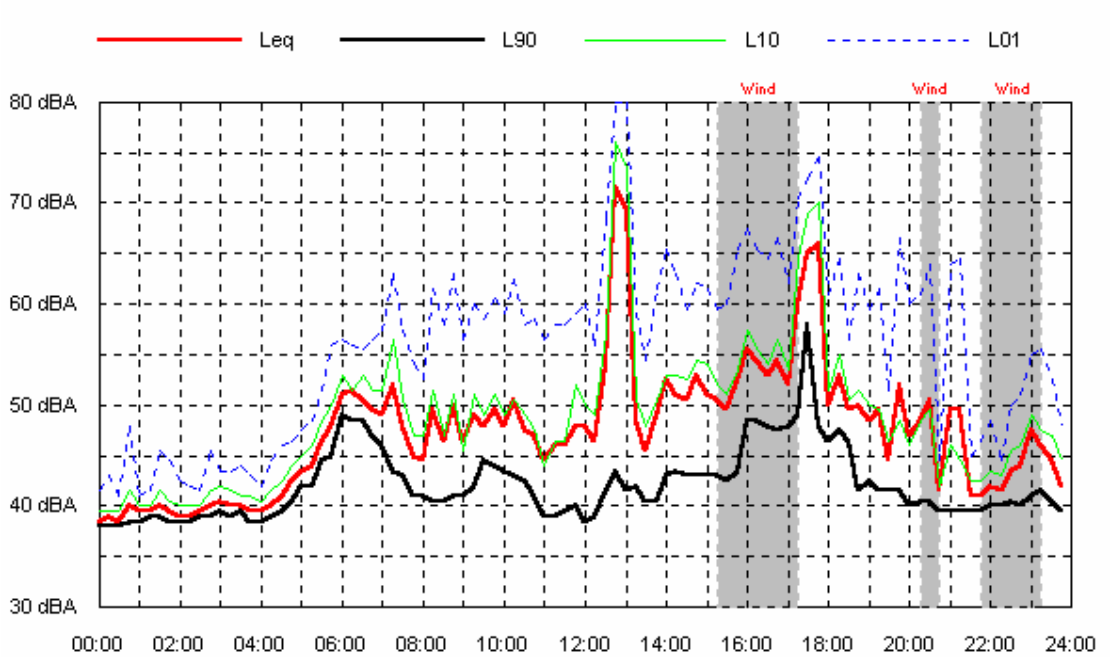

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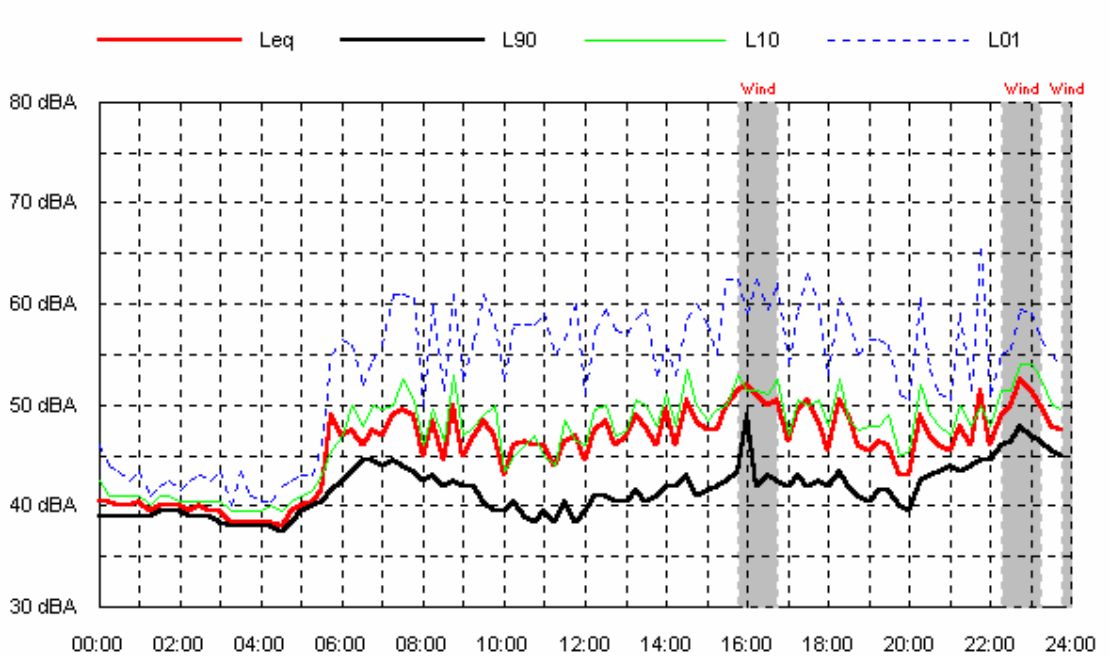

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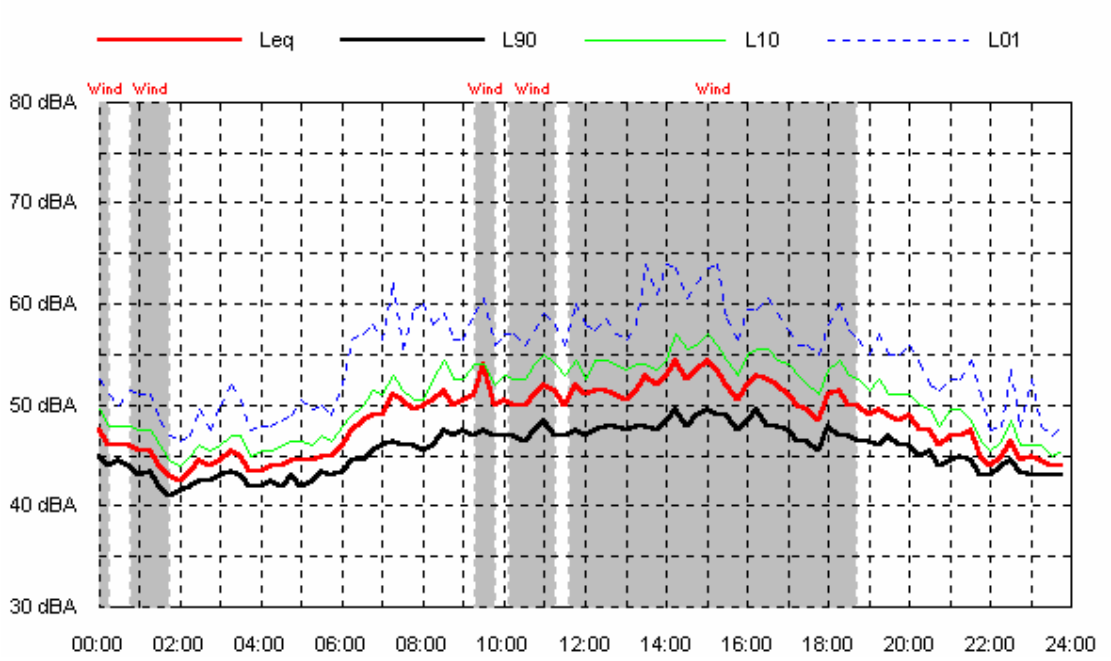
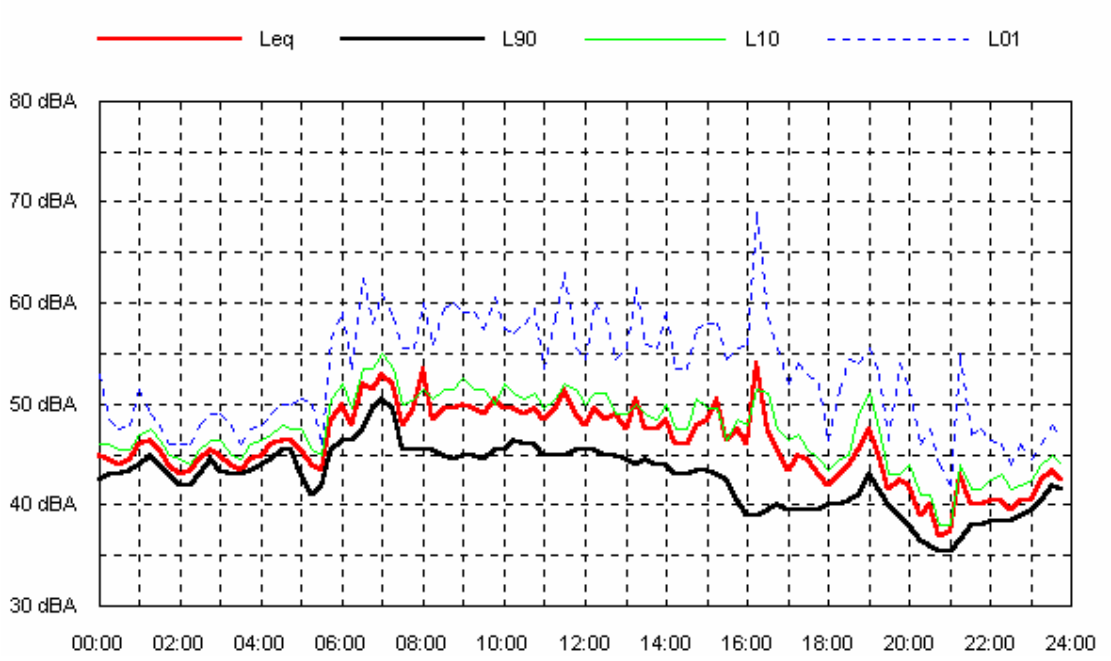


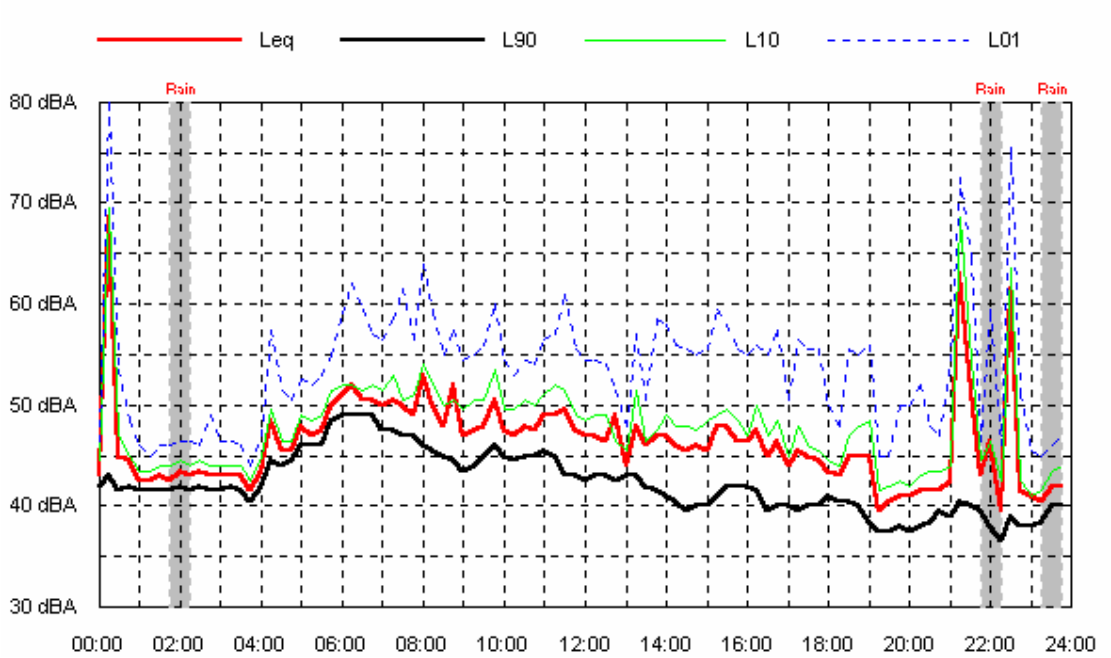
Mon 15 Apr 02



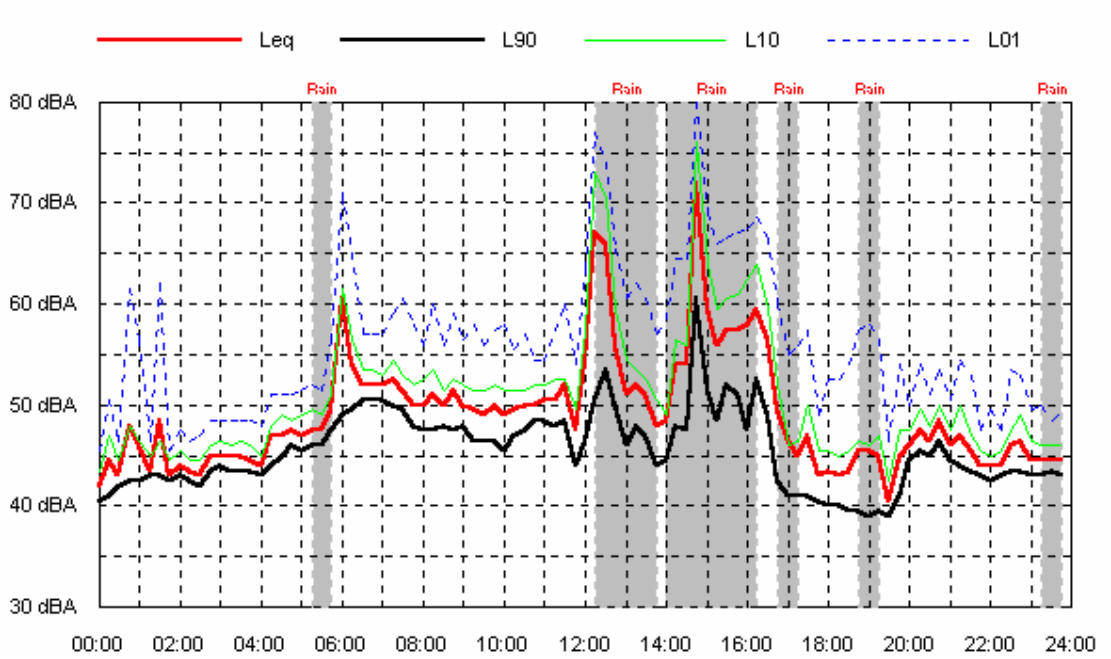
Location: 42 Jennings Street

Data shaded: Wind; Rain

Tue 16 Apr 02



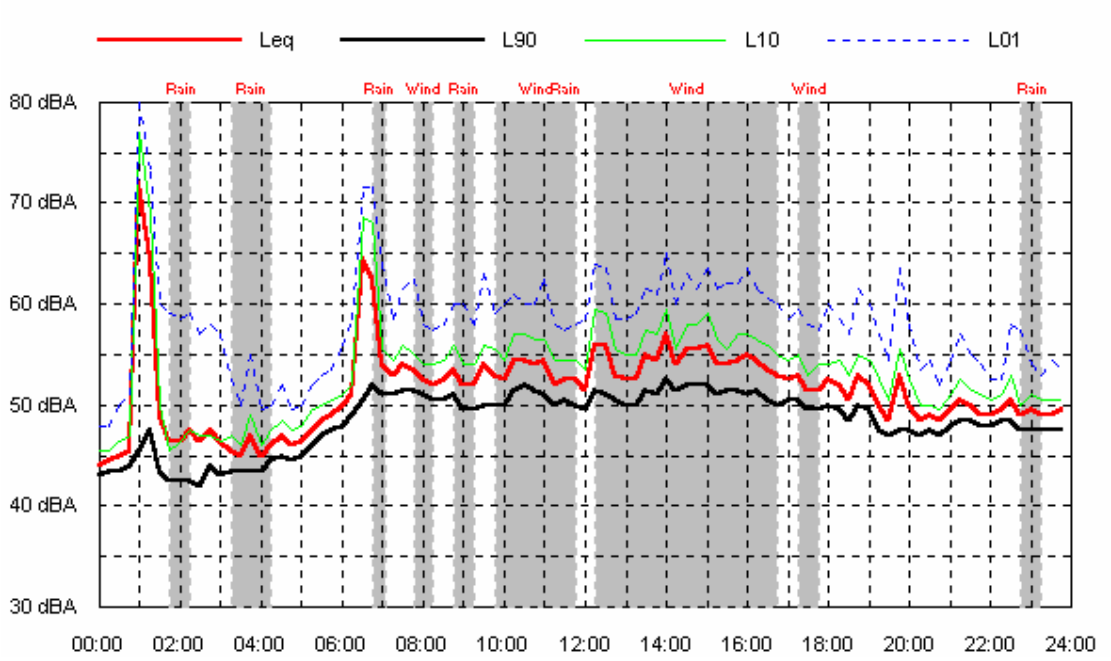
Wed 17 Apr 02



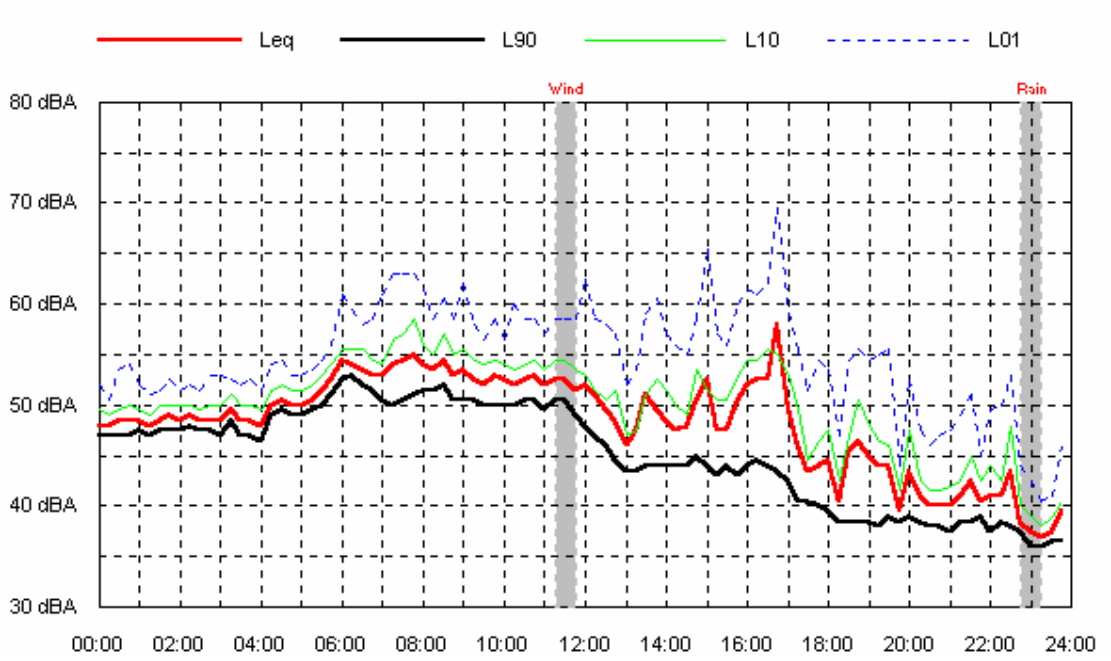
Location: 42 Jennings Street

Data shaded: Wind; Rain

Thu 18 Apr 02



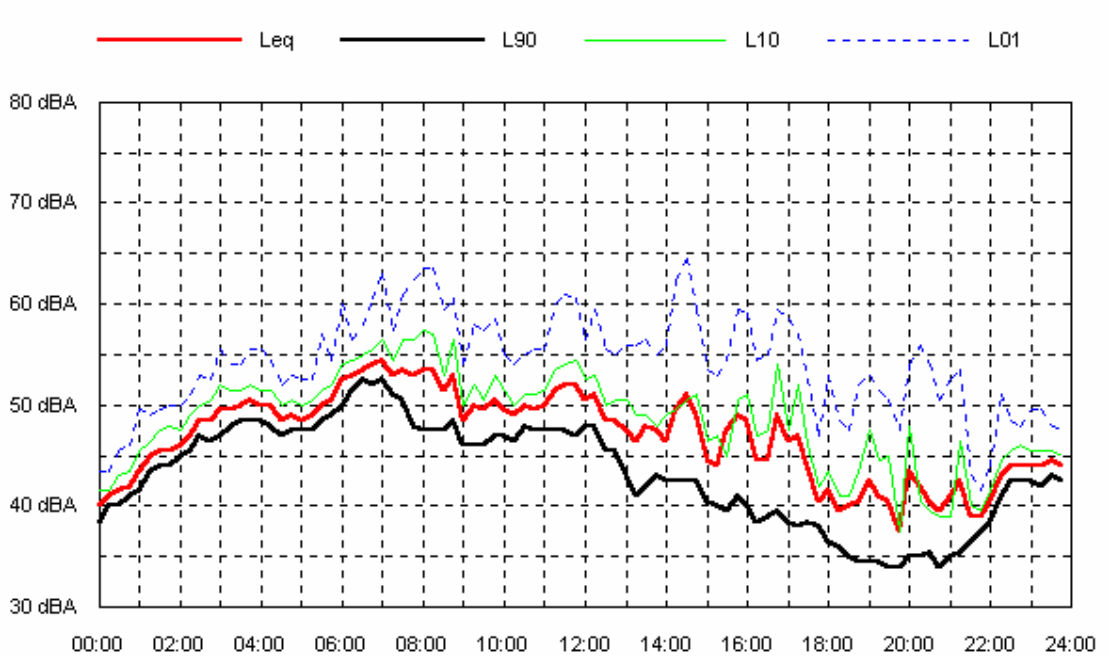
Fri 19 Apr 02



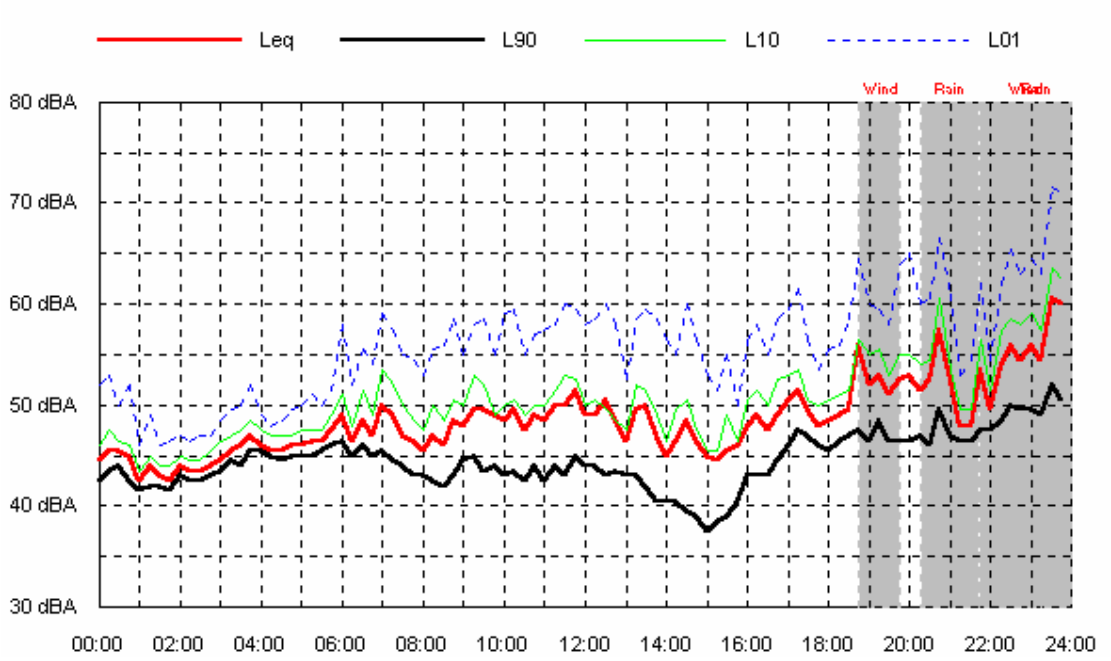
Location: 42 Jennings Street

Data shaded: Wind; Rain

Sat 20 Apr 02



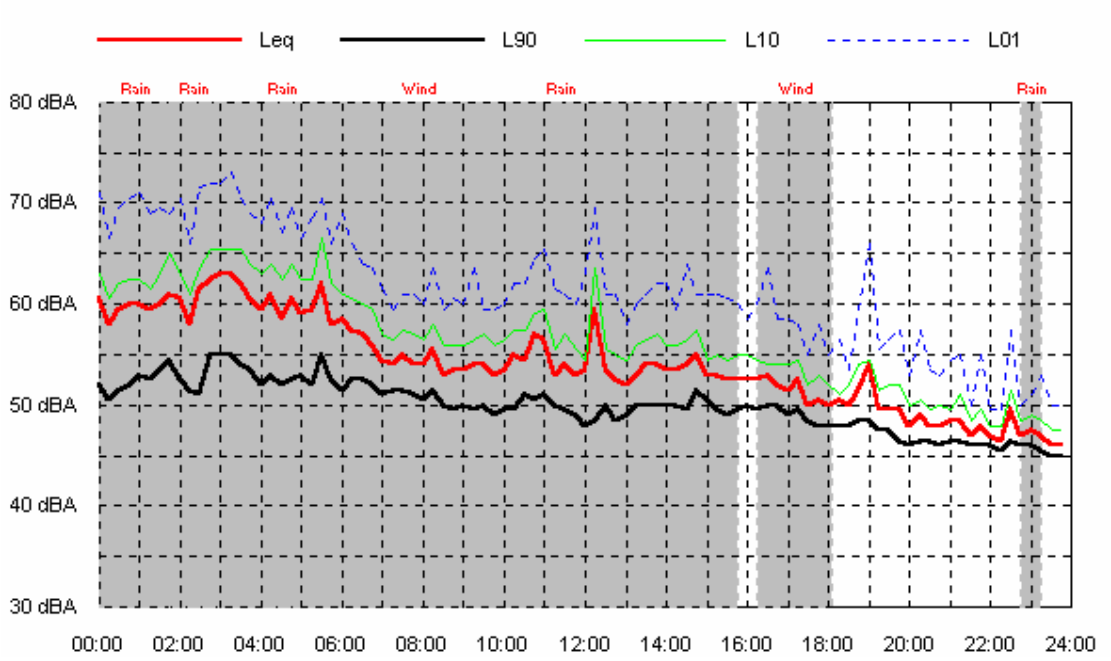
Sun 21 Apr 02



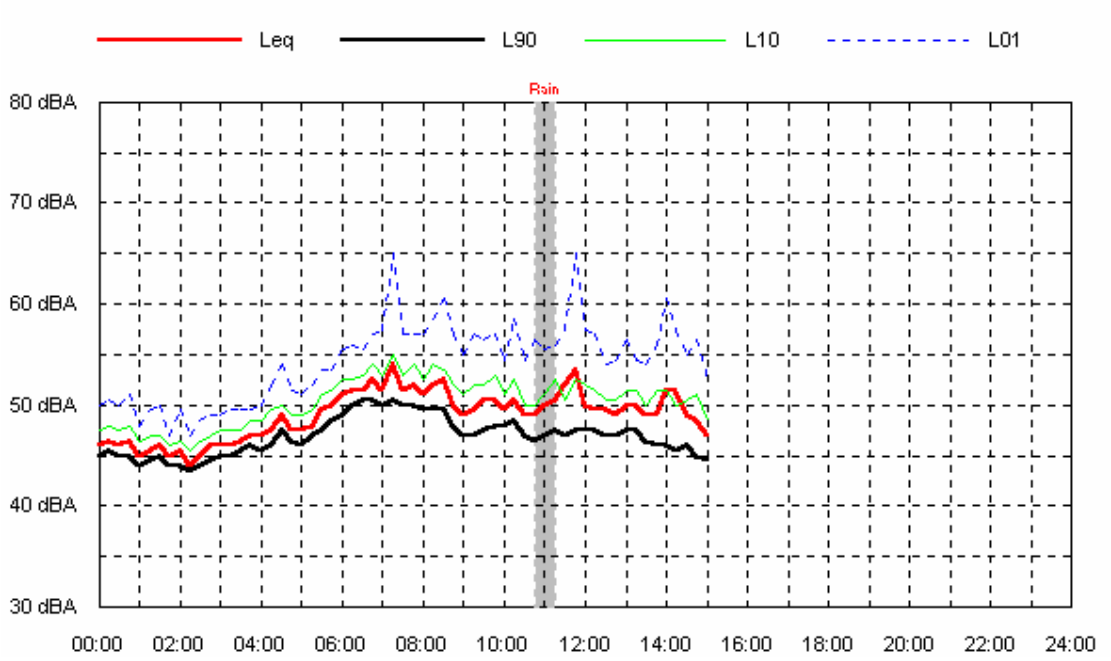
Location: 42 Jennings Street

Data shaded: Wind; Rain

Mon 22 Apr 02



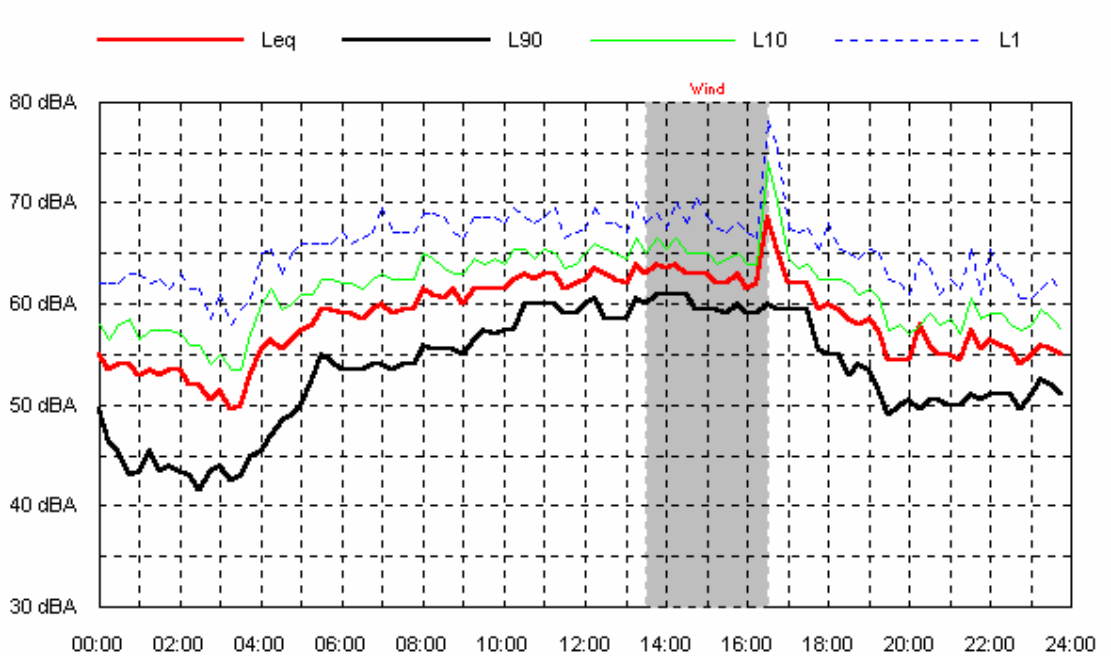
Tue 23 Apr 02



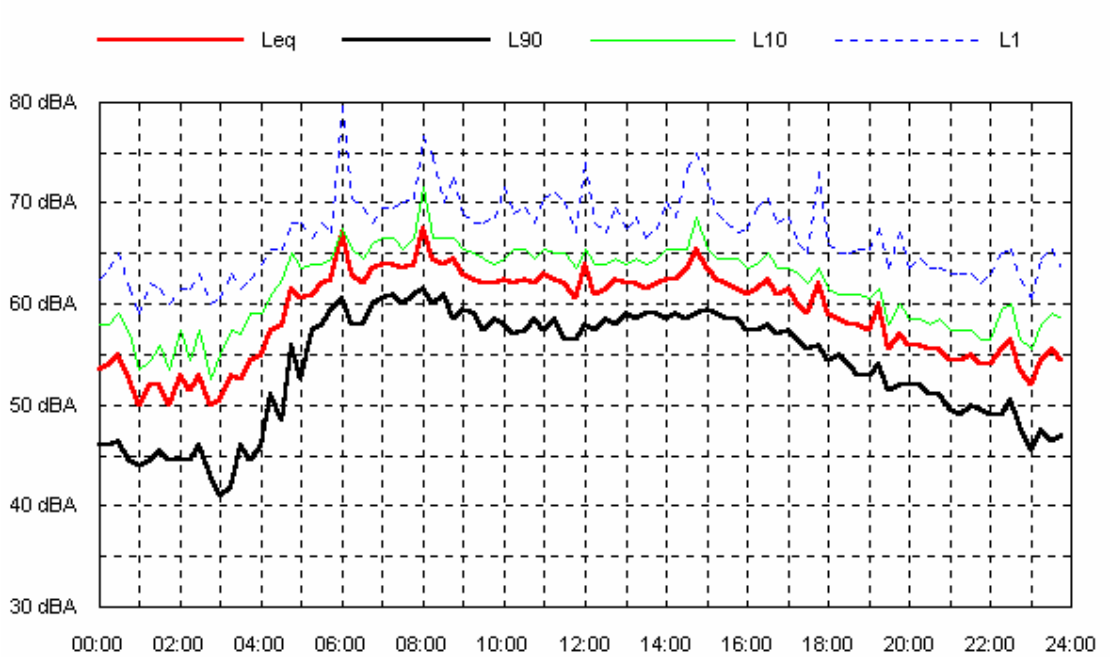
Location: Banksmeadow Golf Course

Data shaded: Wind

Tue 16 Oct 01



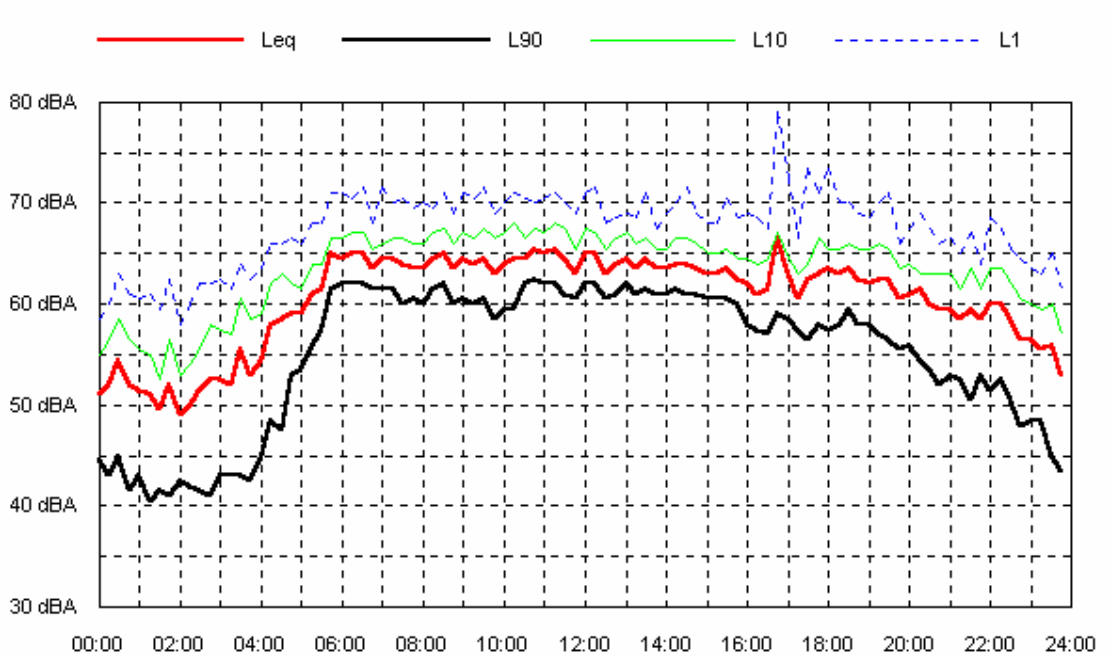
Wed 17 Oct 01



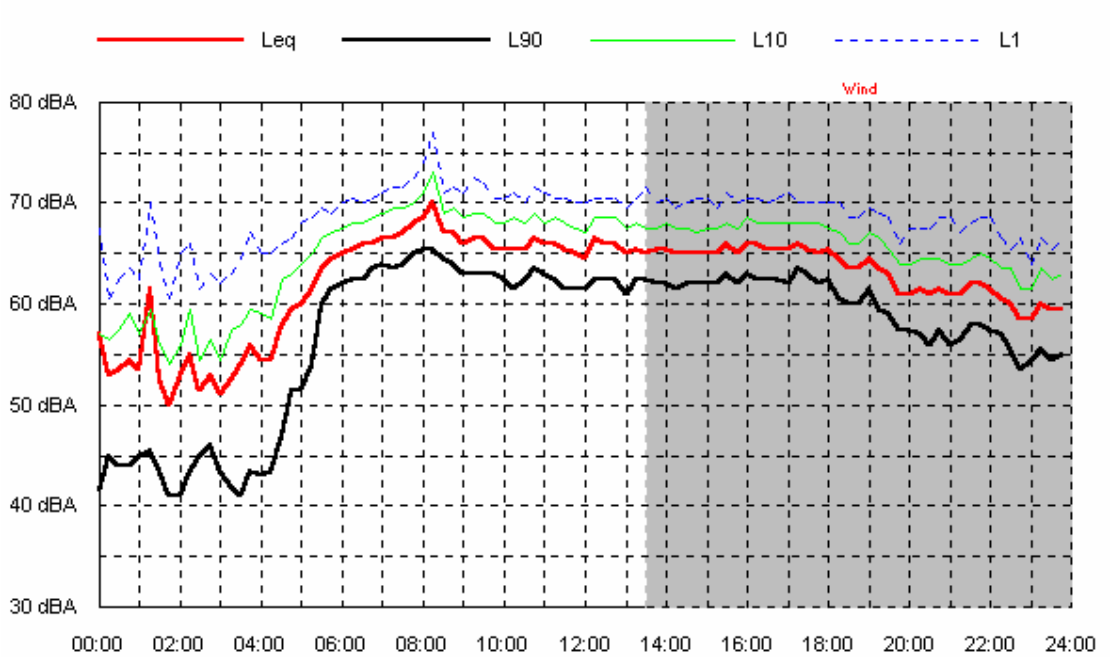
Location: Banksmeadow Golf Course

Data shaded: Wind

Thu 18 Oct 01



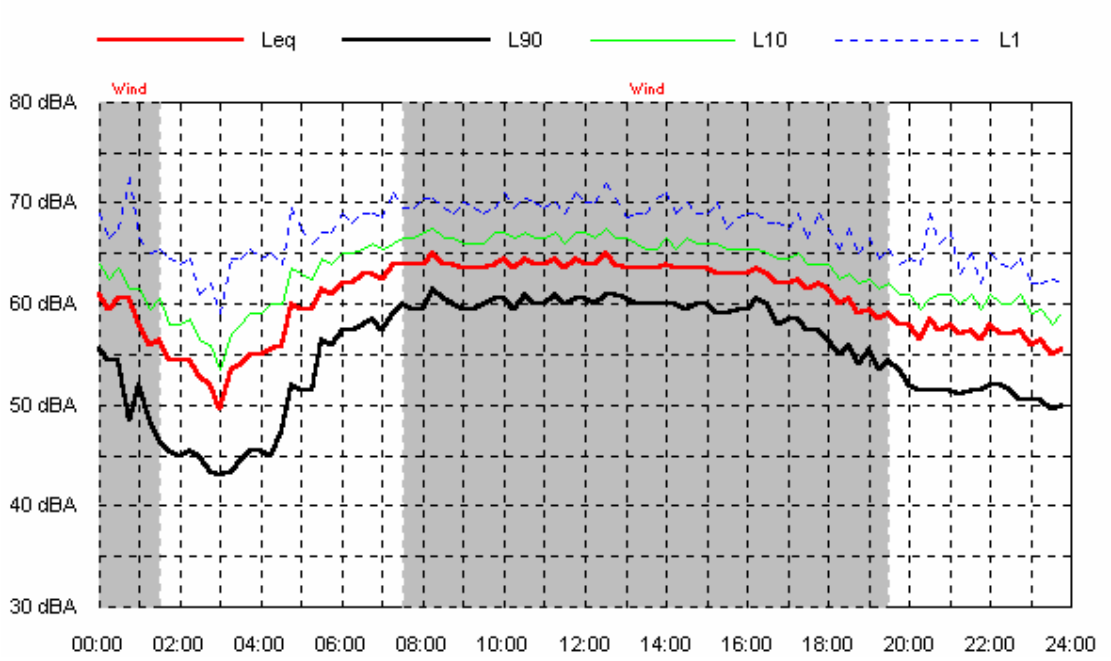
Fri 19 Oct 01



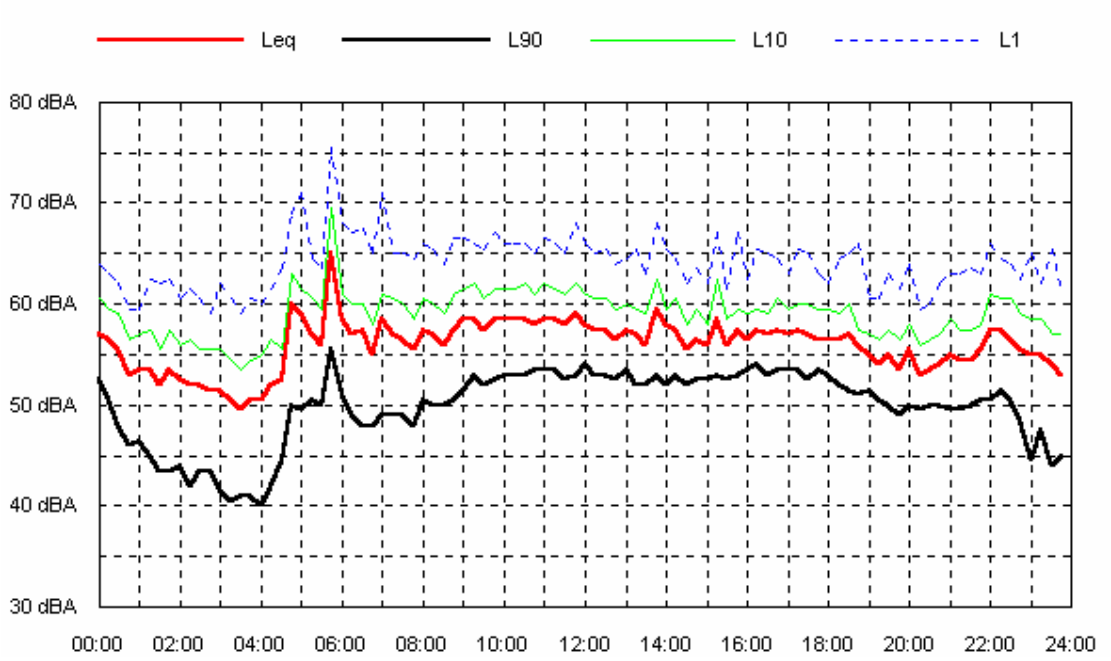
Location: Banksmeadow Golf Course

Data shaded: Wind

Sat 20 Oct 01



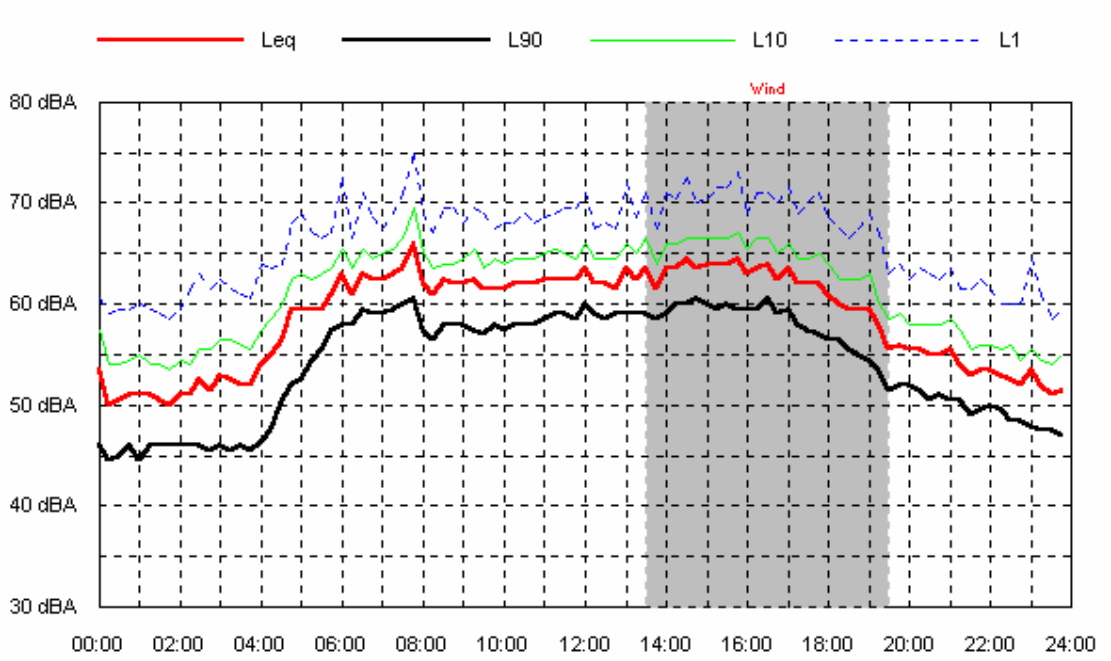
Sun 21 Oct 01



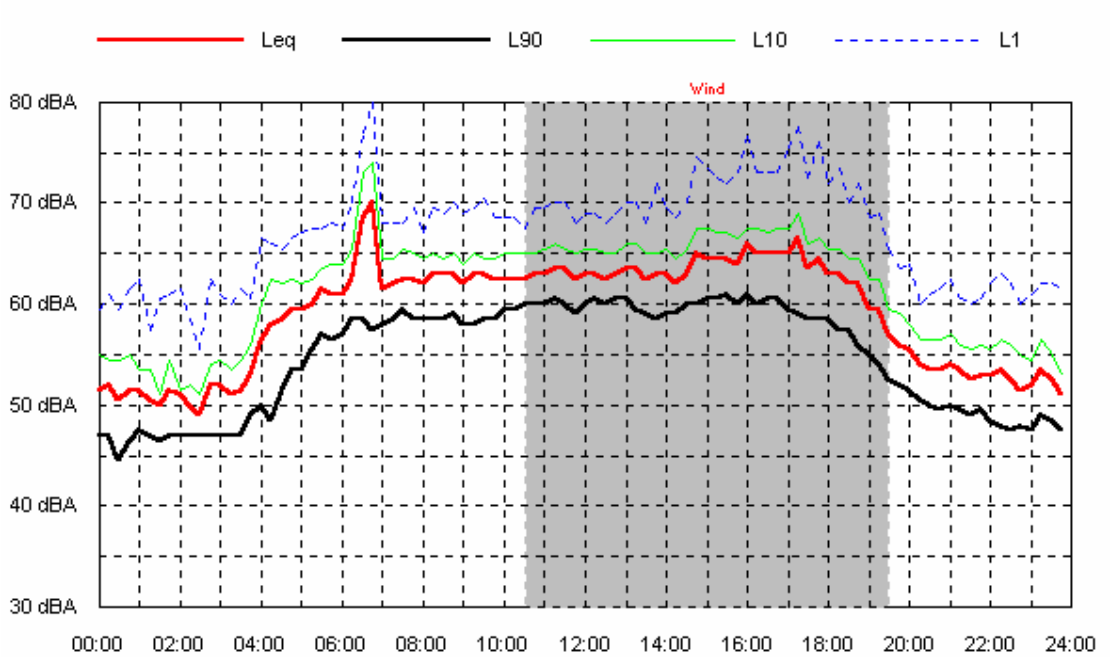
Location: Banksmeadow Golf Course

Data shaded: Wind

Mon 22 Oct 01



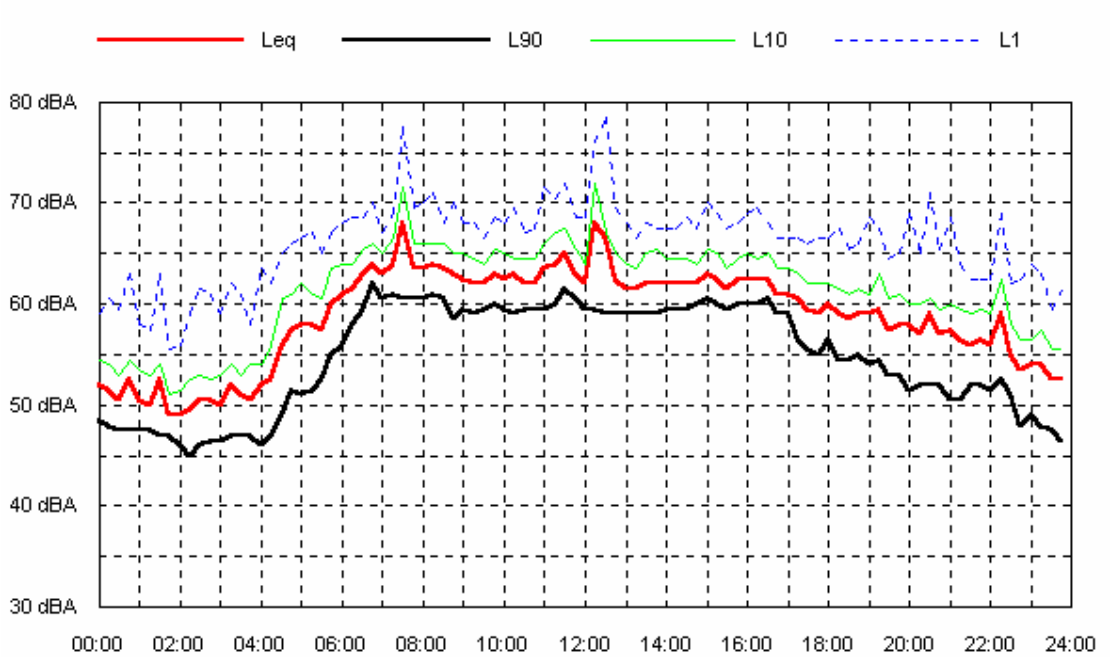
Tue 23 Oct 01



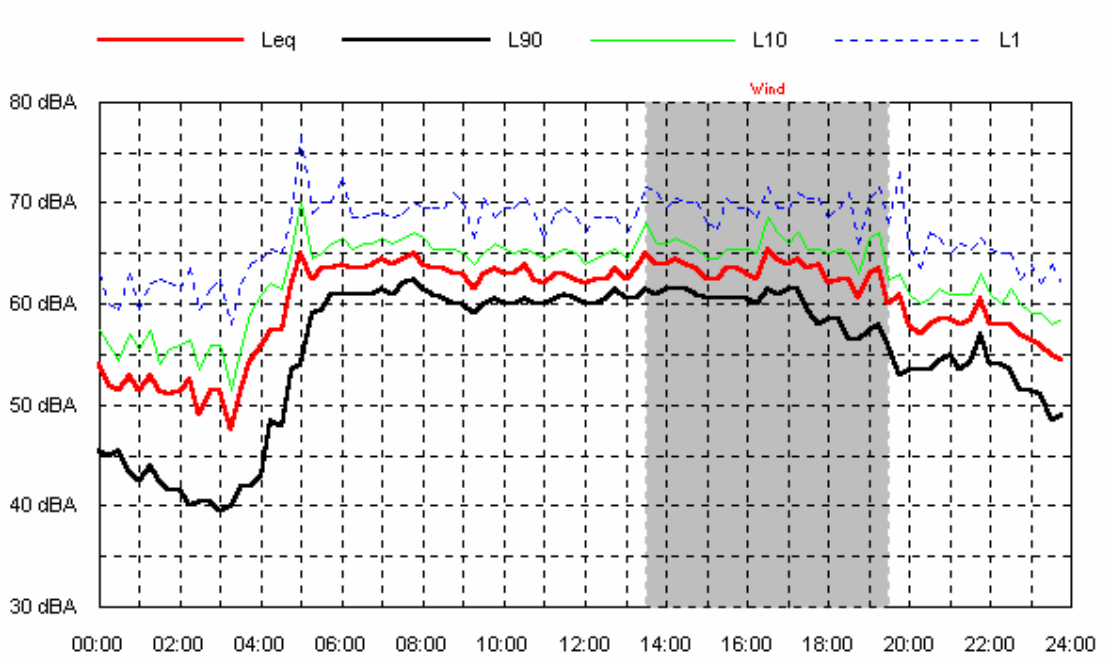
Location: Banksmeadow Golf Course

Data shaded: Wind

Wed 24 Oct 01



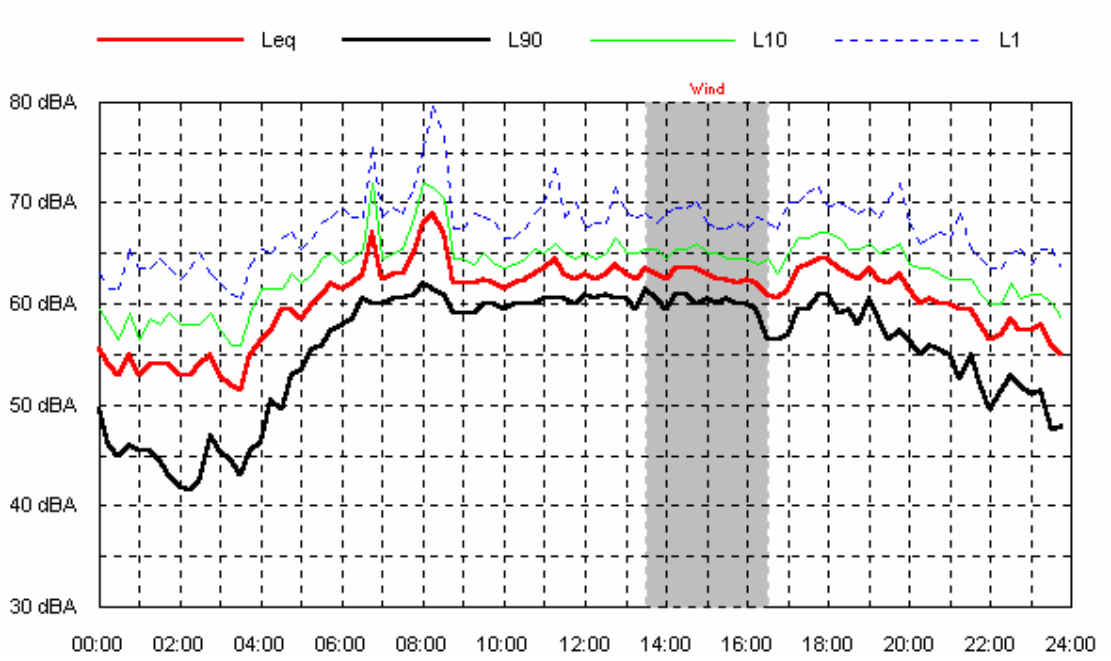
Thu 25 Oct 01



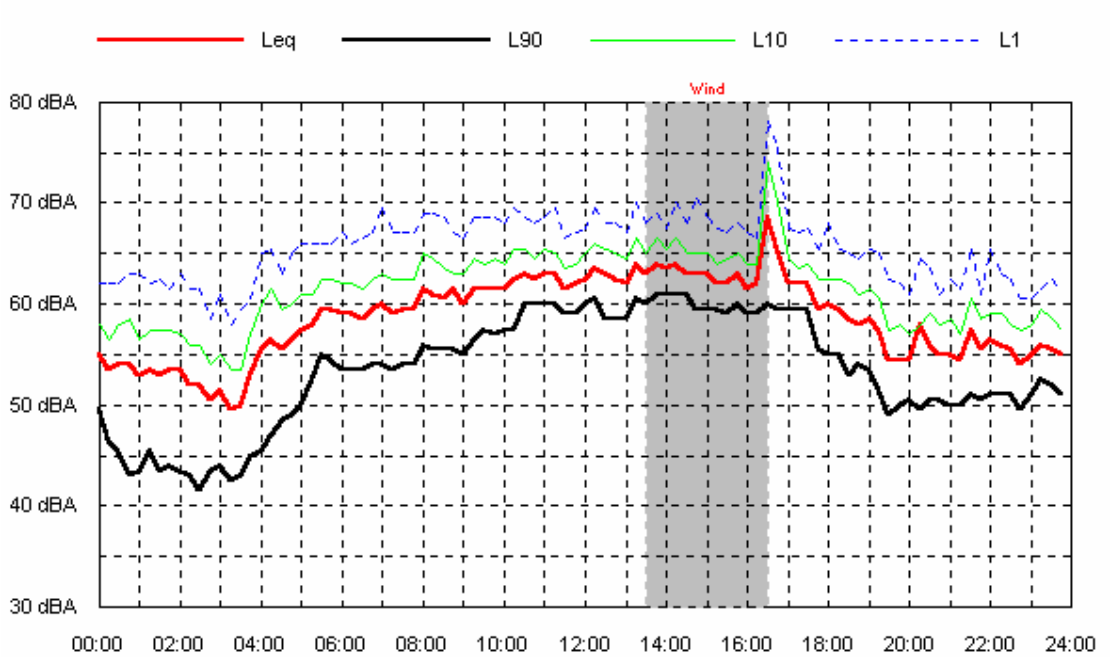
Location: Banksmeadow Golf Course

Data shaded: Wind

Fri 26 Oct 01



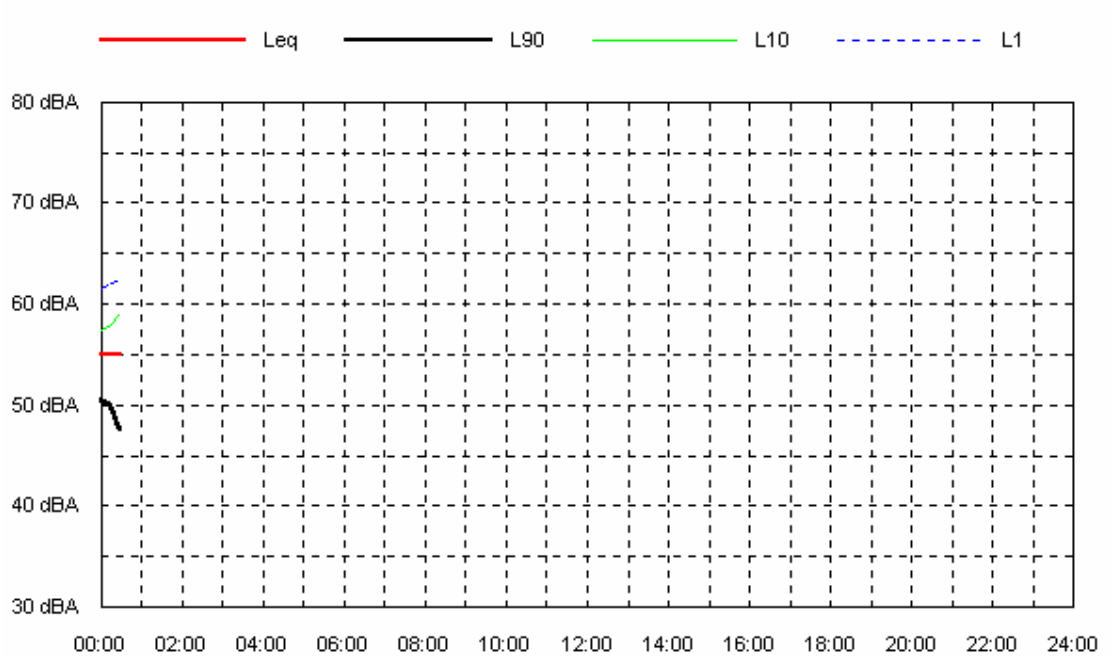
Sat 27 Oct 01



Location: Banksmeadow Golf Course

Data shaded: Wind

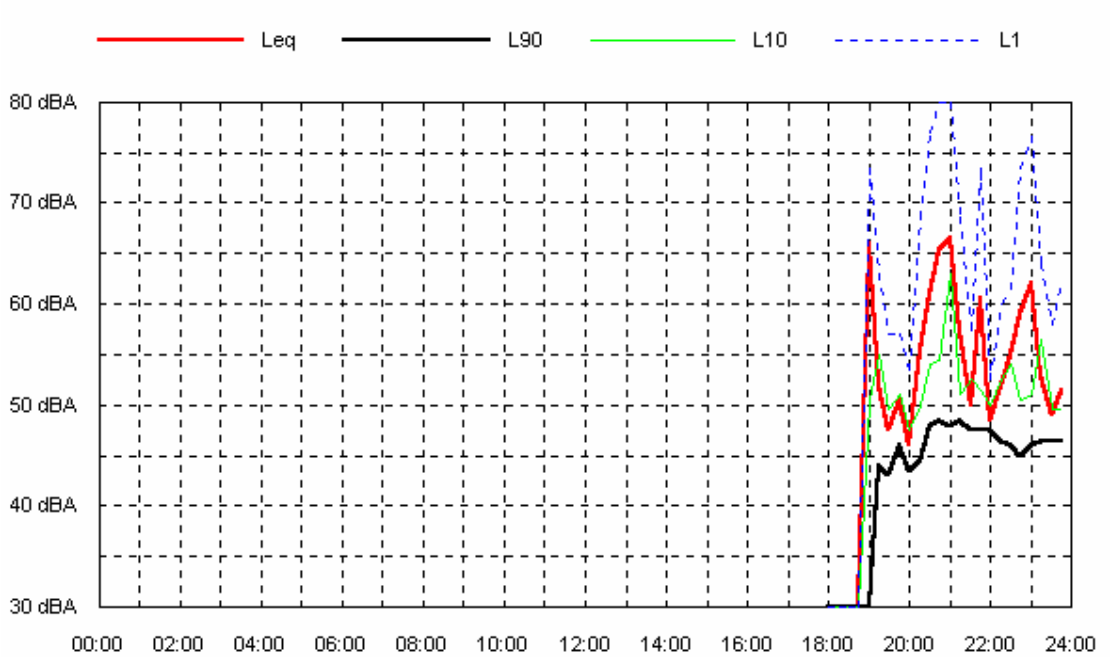
Sun 28 Oct 01



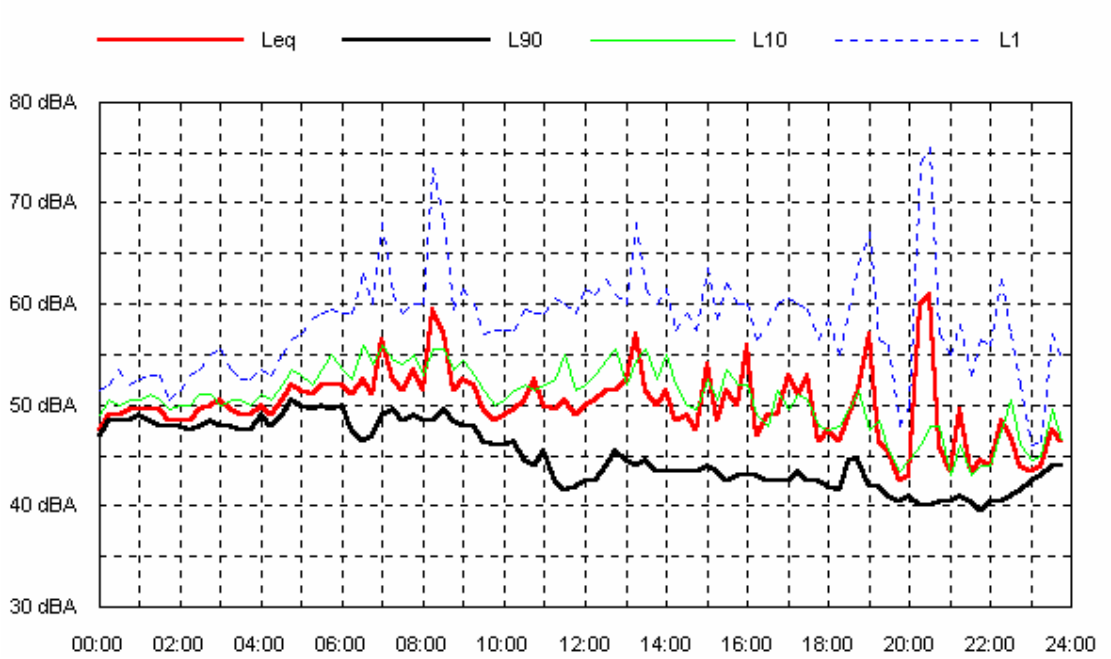
Location: Australia Avenue

Data shaded: Wind

Tue 16 Oct 01



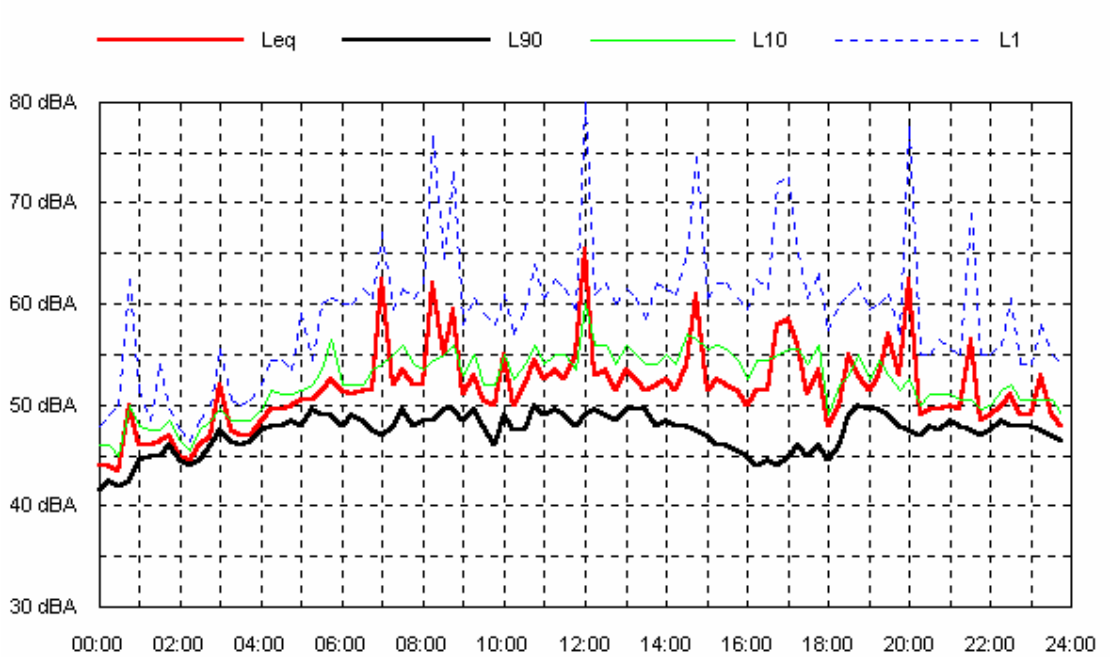
Wed 17 Oct 01



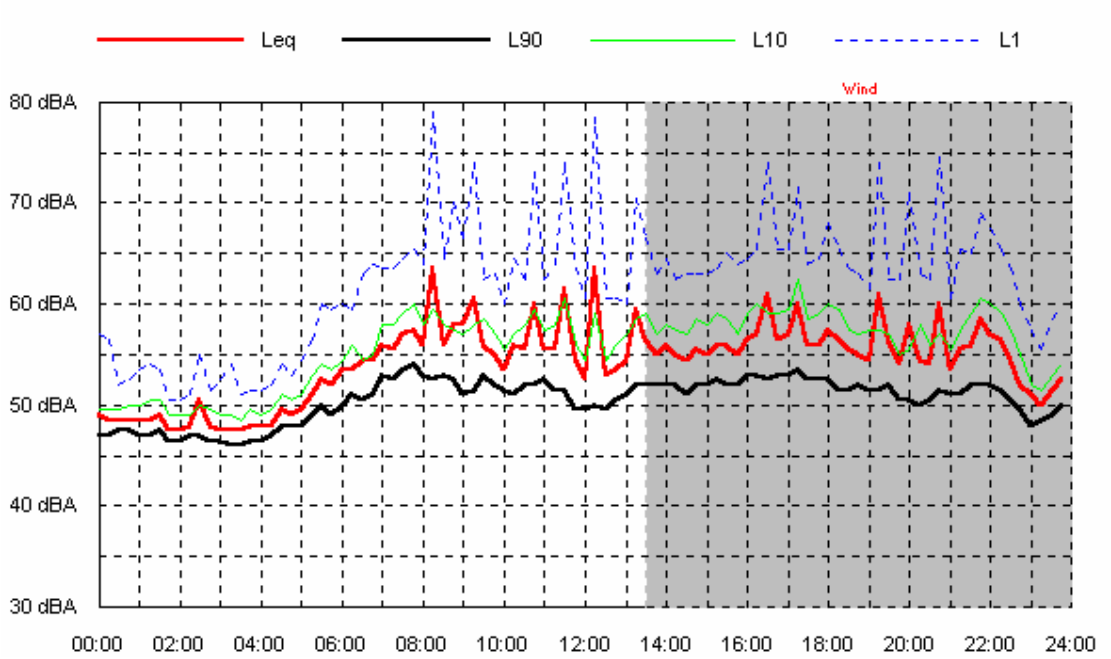
Location: Australia Avenue

Data shaded: Wind

Thu 18 Oct 01



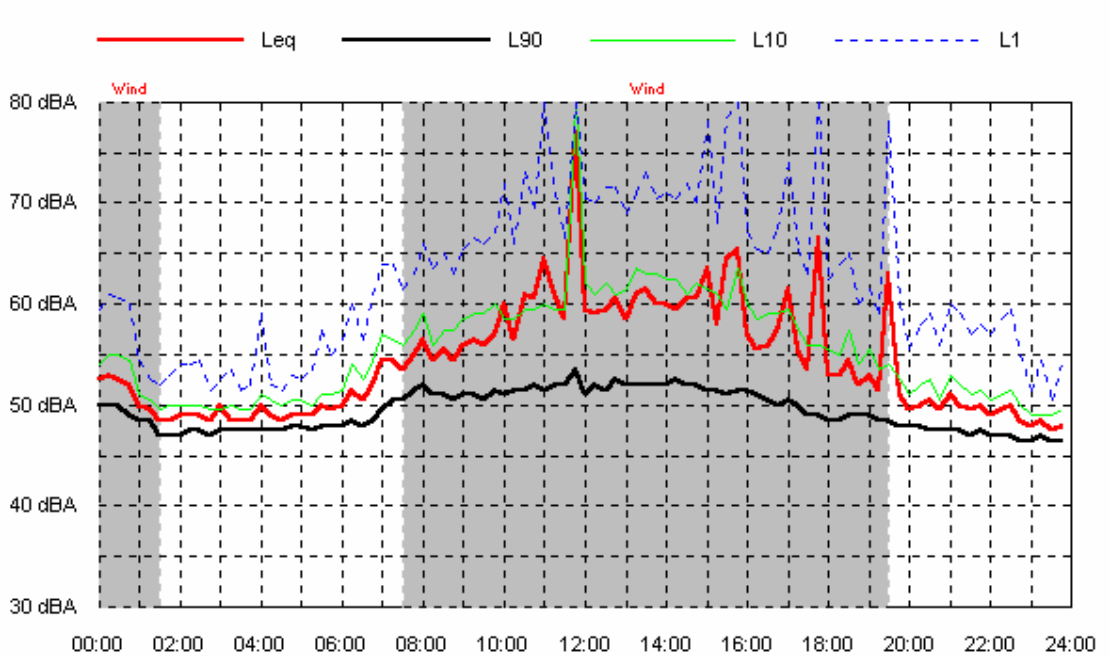
Fri 19 Oct 01



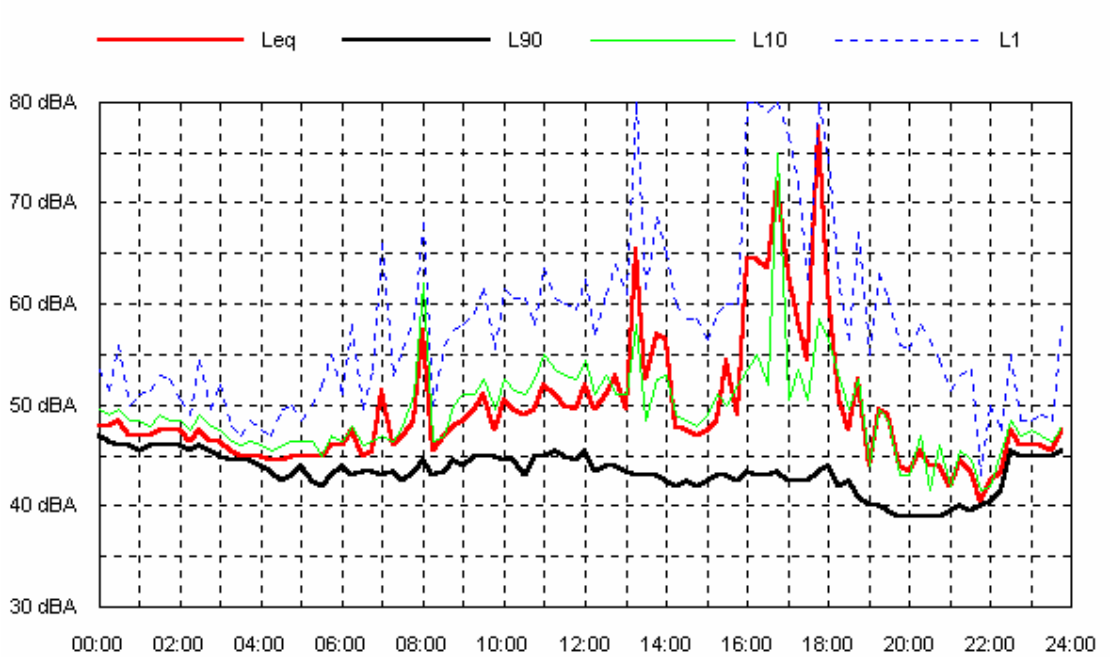
Location: Australia Avenue

Data shaded: Wind

Sat 20 Oct 01



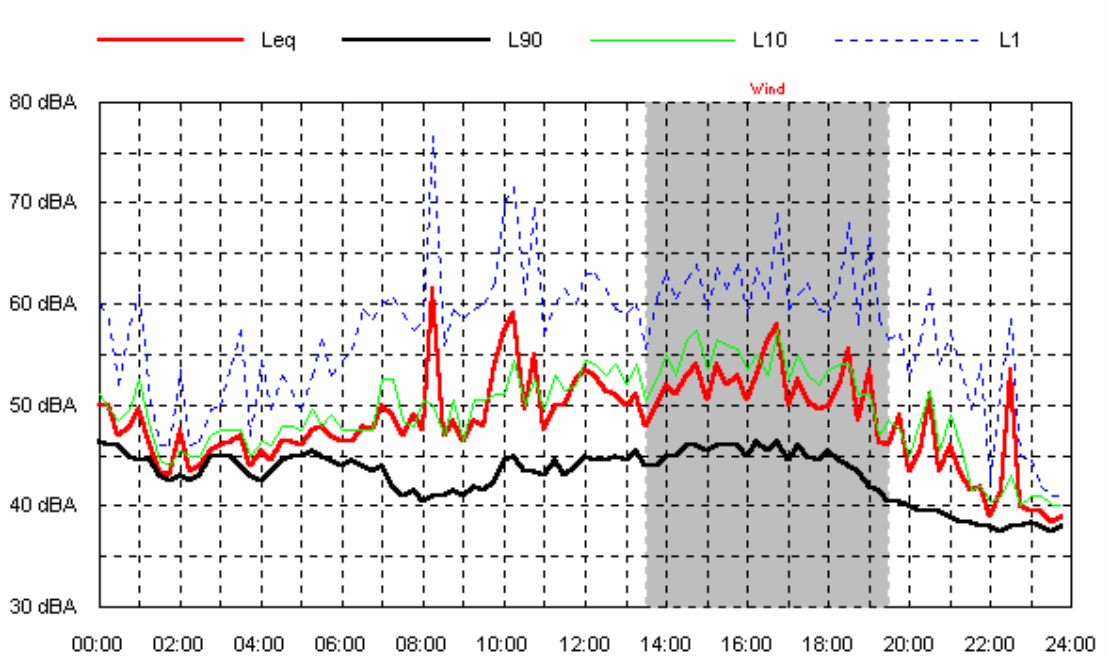
Sun 21 Oct 01



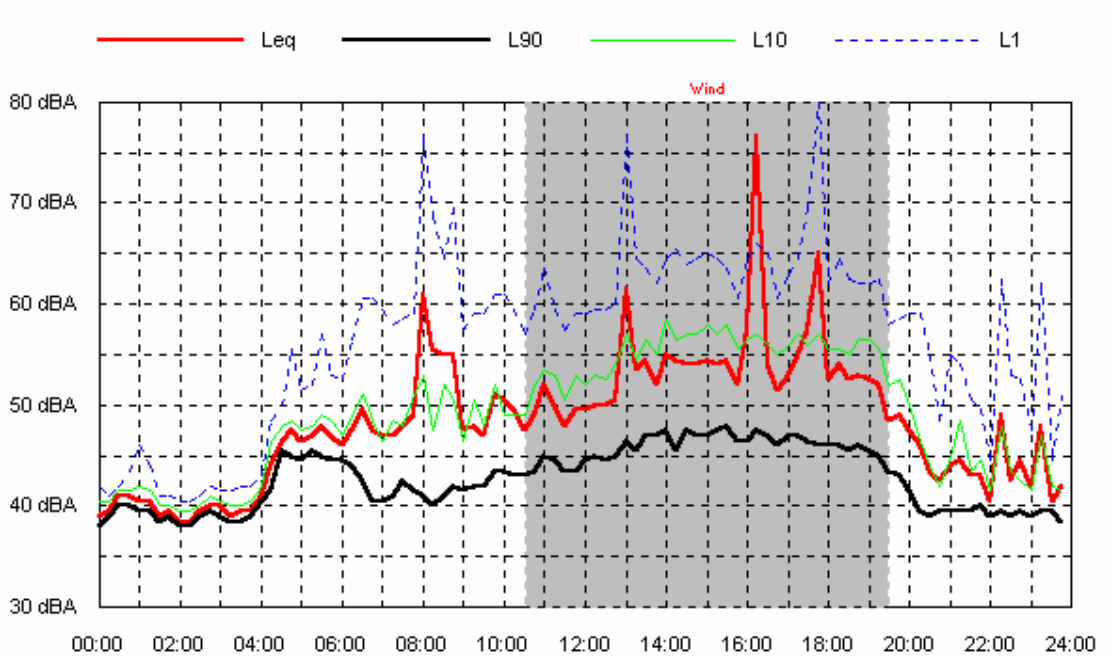
Location: Australia Avenue

Data shaded: Wind

Mon 22 Oct 01



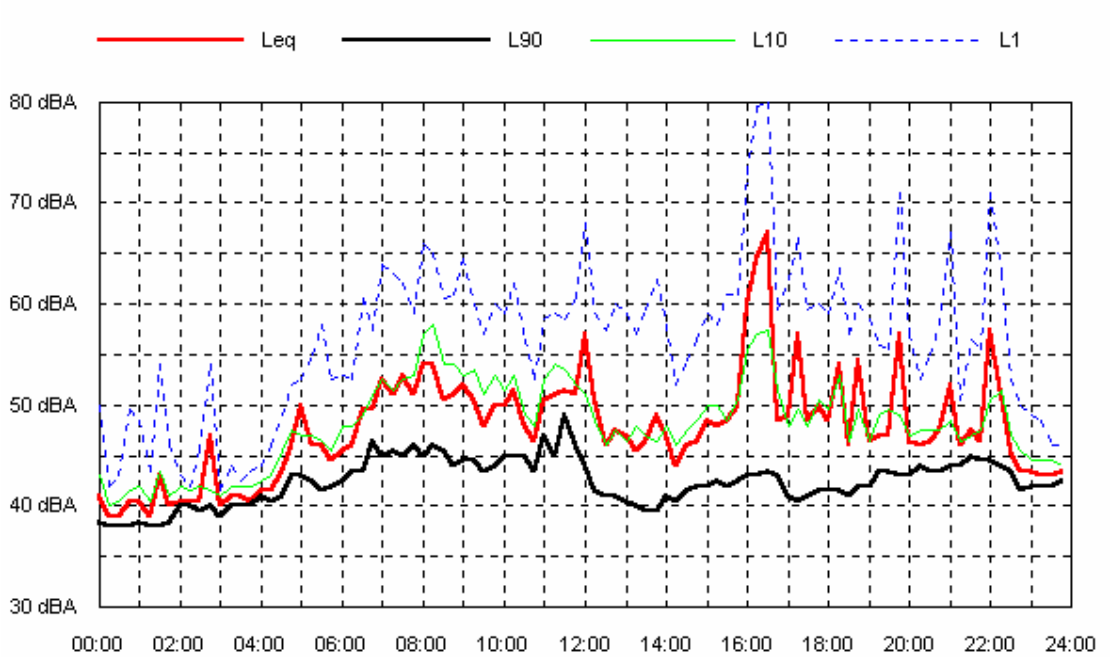
Tue 23 Oct 01



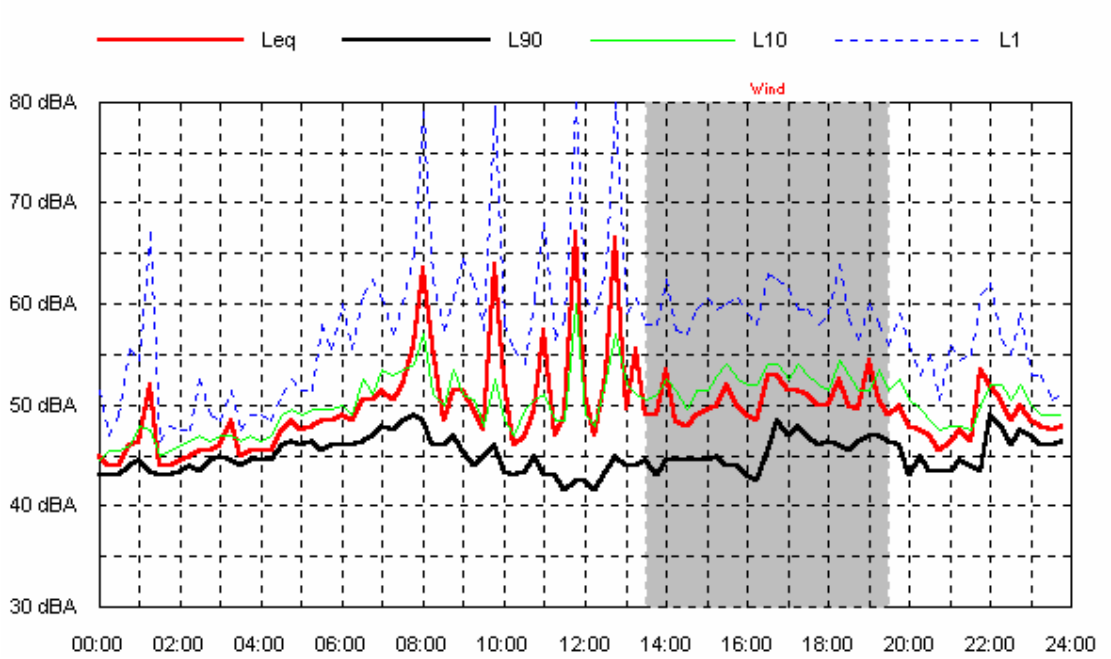
Location: Australia Avenue

Data shaded: Wind

Wed 24 Oct 01



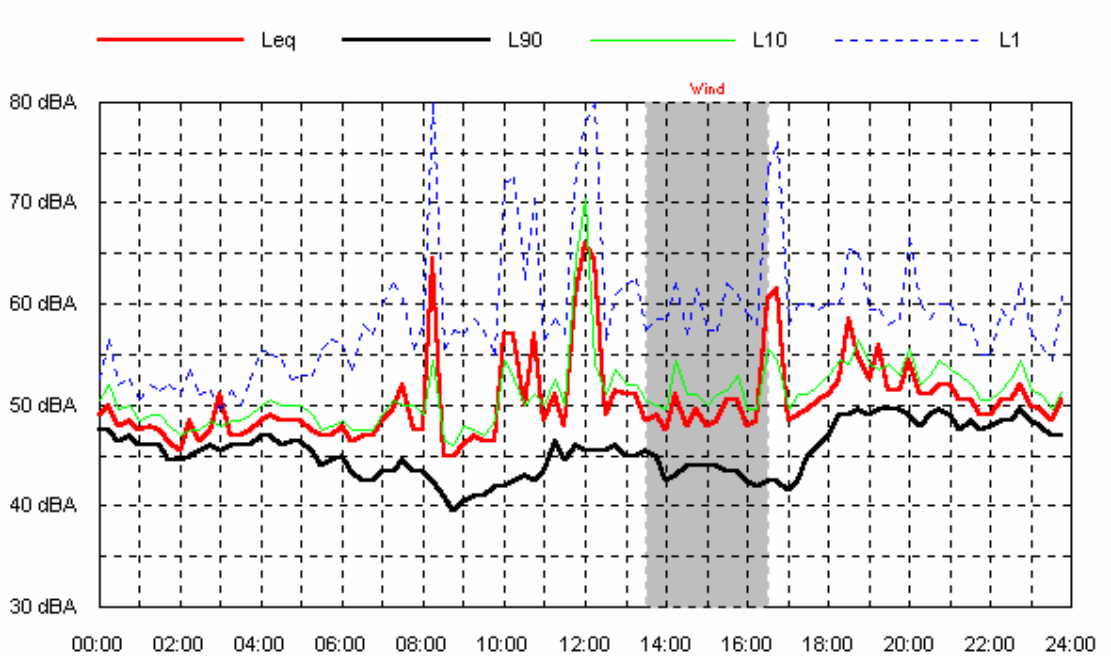
Thu 25 Oct 01



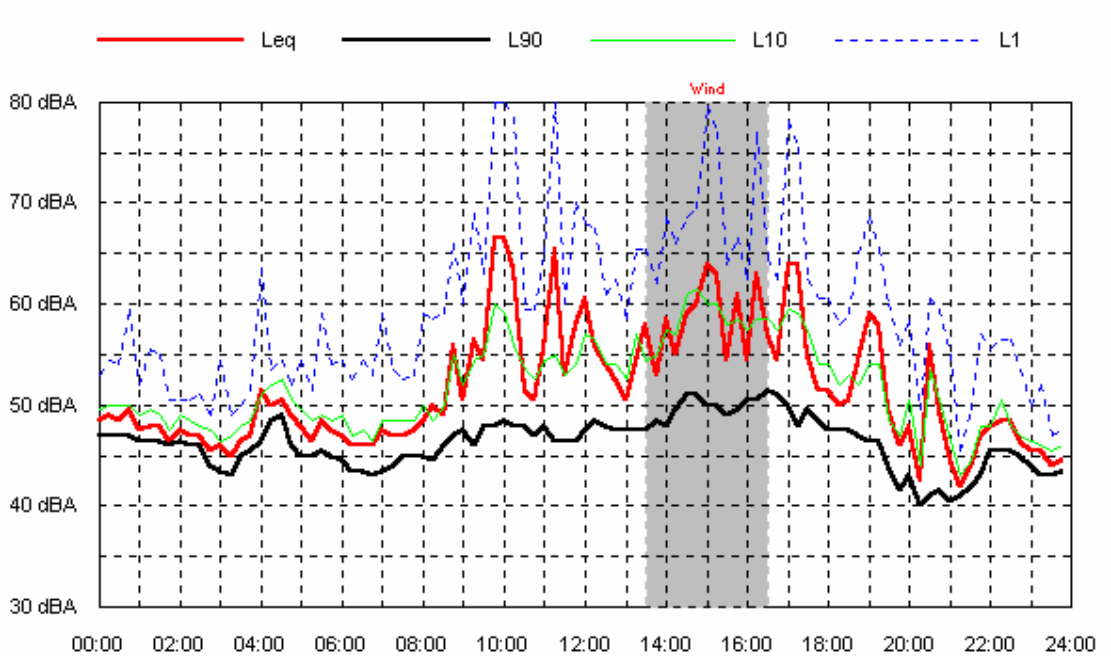
Location: Australia Avenue

Data shaded: Wind

Fri 26 Oct 01



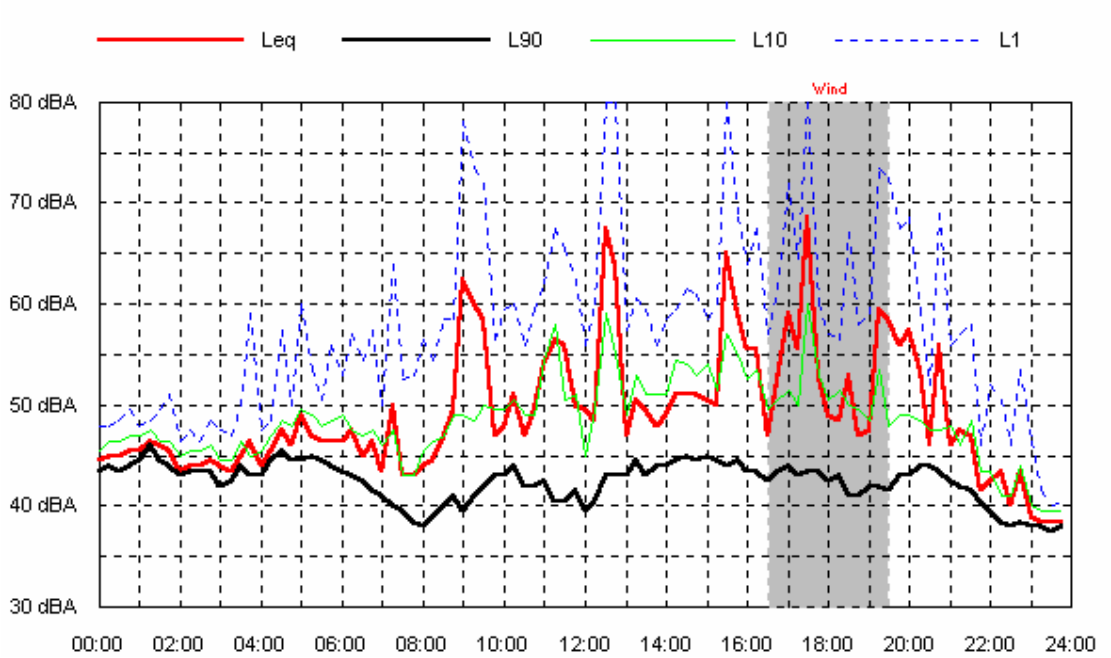
Sat 27 Oct 01



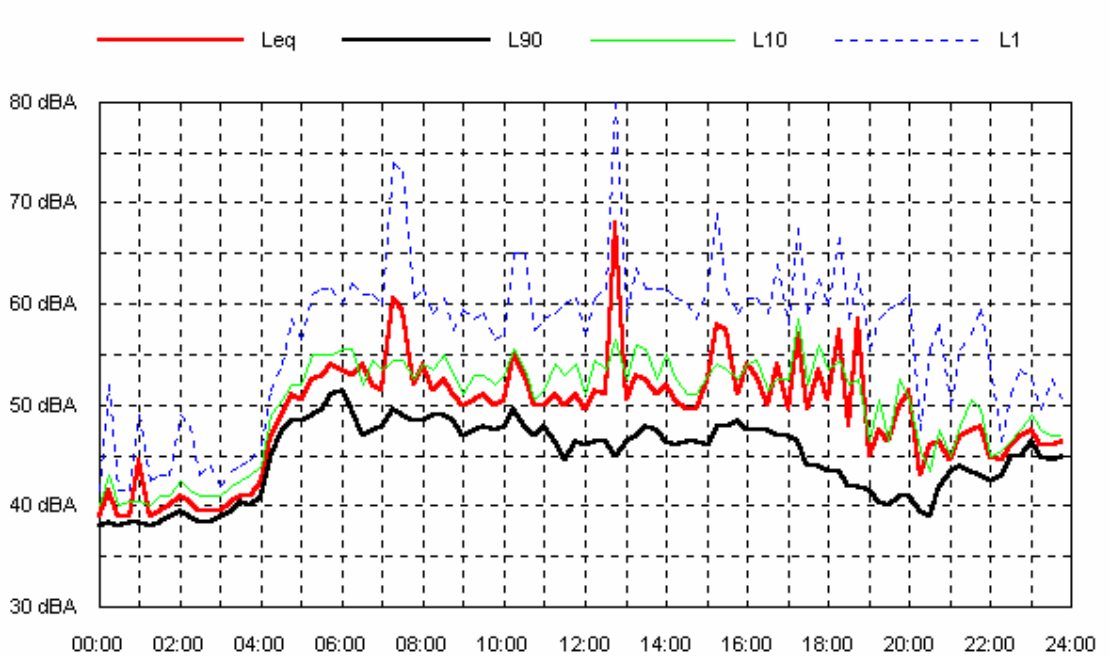
Location: Australia Avenue

Data shaded: Wind

Sun 28 Oct 01



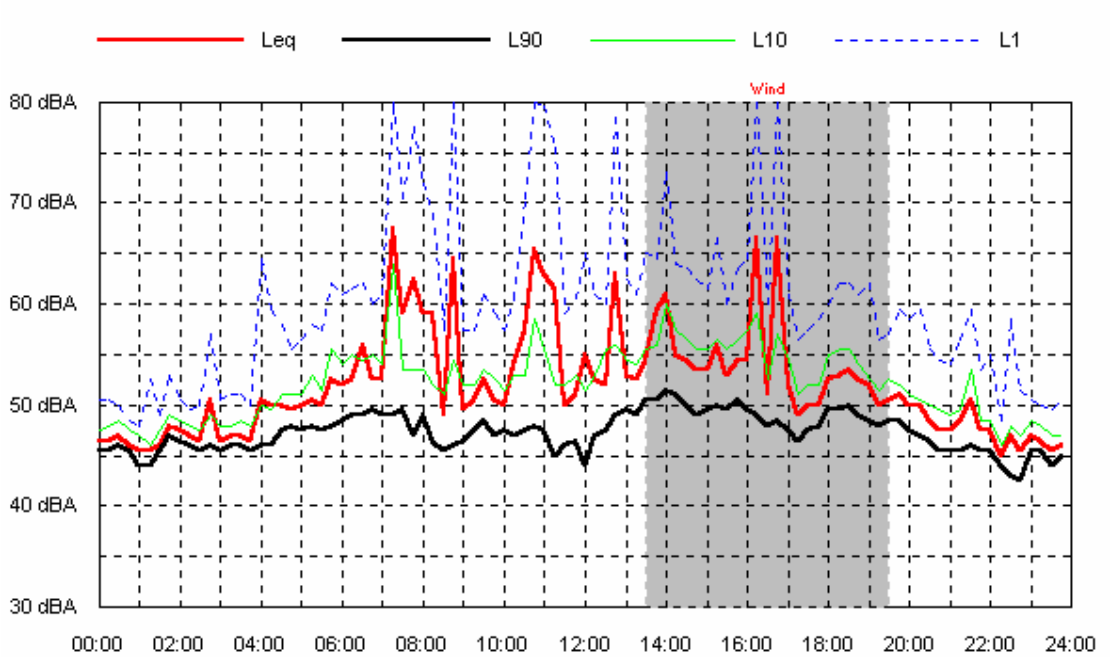
Mon 29 Oct 01



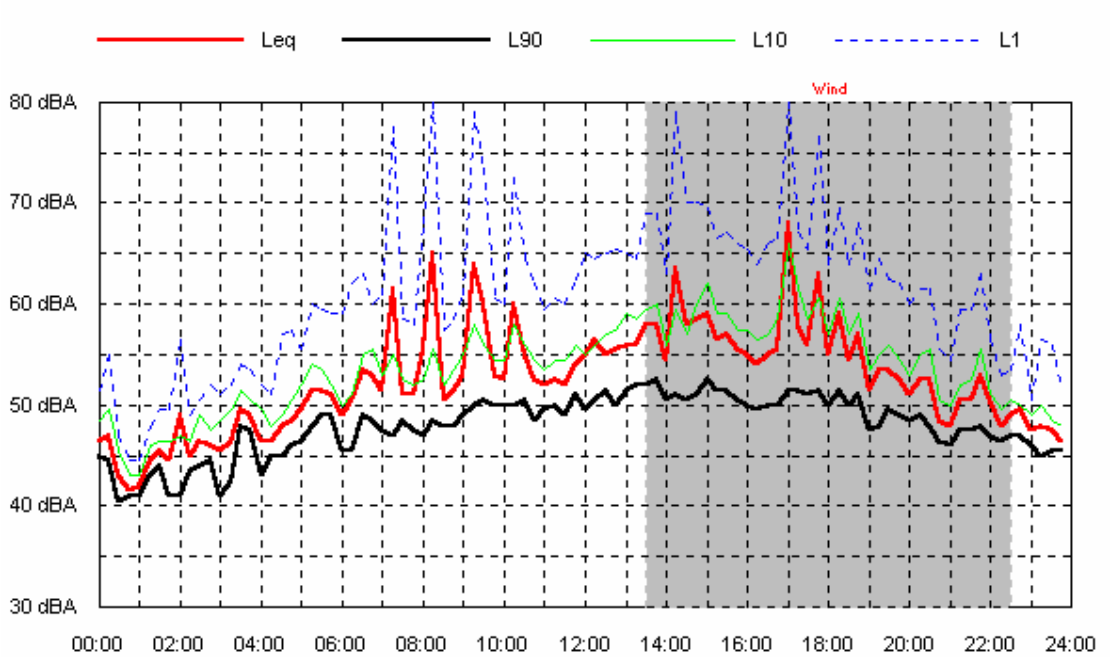
Location: Australia Avenue

Data shaded: Wind

Tue 30 Oct 01



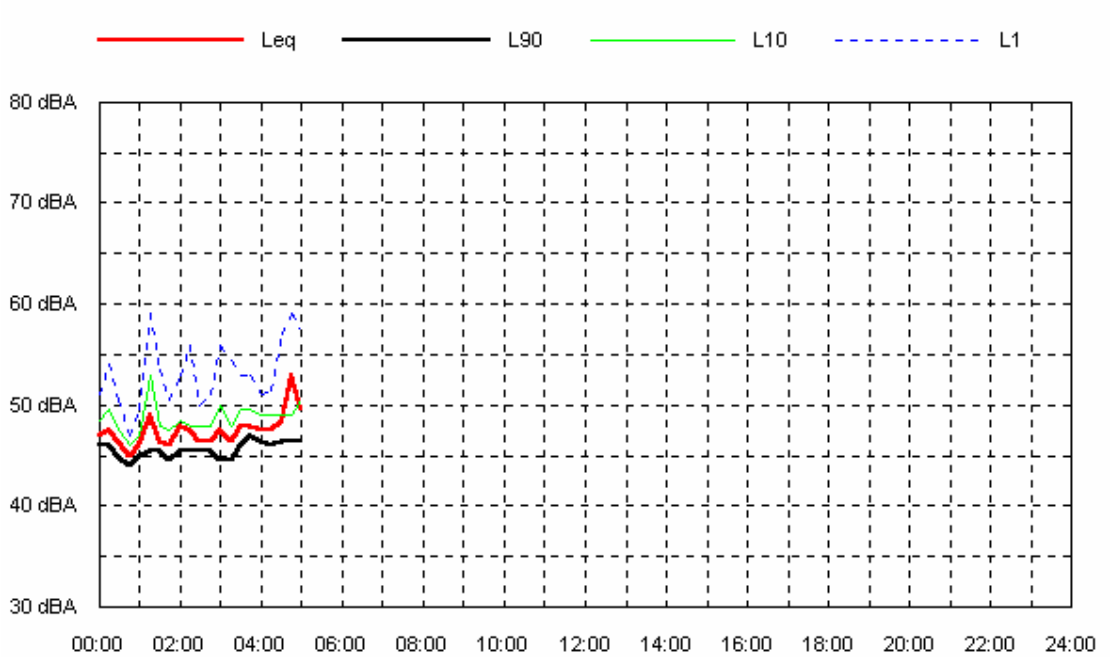
Wed 31 Oct 01



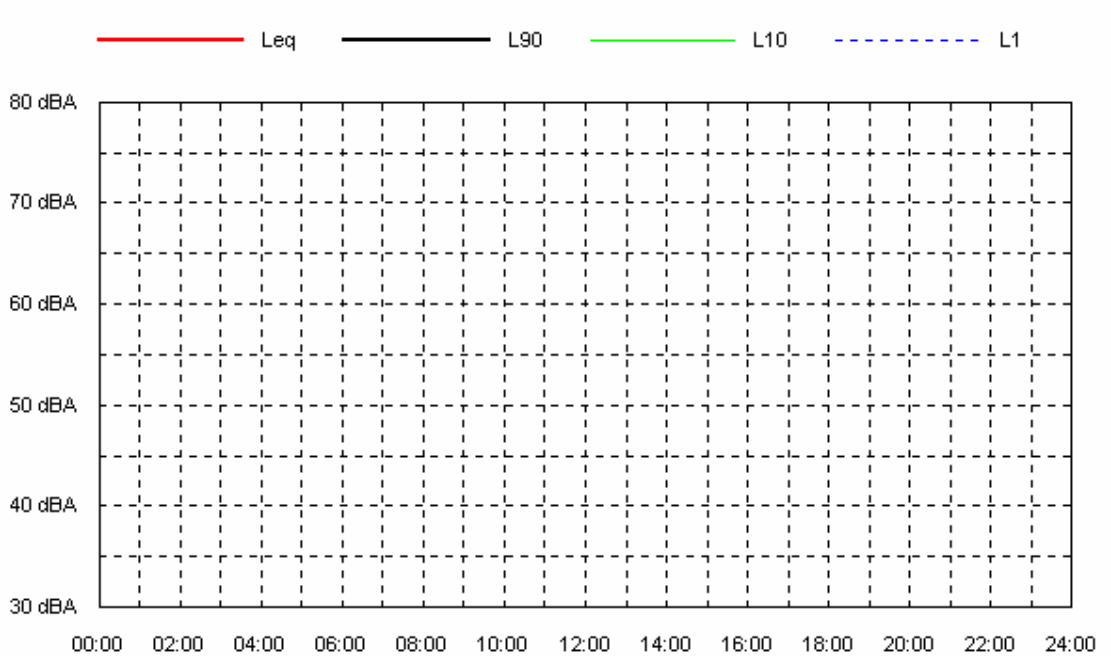
Location: Australia Avenue

Data shaded: Wind

Thu 01 Nov 01



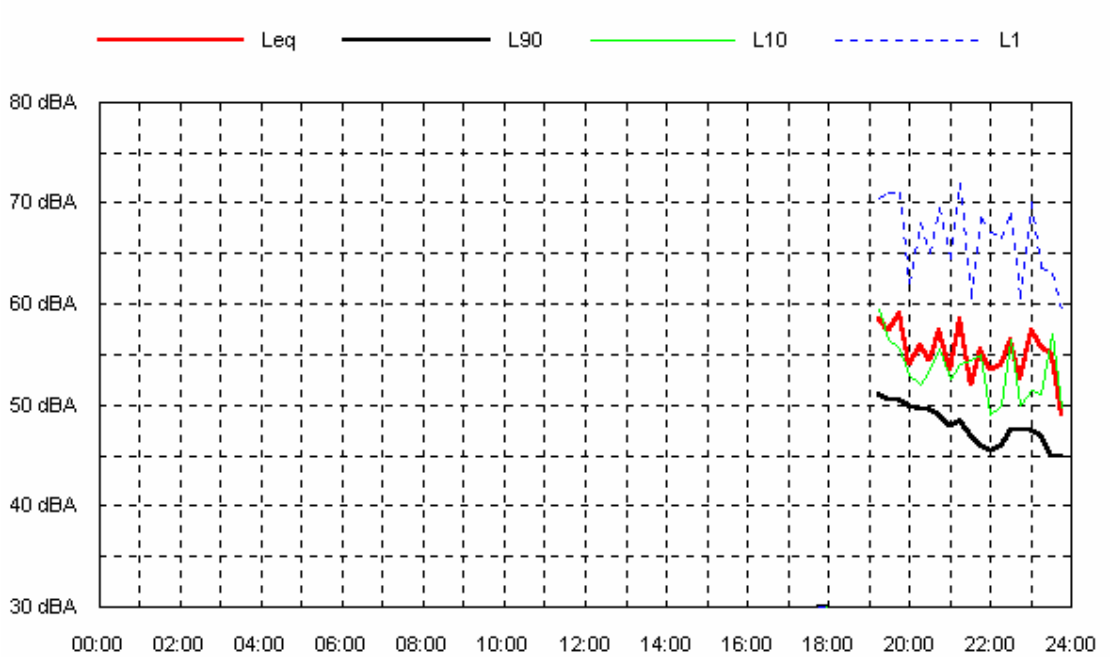
Tue 31 Dec 02



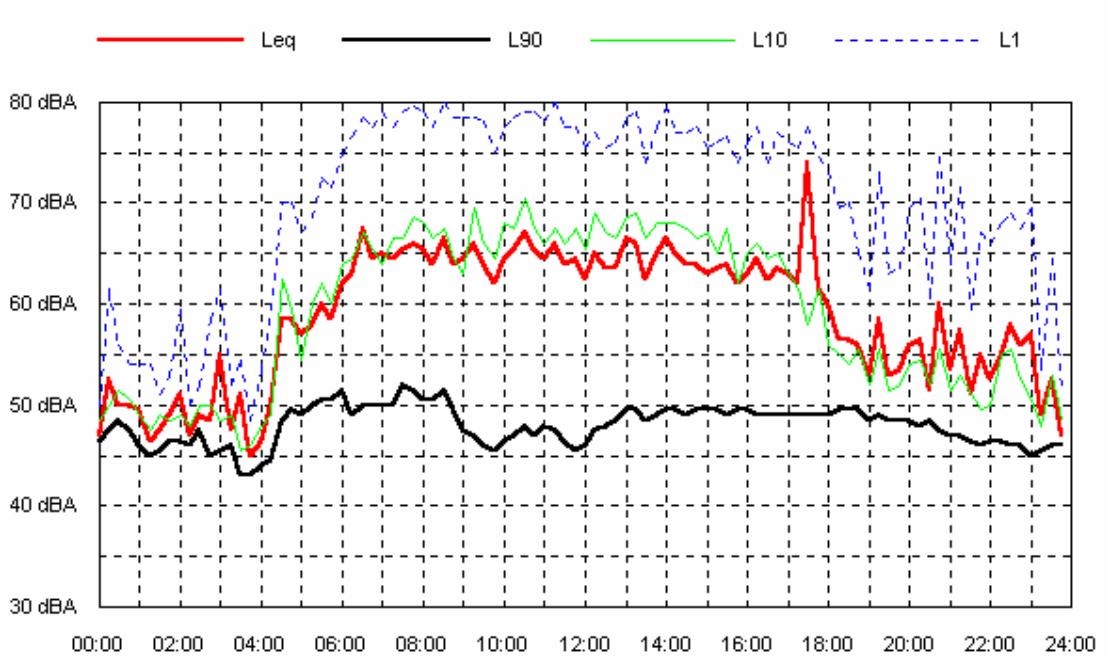
Location: Military Road

Data shaded: Wind

Tue 16 Oct 01



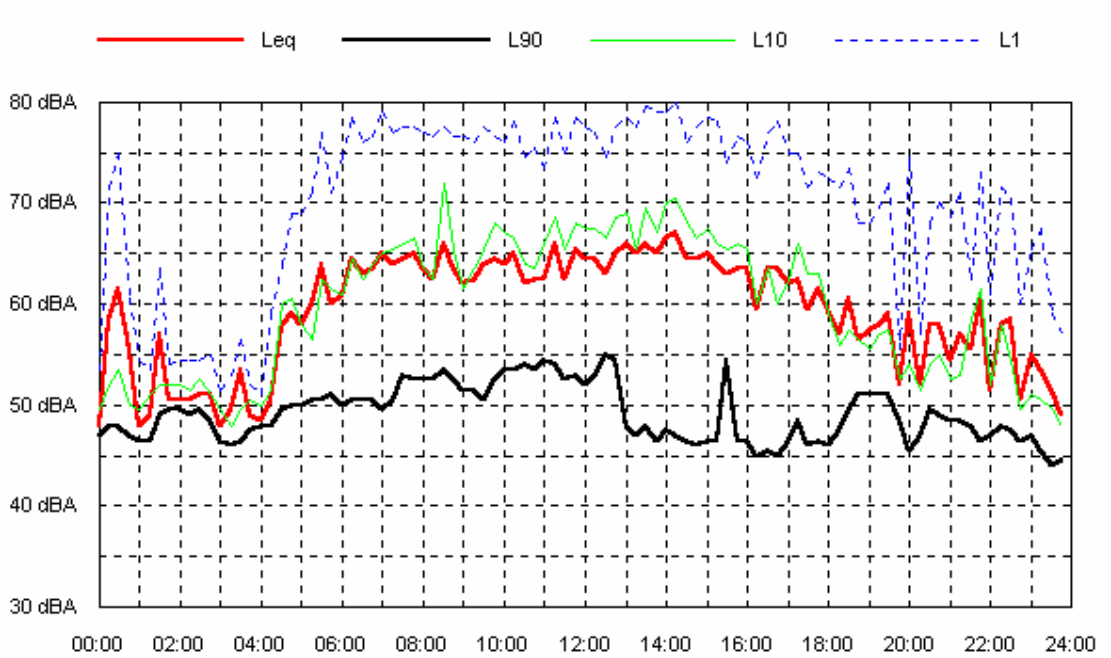
Wed 17 Oct 01



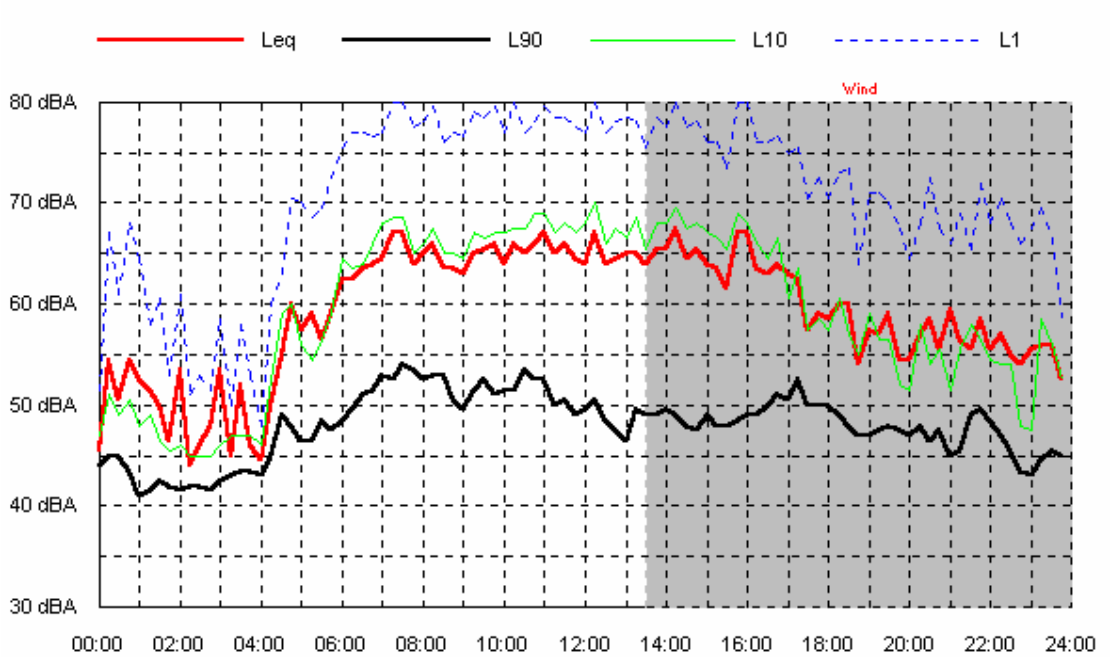
Location: Military Road

Data shaded: Wind

Thu 18 Oct 01



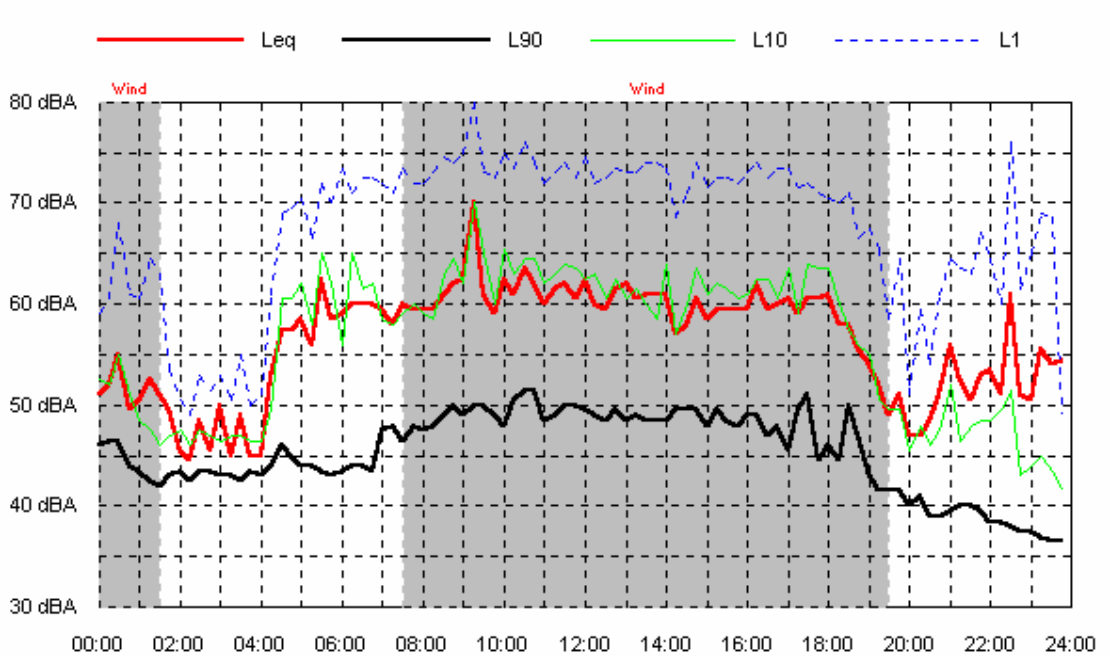
Fri 19 Oct 01



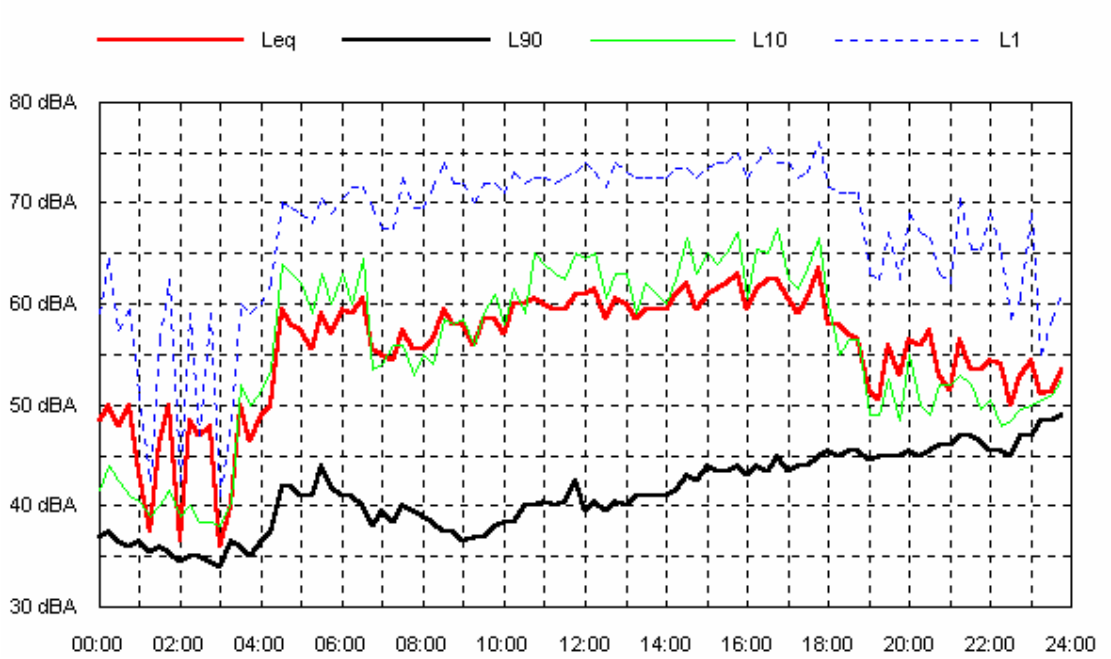
Location: Military Road

Data shaded: Wind

Sat 20 Oct 01



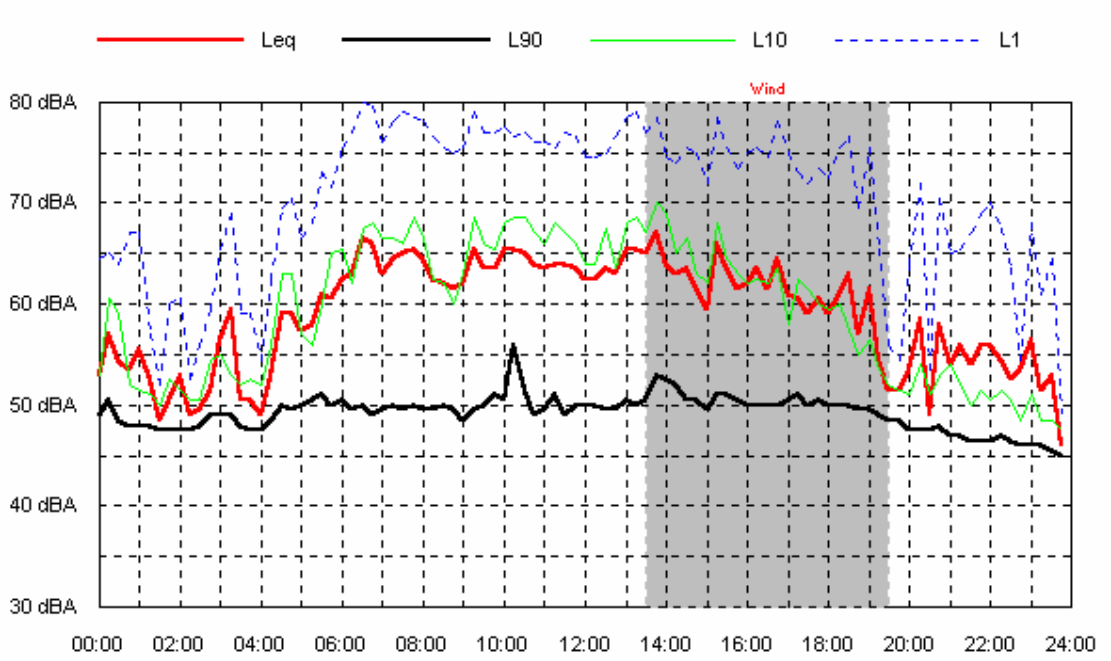
Sun 21 Oct 01



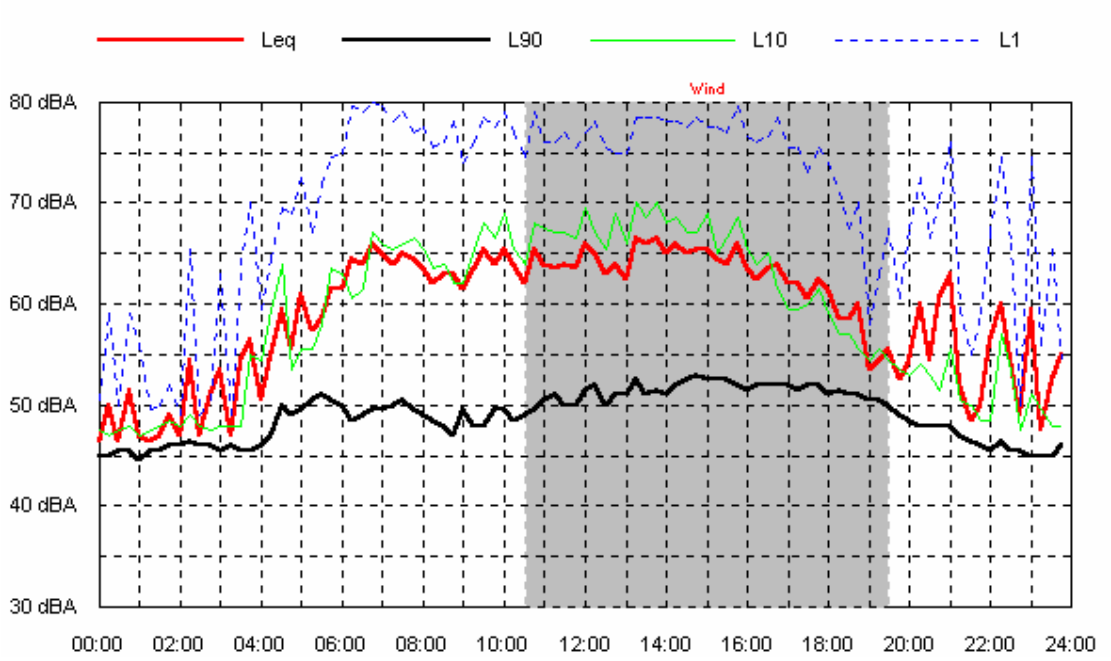
Location: Military Road

Data shaded: Wind

Mon 22 Oct 01



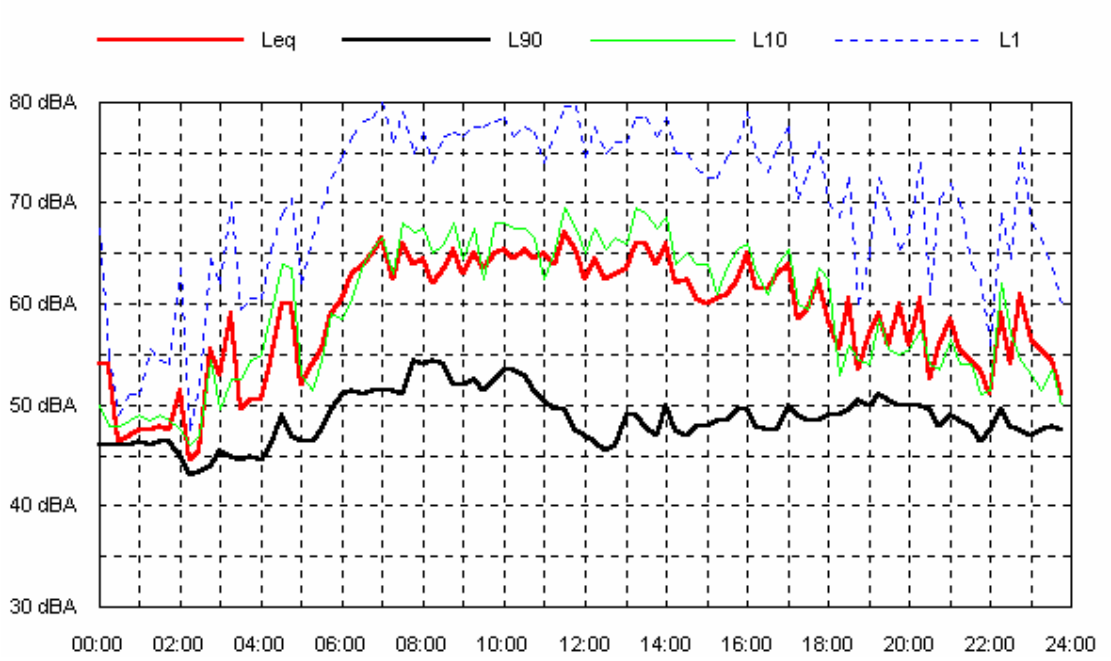
Tue 23 Oct 01



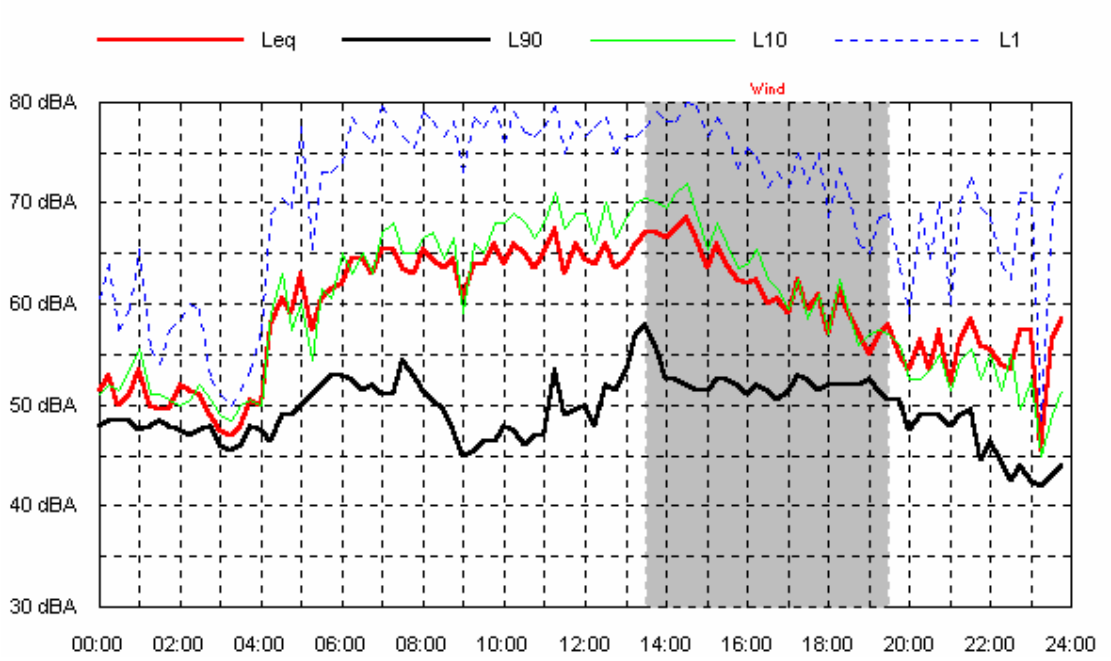
Location: Military Road

Data shaded: Wind

Wed 24 Oct 01



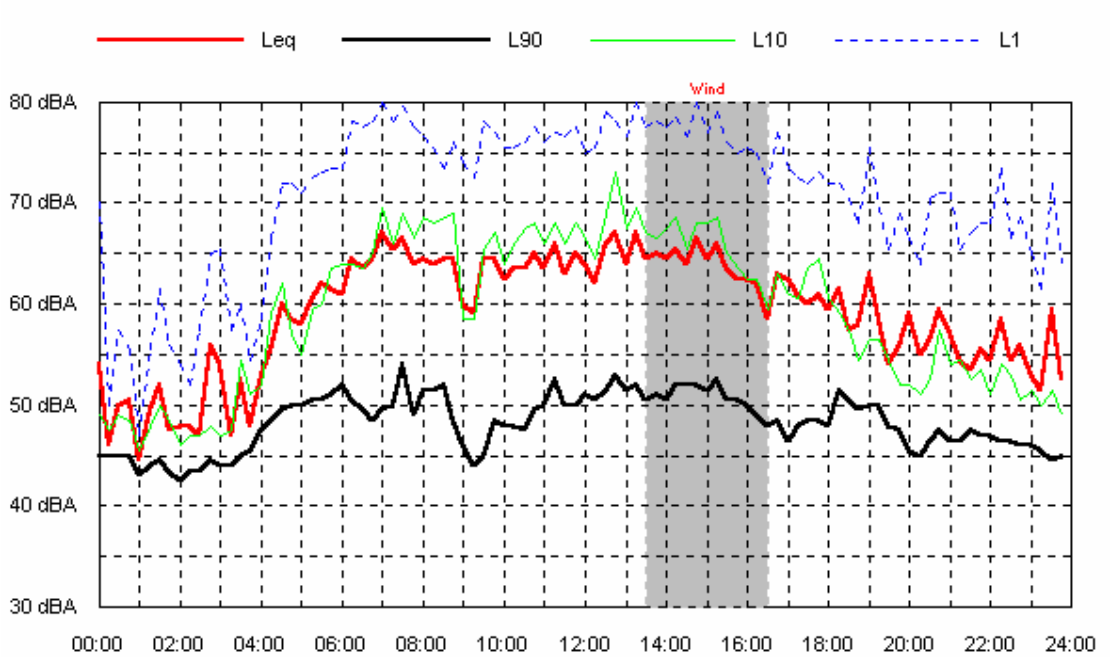
Thu 25 Oct 01



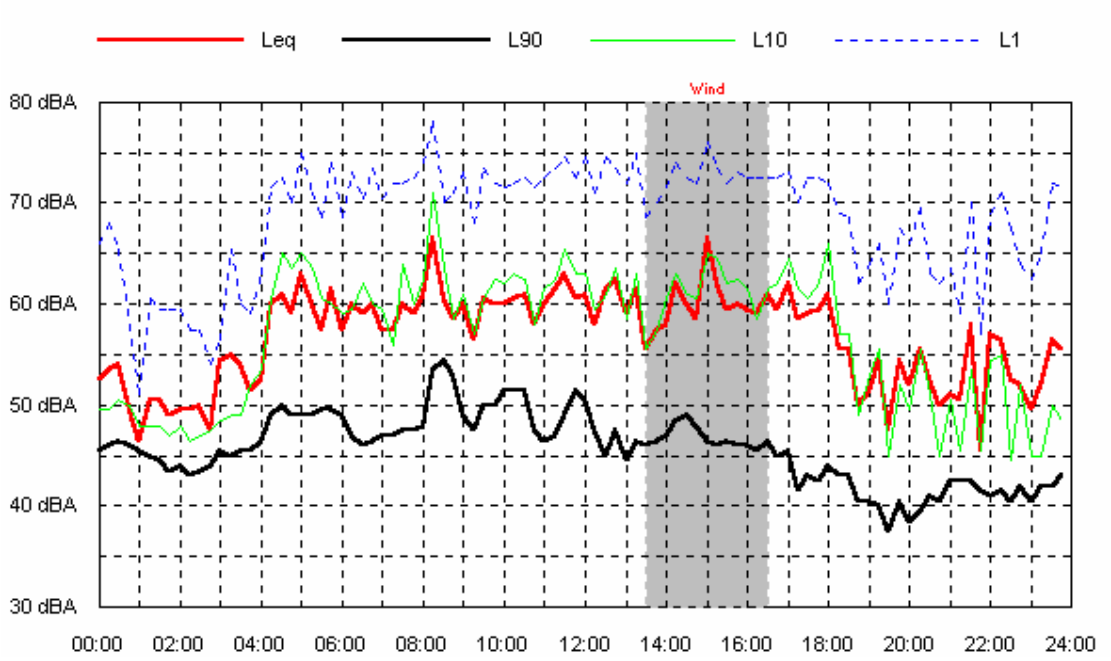
Location: Military Road

Data shaded: Wind

Fri 26 Oct 01



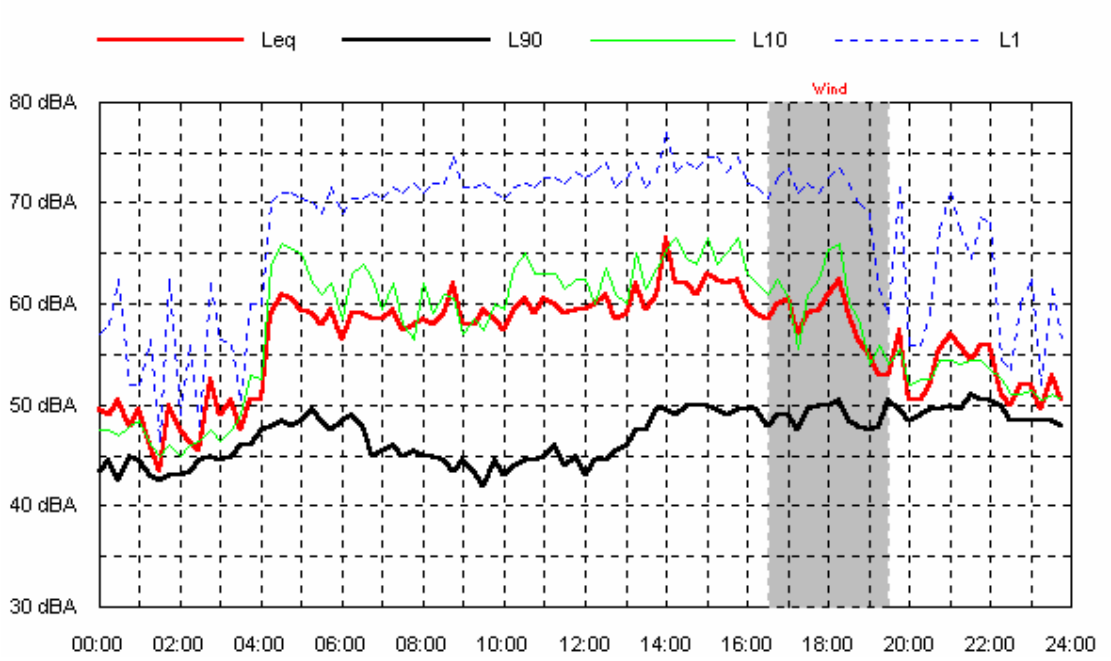
Sat 27 Oct 01



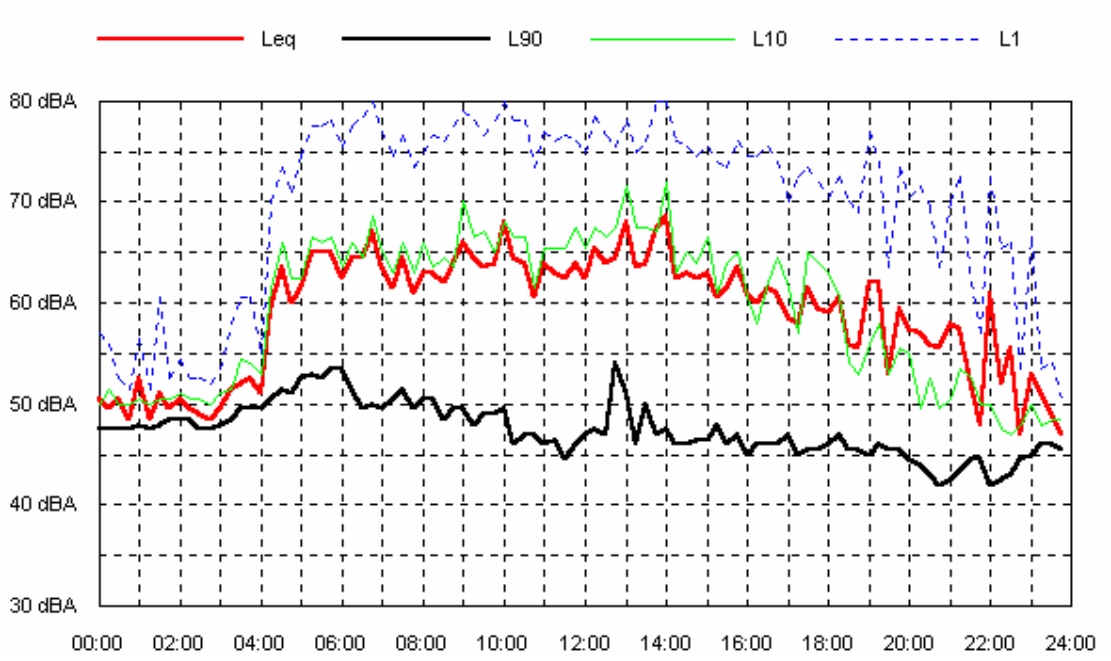
Location: Military Road

Data shaded: Wind

Sun 28 Oct 01



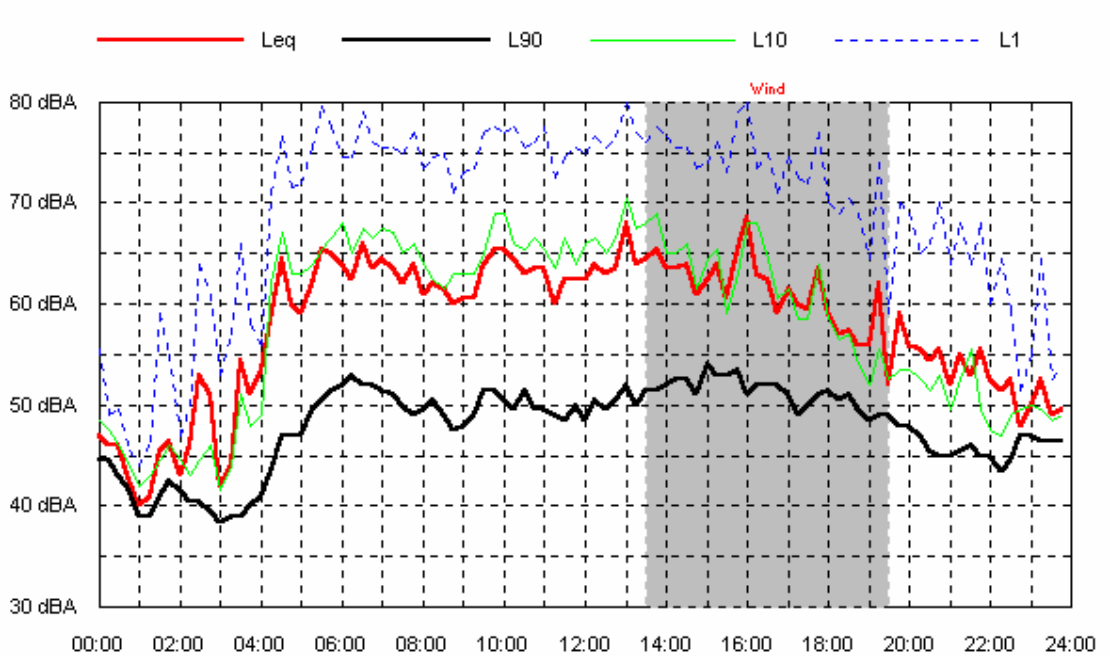
Mon 29 Oct 01



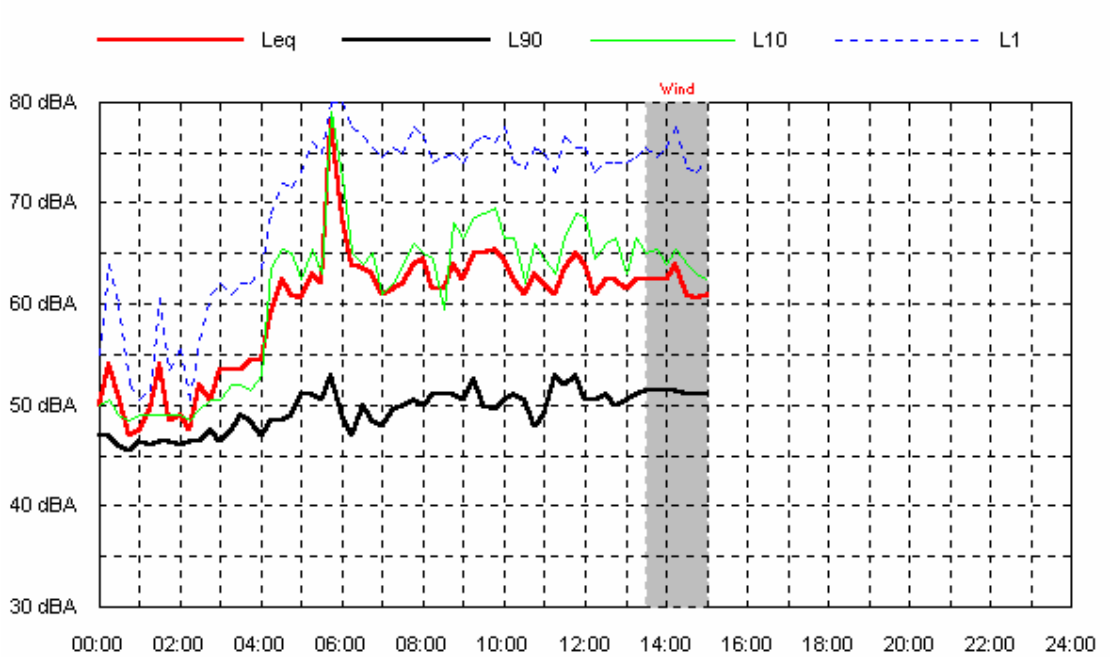
Location: Military Road

Data shaded: Wind

Tue 30 Oct 01



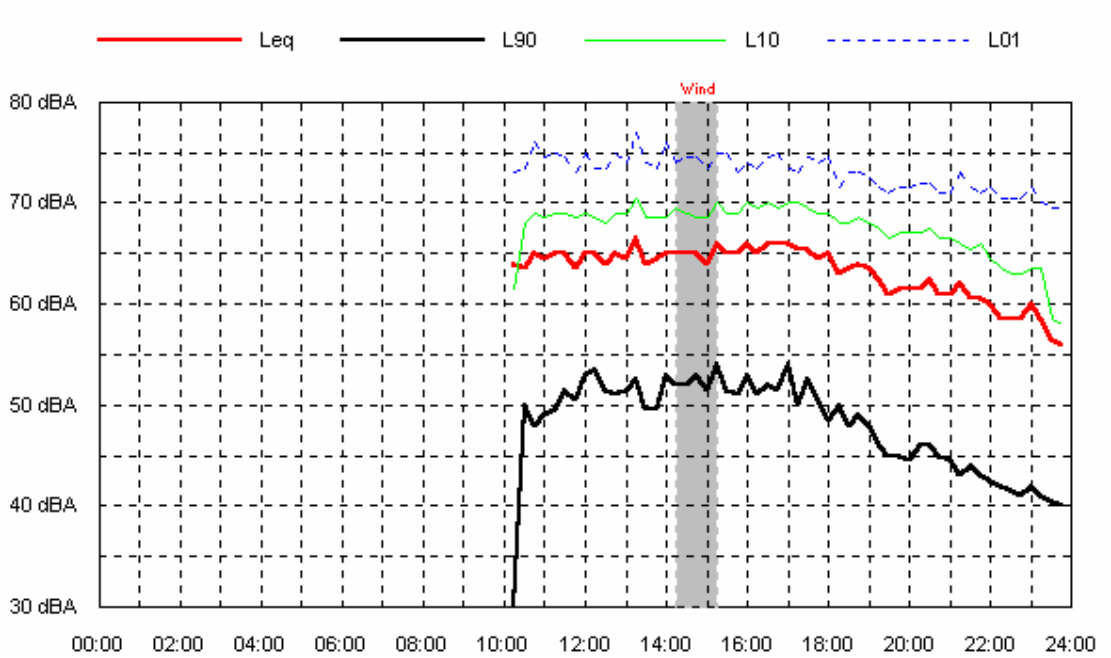
Wed 31 Oct 01



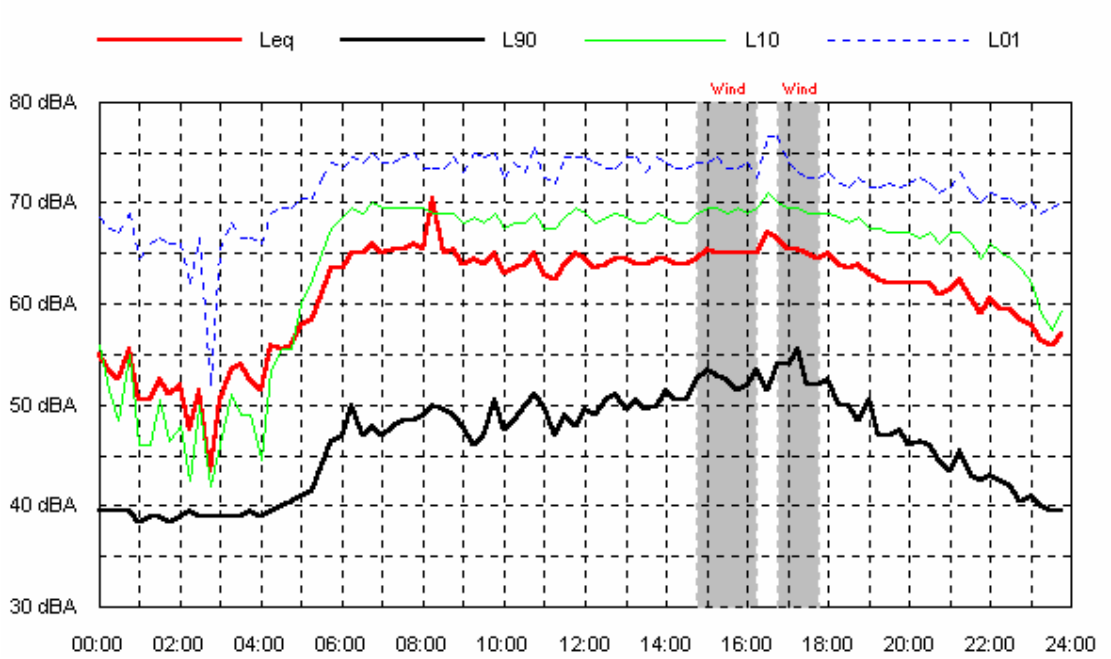
Location: 36 Beauchamp Road

Data shaded: Wind; Rain

Wed 10 Apr 02



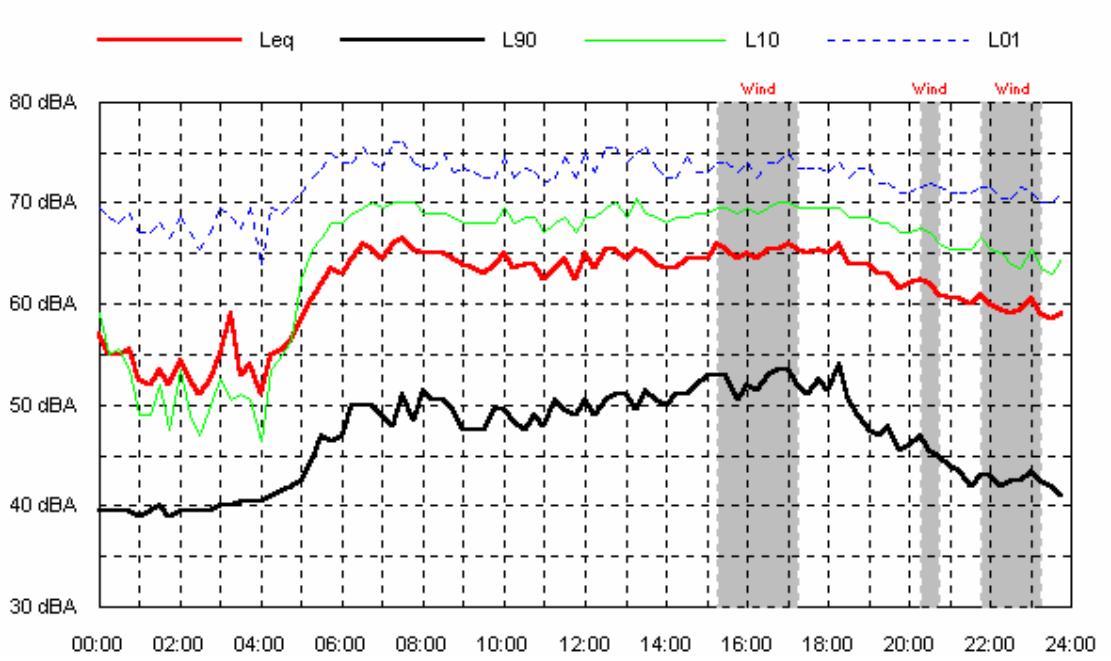
Thu 11 Apr 02



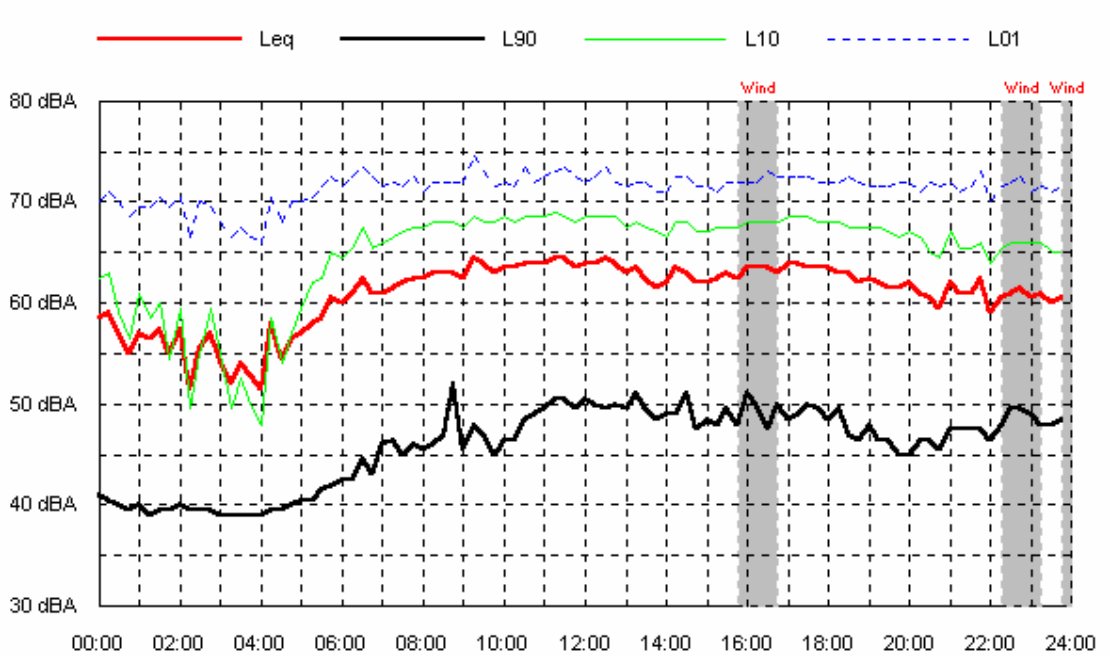
Location: 36 Beauchamp Road

Data shaded: Wind; Rain

Fri 12 Apr 02



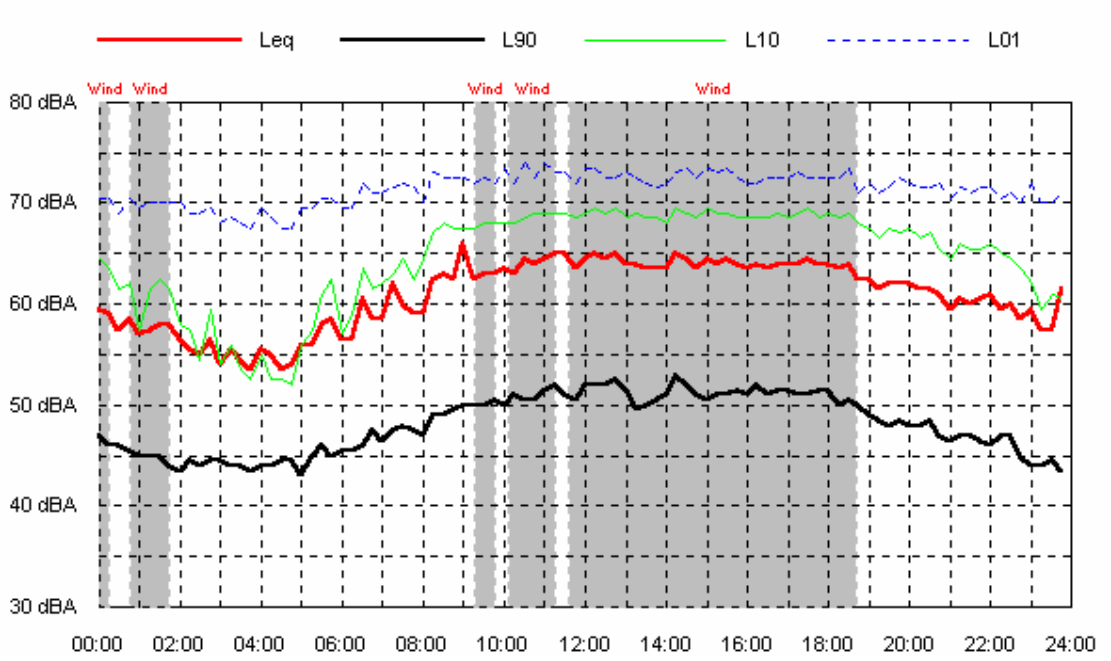
Sat 13 Apr 02



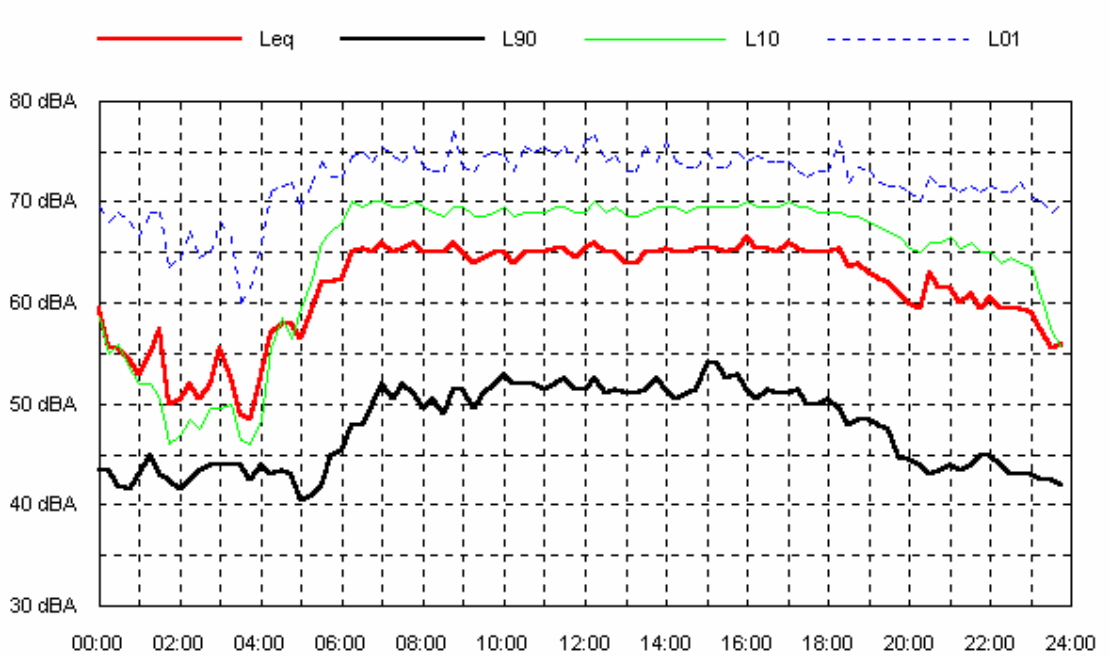
Location: 36 Beauchamp Road

Data shaded: Wind; Rain

Sun 14 Apr 02



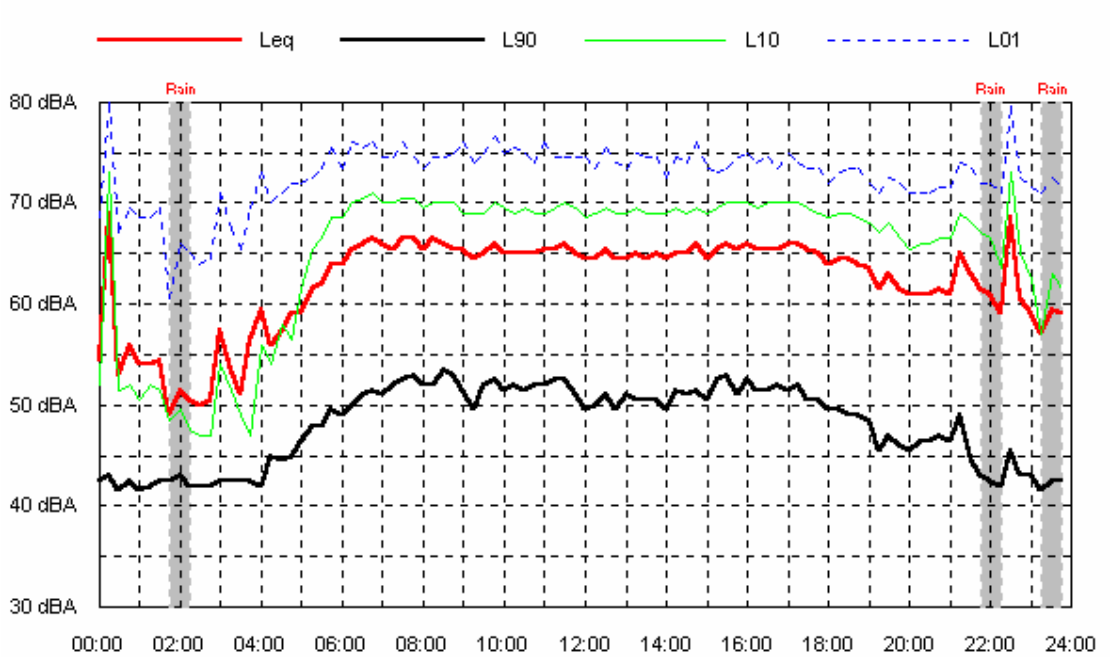
Mon 15 Apr 02



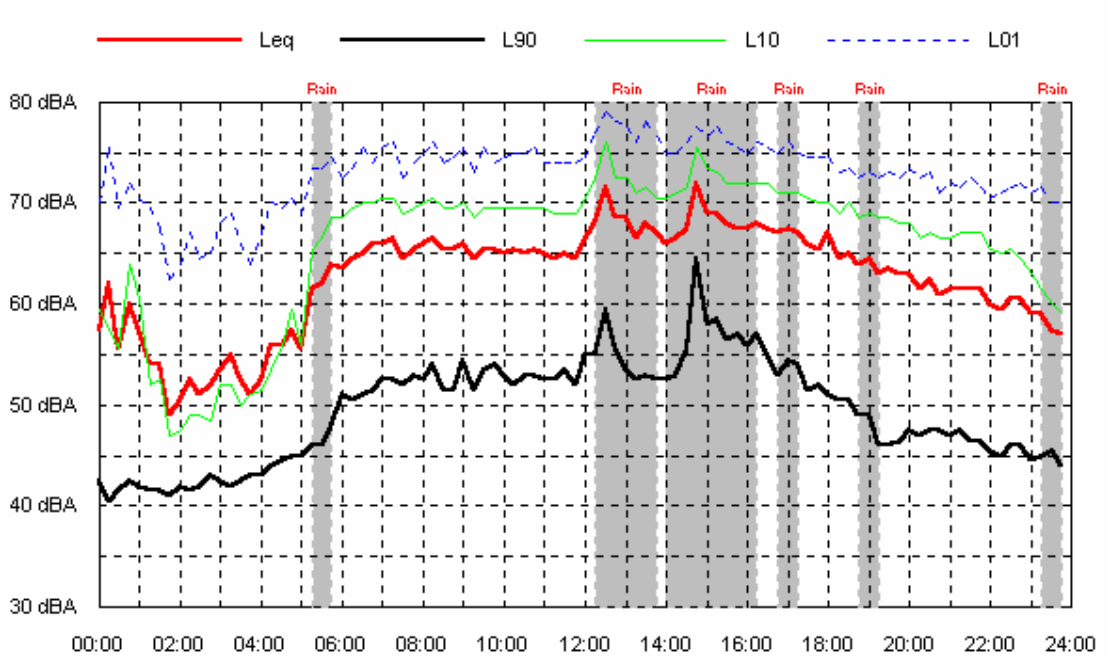
Location: 36 Beauchamp Road

Data shaded: Wind; Rain

Tue 16 Apr 02



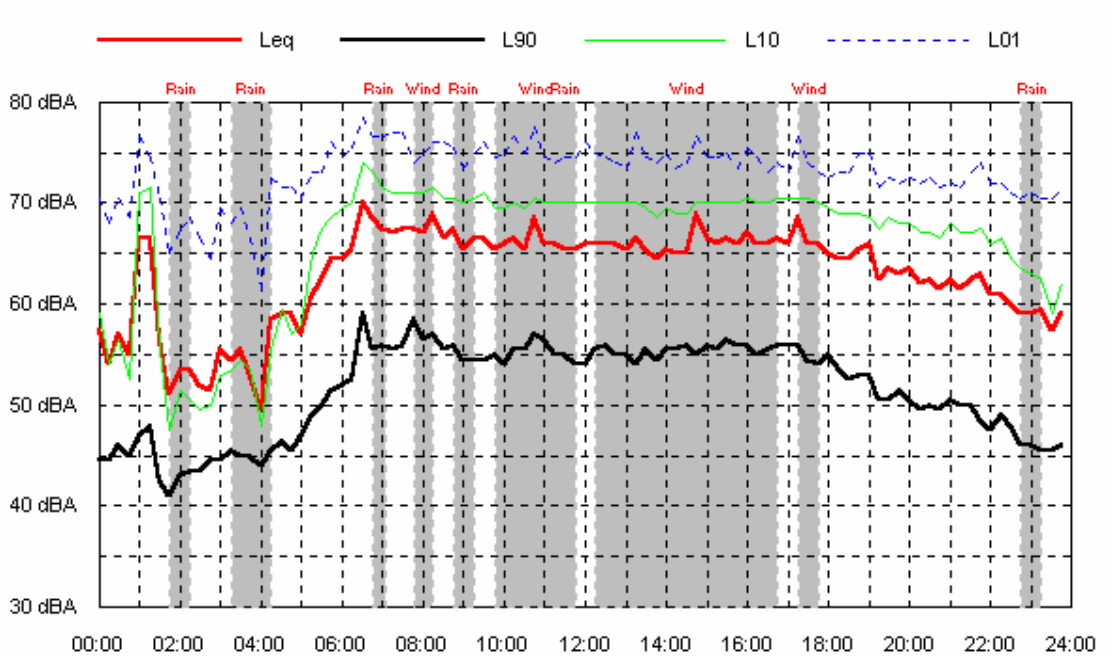
Wed 17 Apr 02



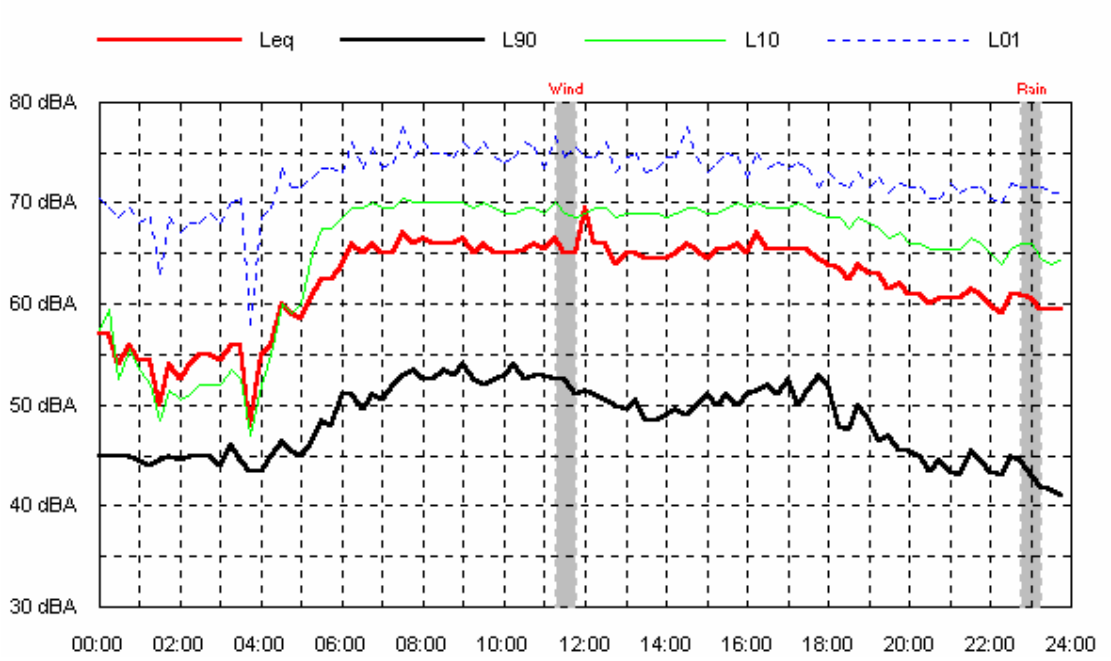
Location: 36 Beauchamp Road

Data shaded: Wind; Rain

Thu 18 Apr 02



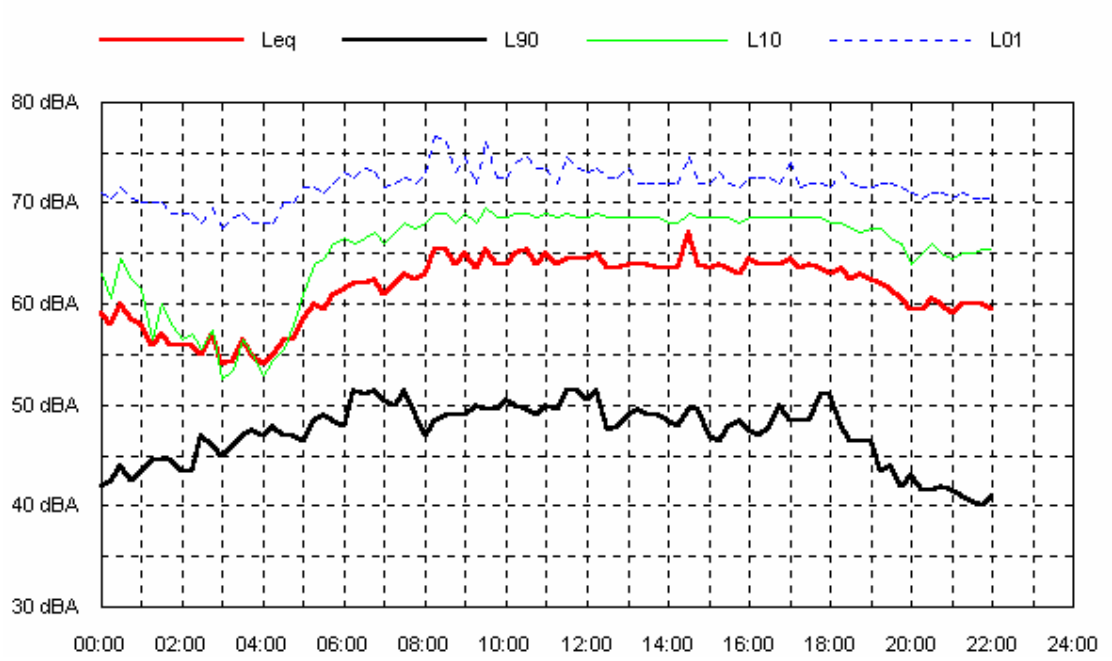
Fri 19 Apr 02



Location: 36 Beauchamp Road

Data shaded: Wind; Rain

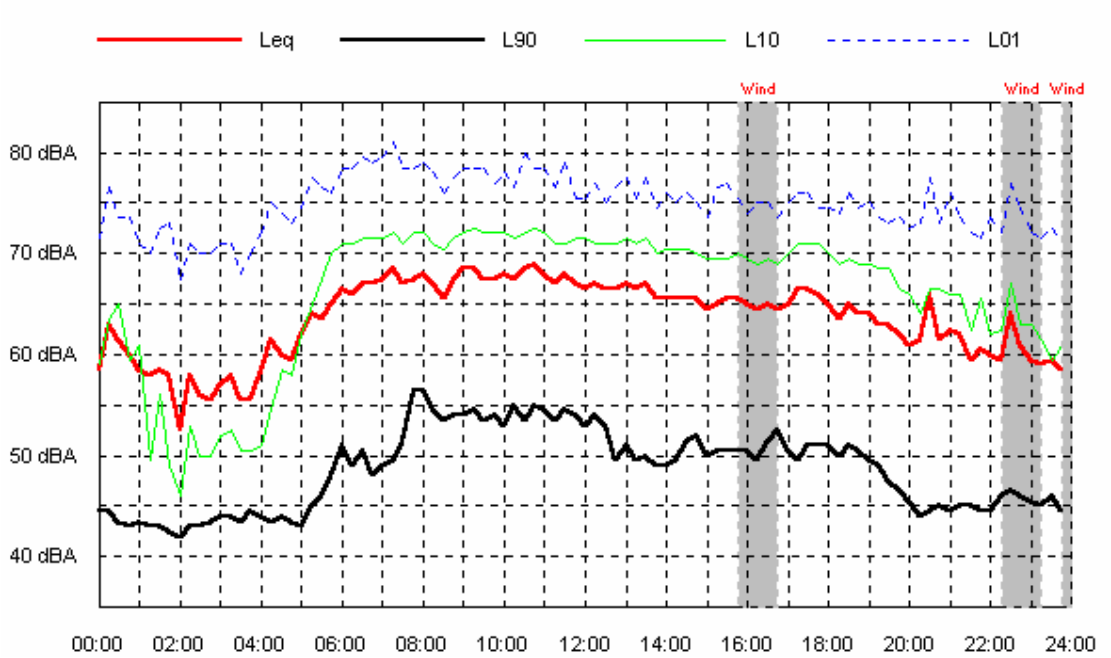
Sat 20 Apr 02



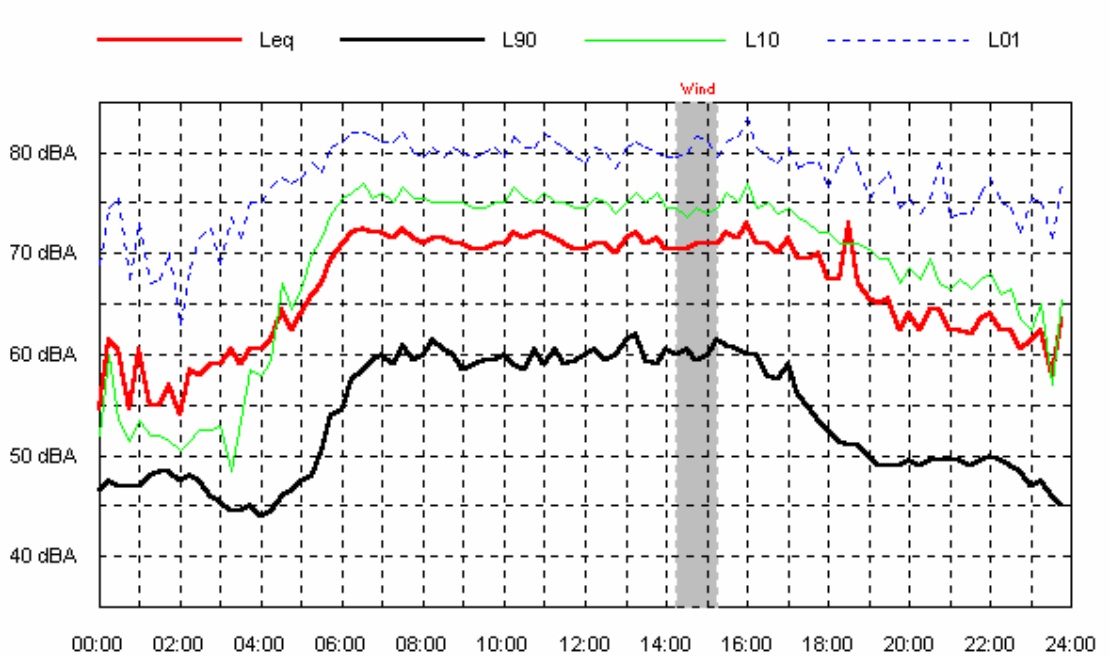
Location: 1424 Botany Road

Data shaded: Wind; Rain

Tue 09 Apr 02



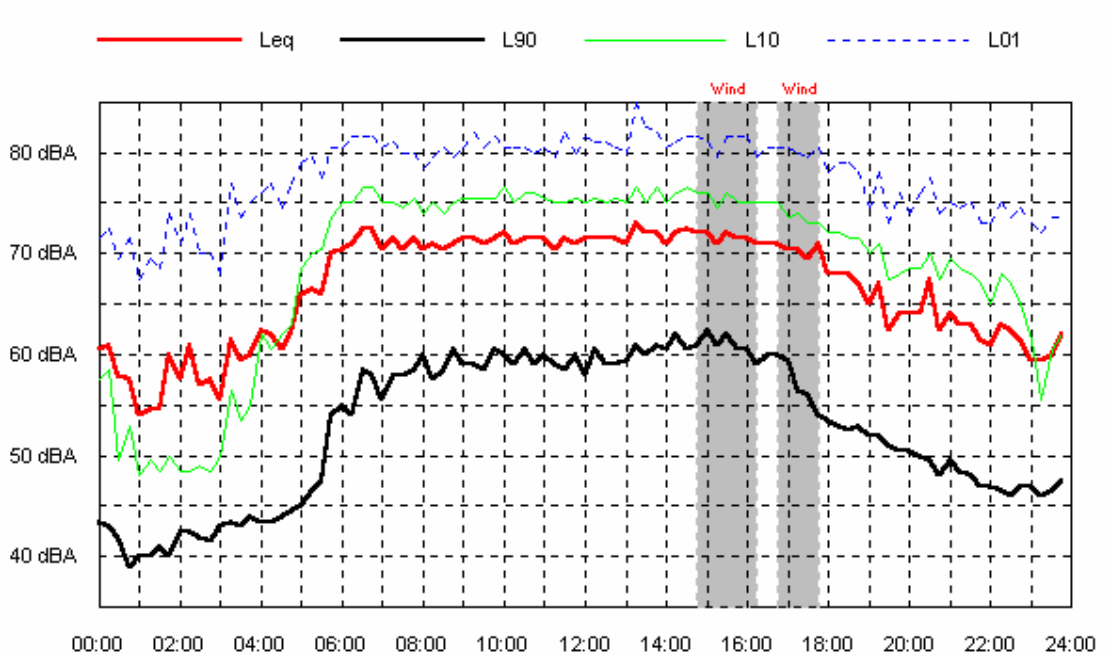
Wed 10 Apr 02



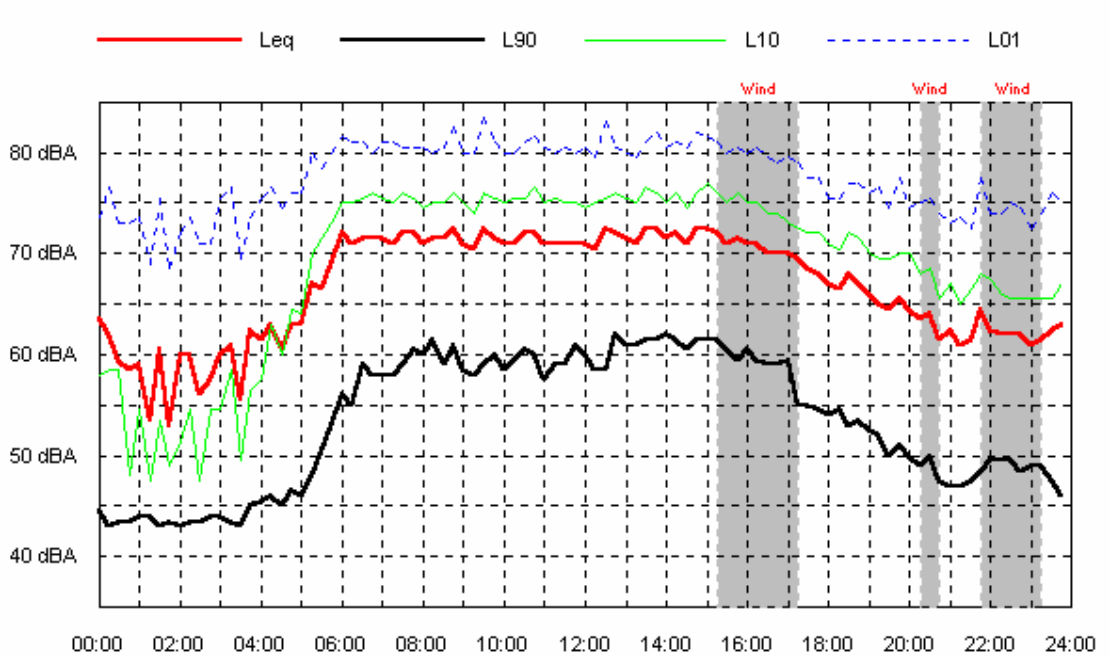
Location: 1424 Botany Road

Data shaded: Wind; Rain

Thu 11 Apr 02



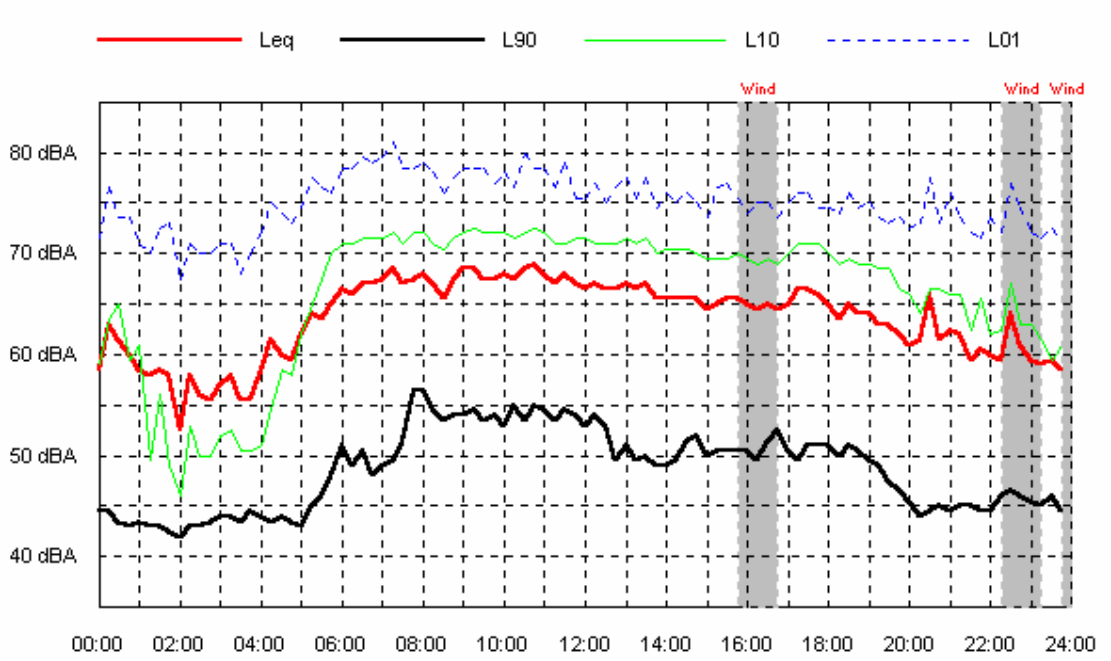
Fri 12 Apr 02



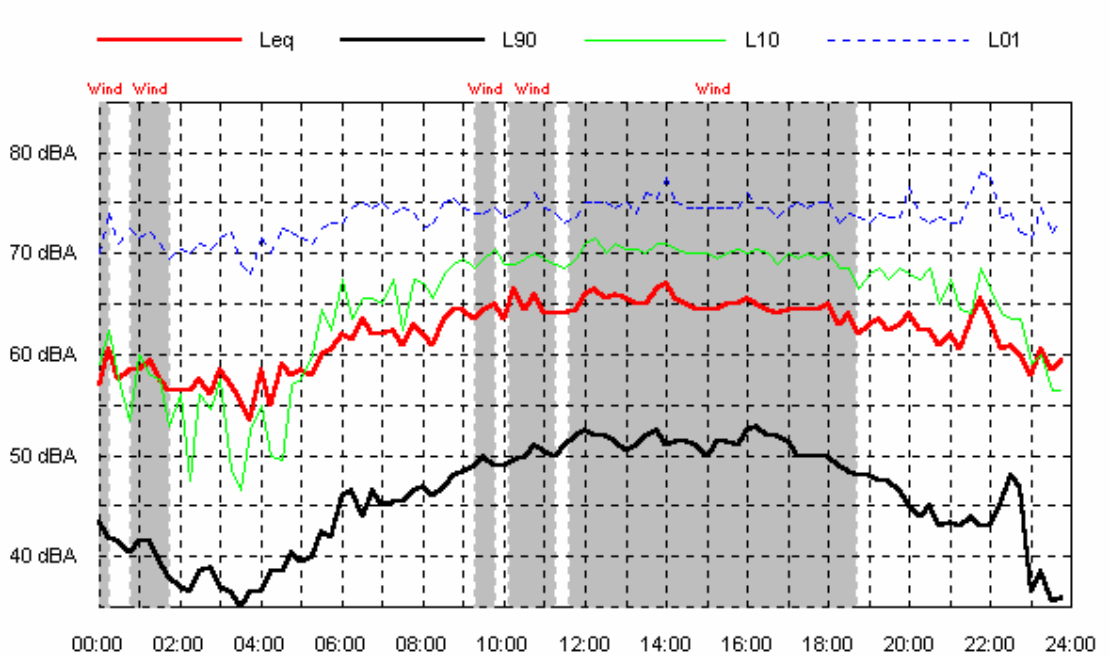
Location: 1424 Botany Road

Data shaded: Wind; Rain

Sat 13 Apr 02



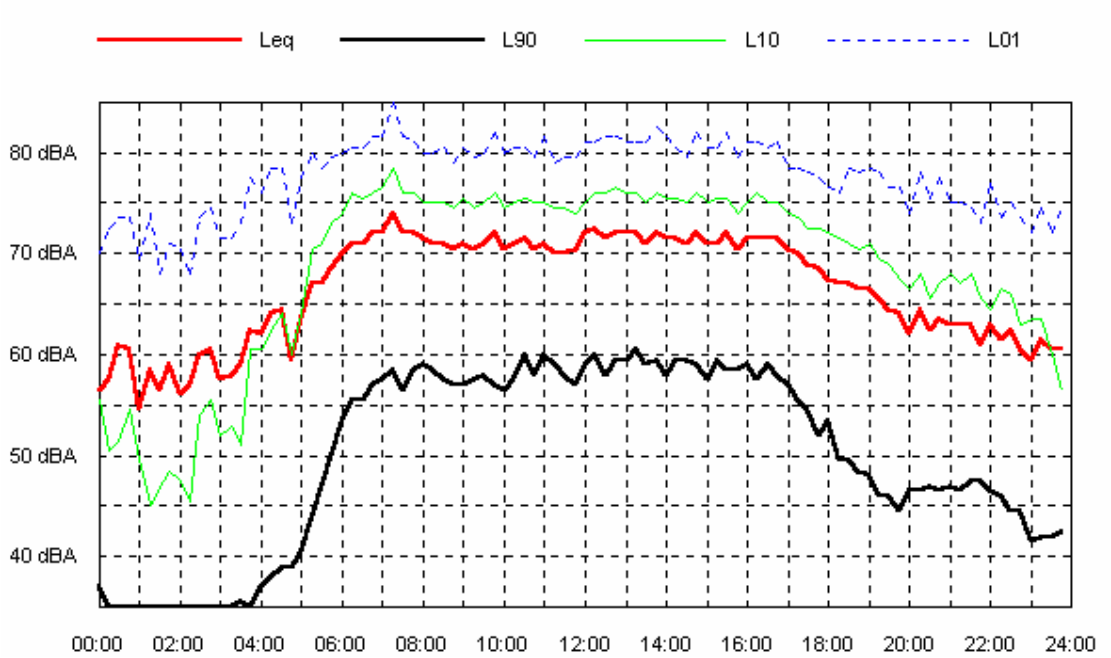
Sun 14 Apr 02



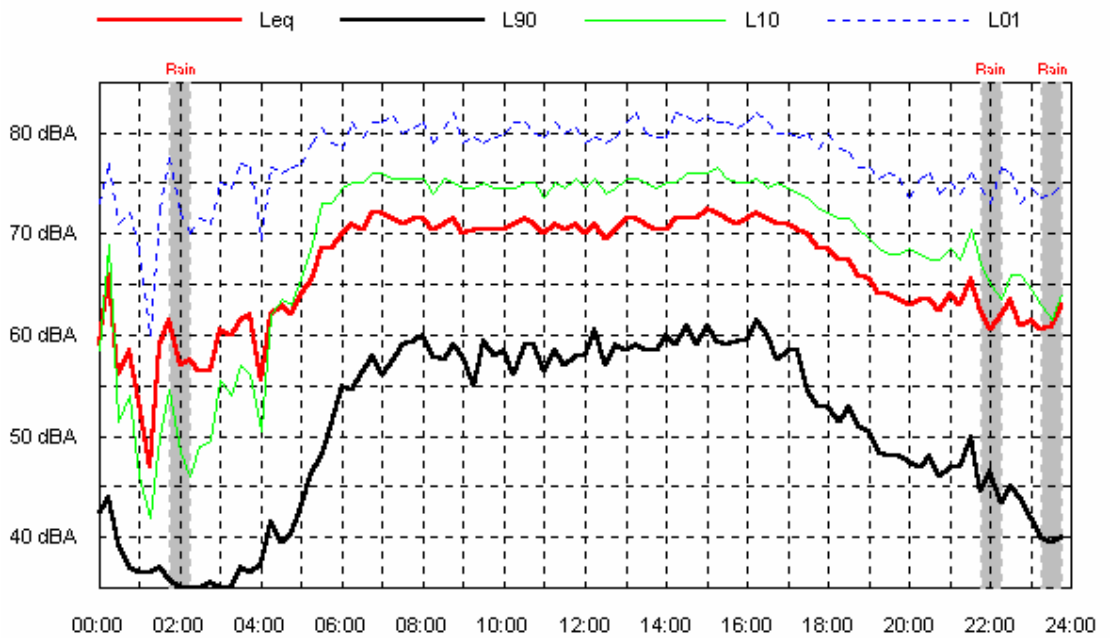
Location: 1424 Botany Road

Data shaded: Wind; Rain

Mon 15 Apr 02



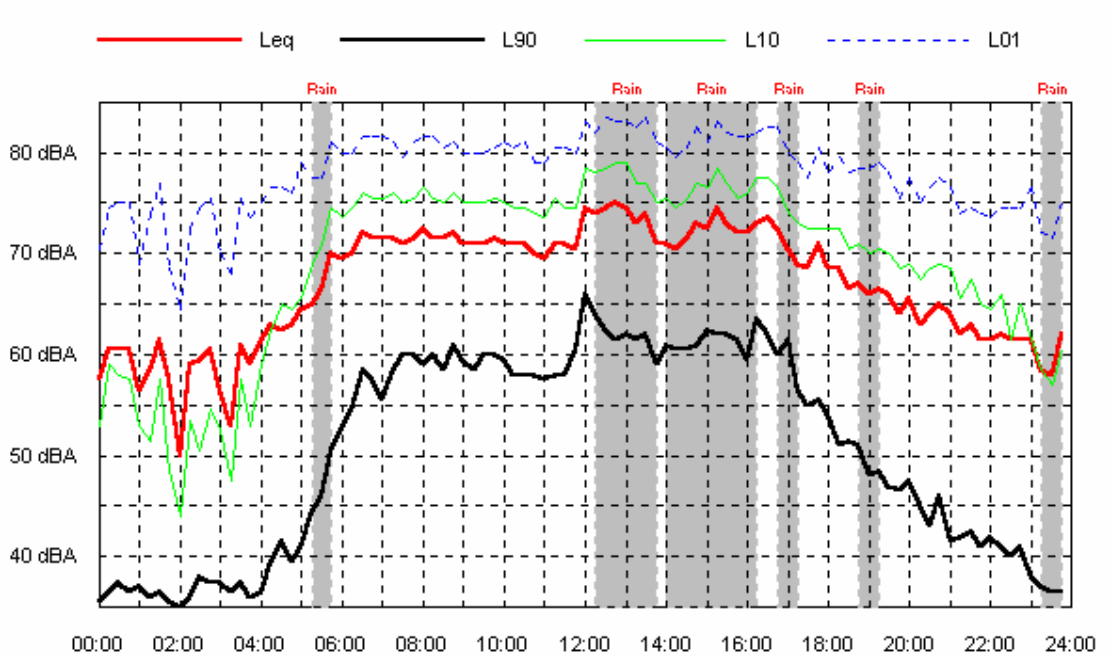
Tue 16 Apr 02



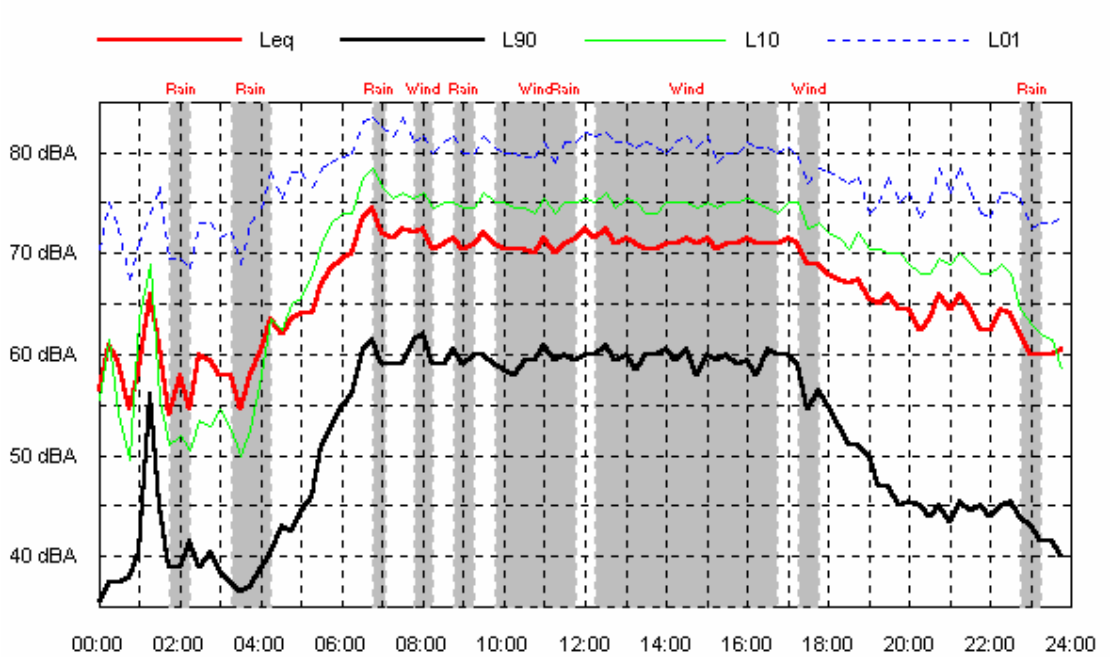
Location: 1424 Botany Road

Data shaded: Wind; Rain

Wed 17 Apr 02



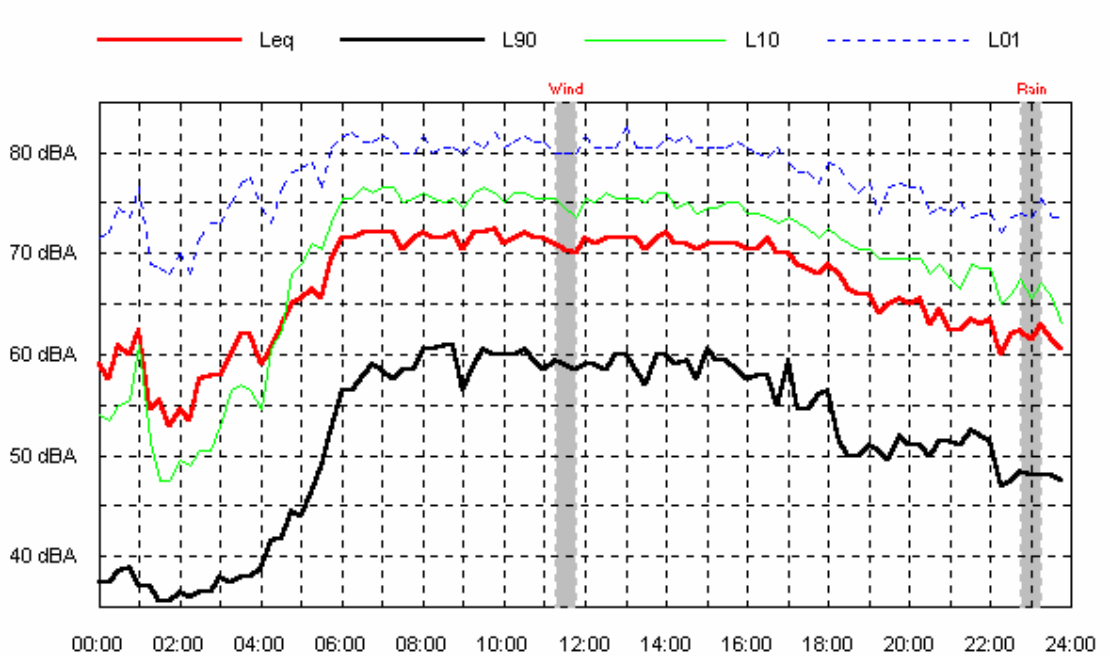
Thu 18 Apr 02



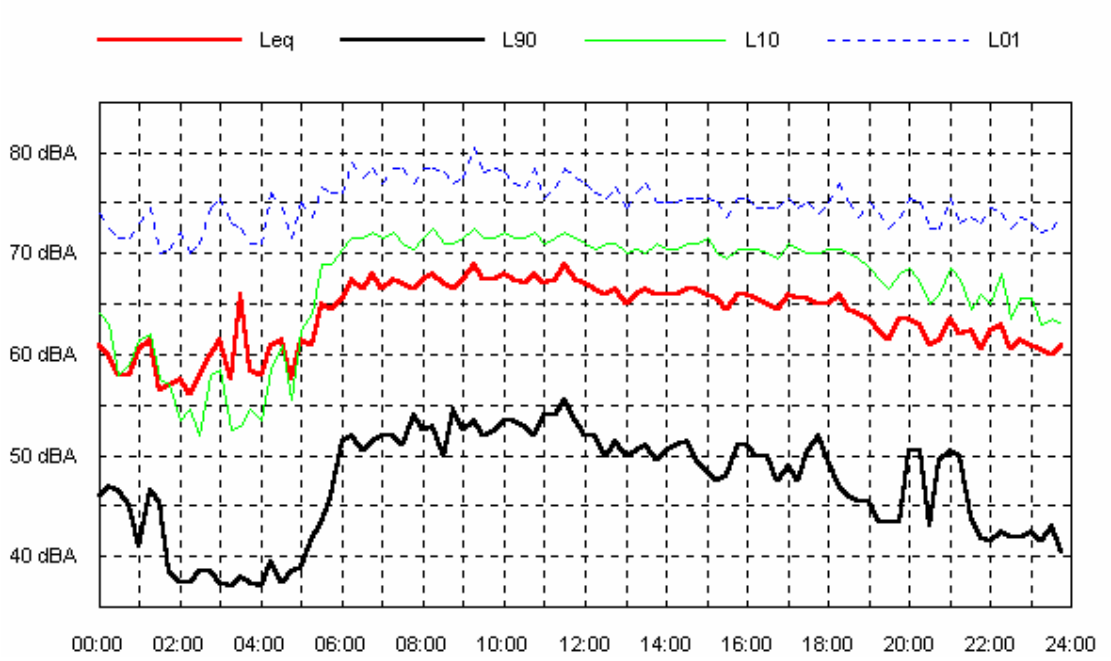
Location: 1424 Botany Road

Data shaded: Wind; Rain

Fri 19 Apr 02



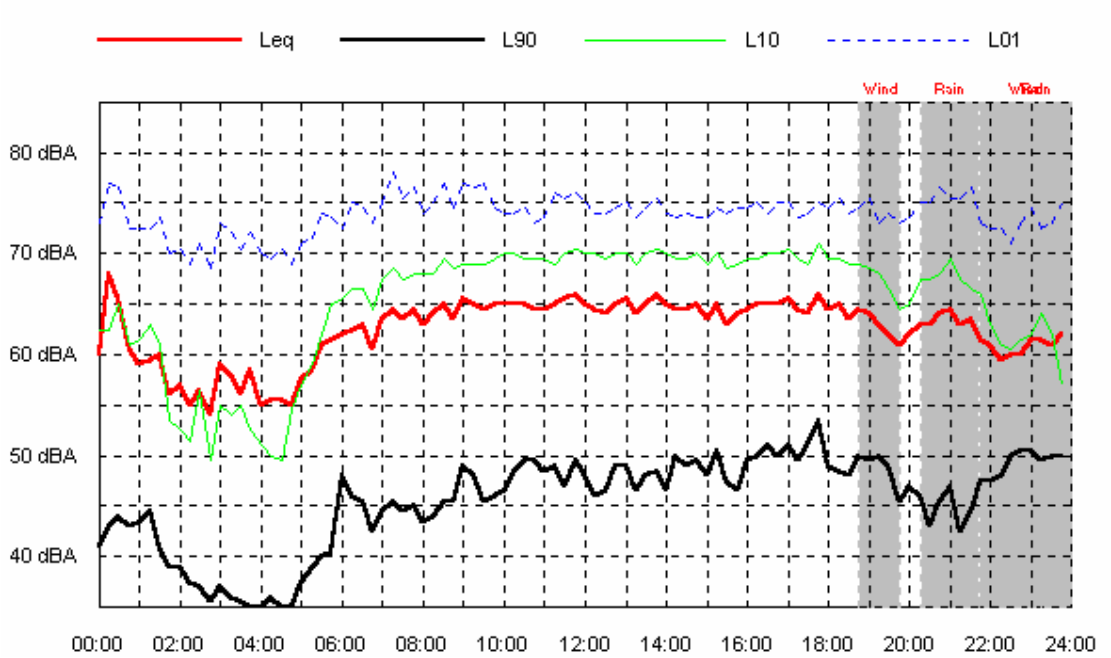
Sat 20 Apr 02



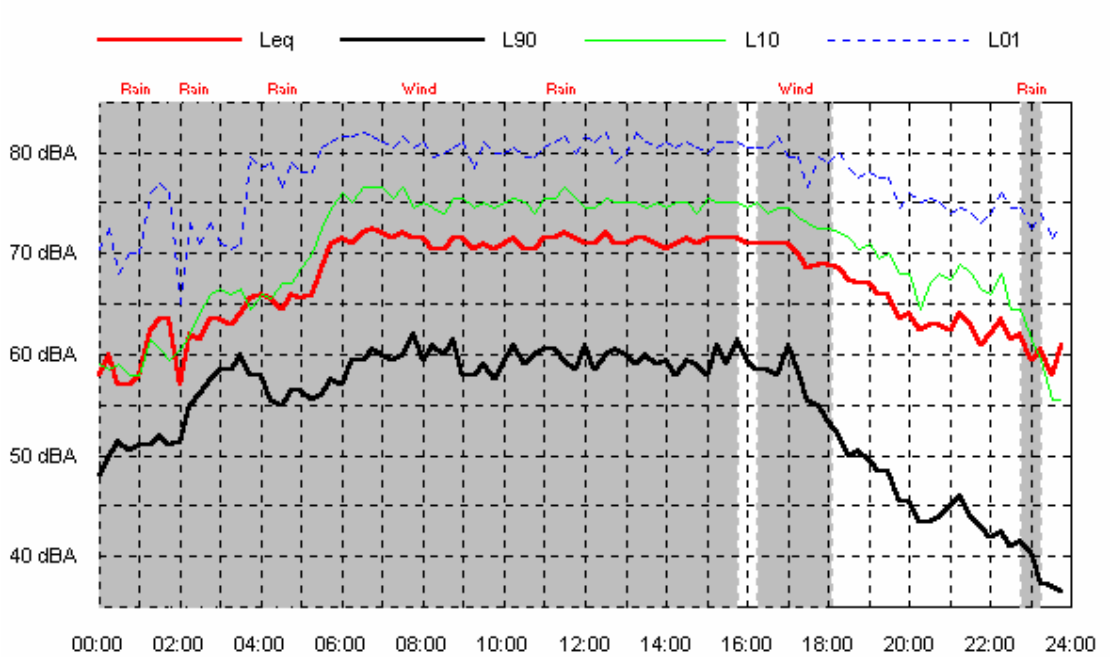
Location: 1424 Botany Road

Data shaded: Wind; Rain

Sun 21 Apr 02



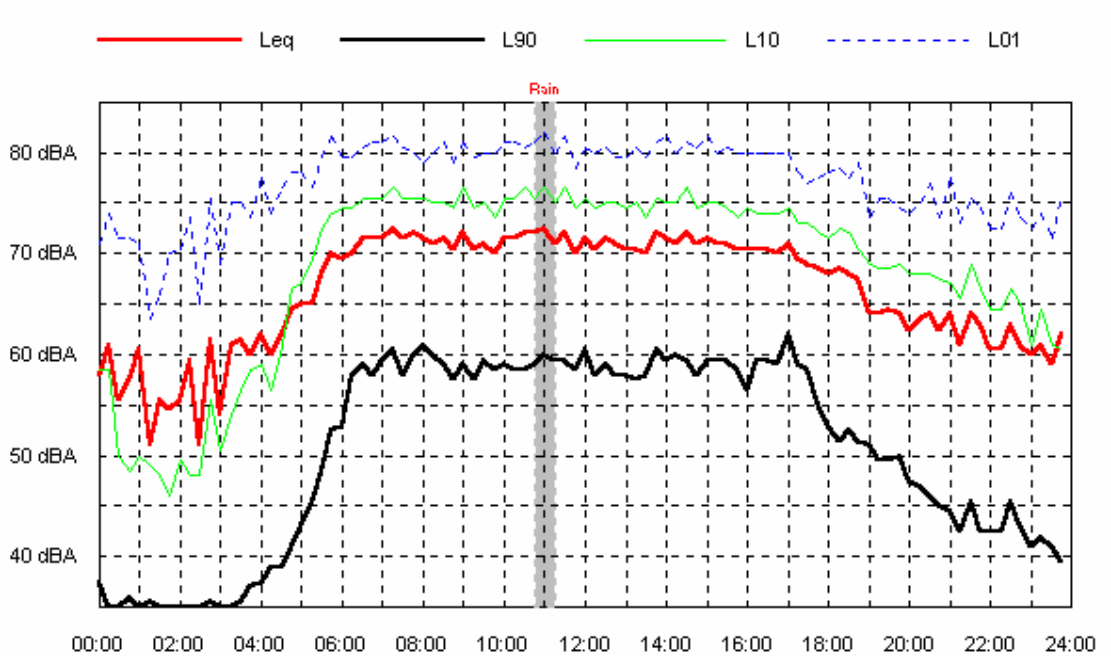
Mon 22 Apr 02



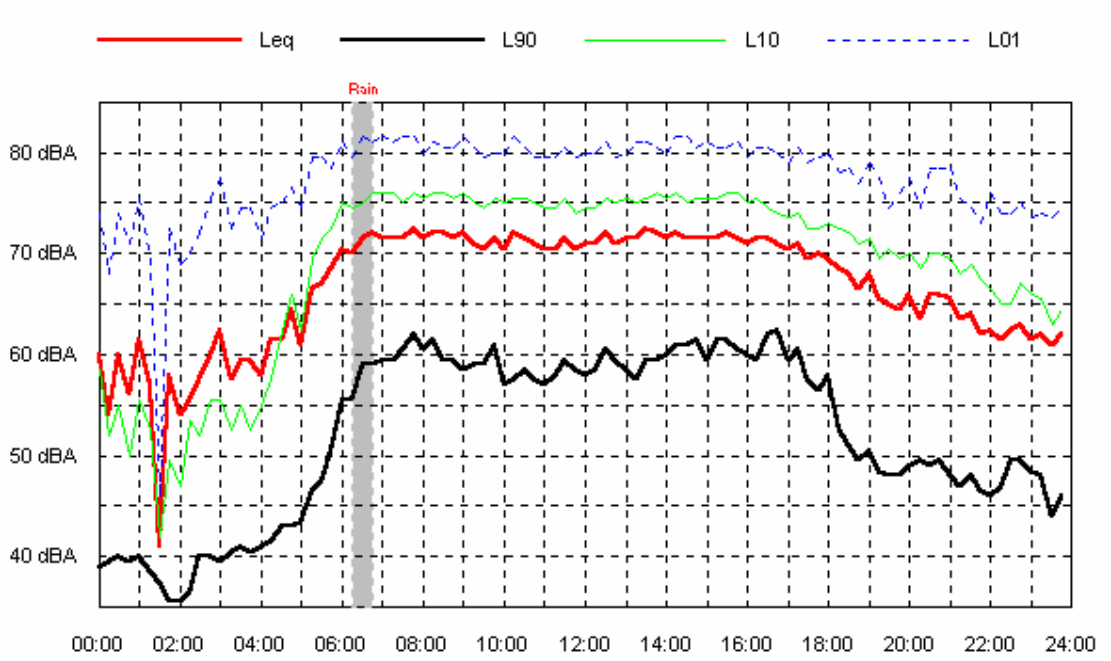
Location: 1424 Botany Road

Data shaded: Wind; Rain

Tue 23 Apr 02



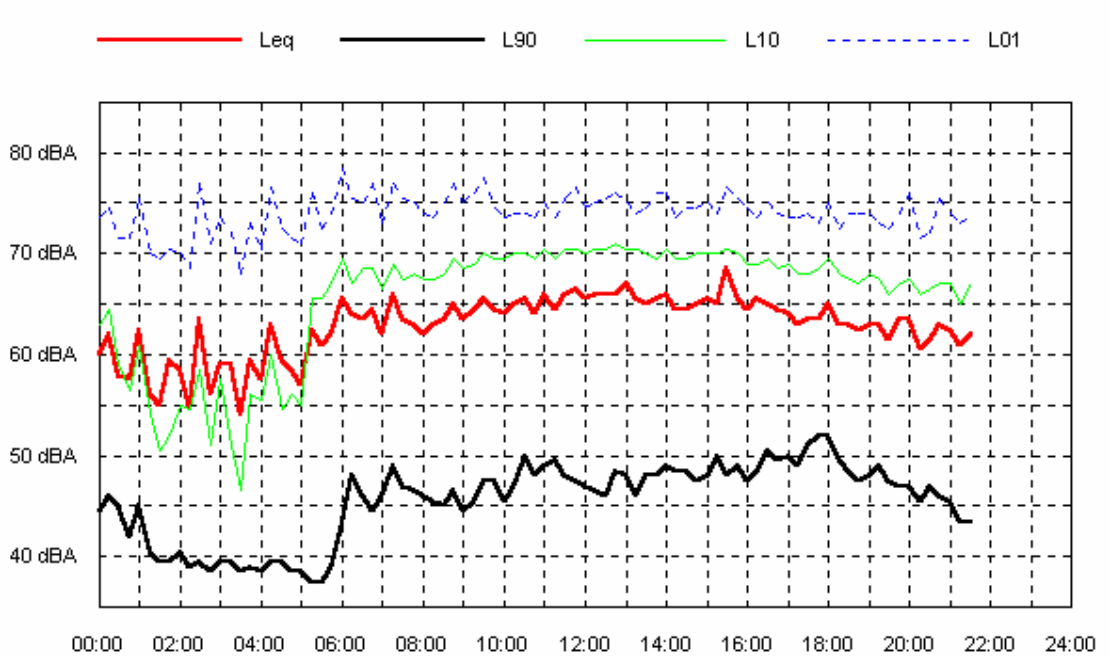
Wed 24 Apr 02



Location: 1424 Botany Road

Data shaded: Wind; Rain

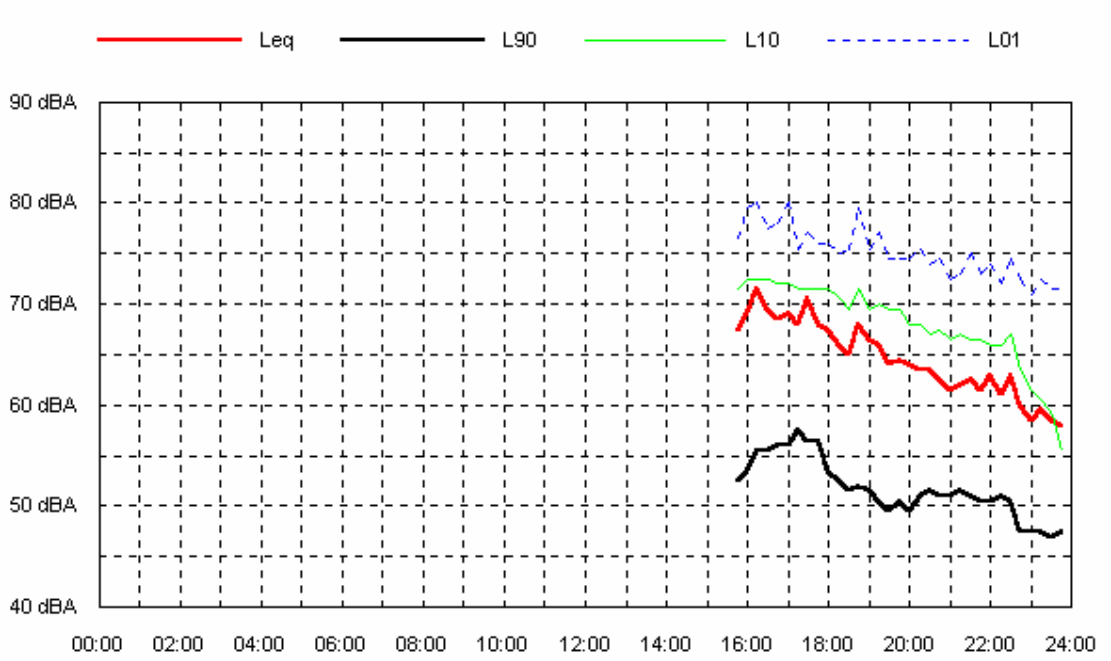
Thu 25 Apr 02



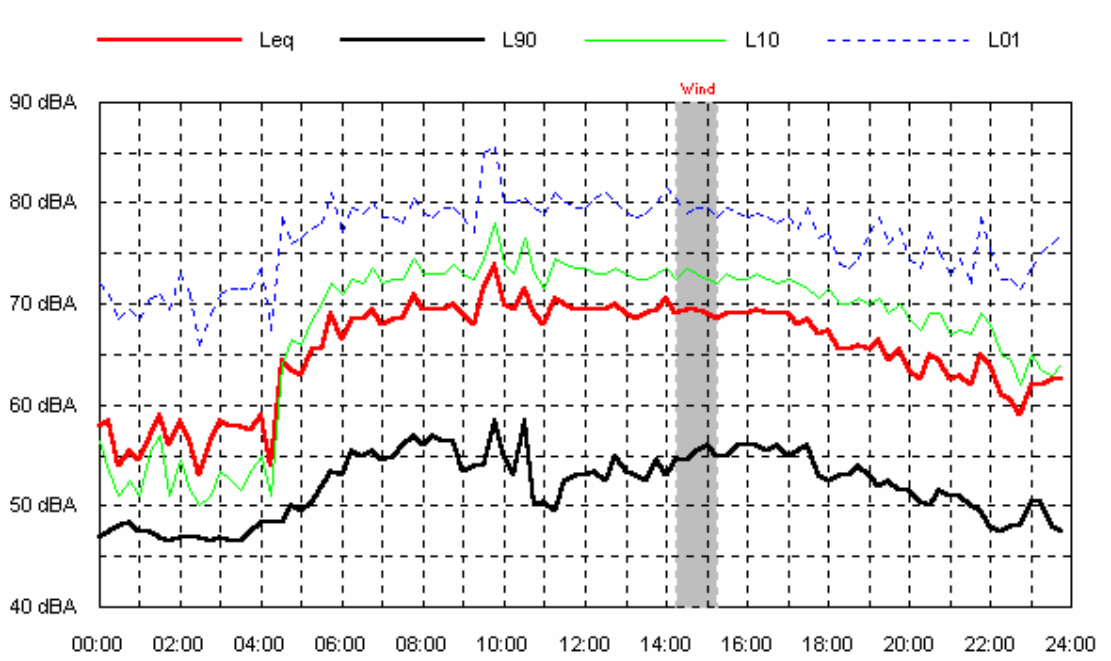
Location: Denison Street

Data shaded: Wind; Rain

Tue 09 Apr 02



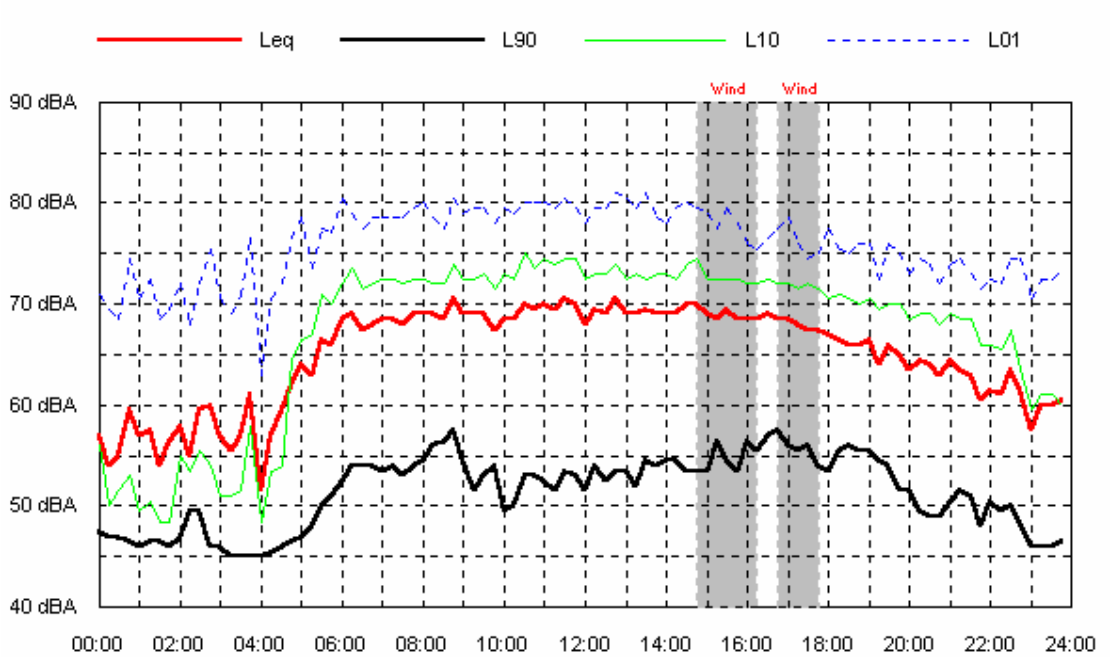
Wed 10 Apr 02



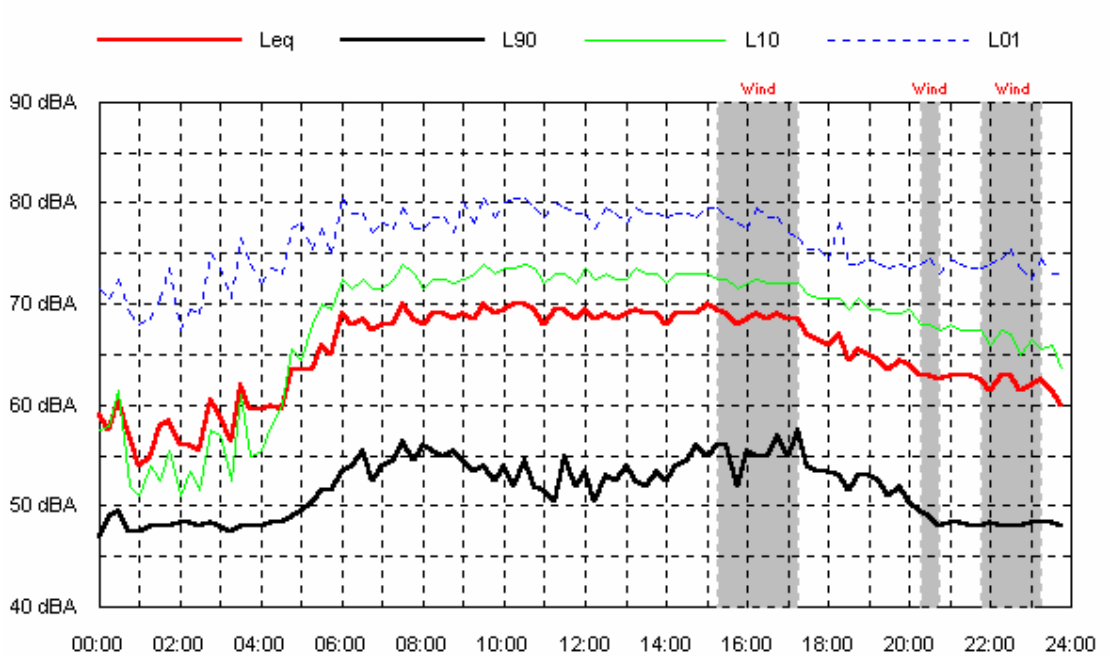
Location: Denison Street

Data shaded: Wind; Rain

Thu 11 Apr 02



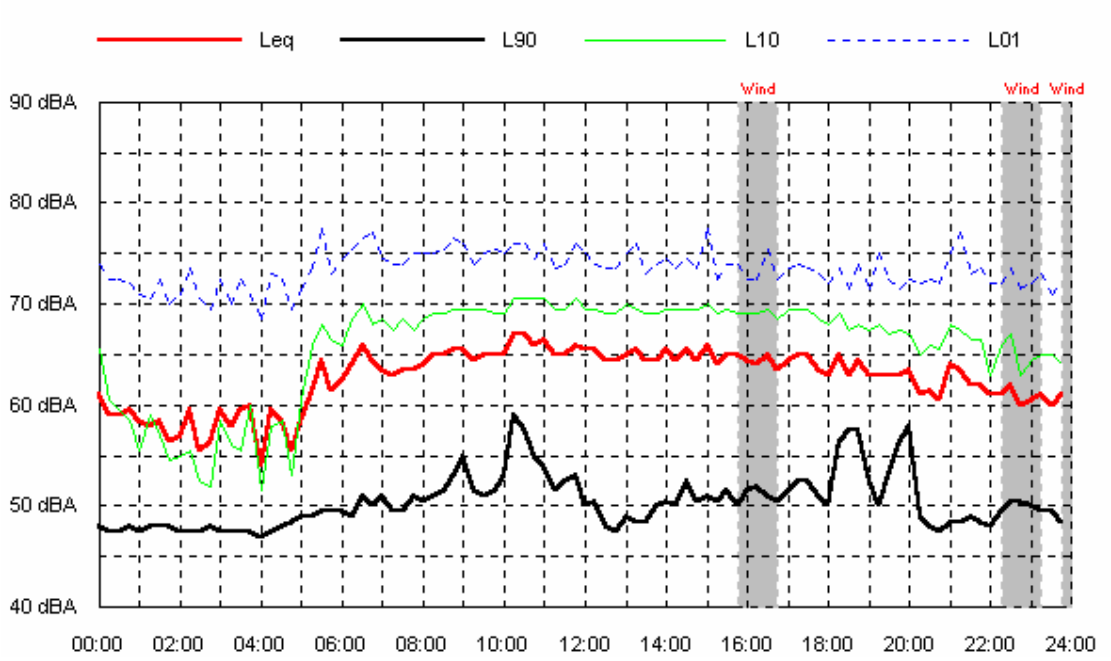
Fri 12 Apr 02



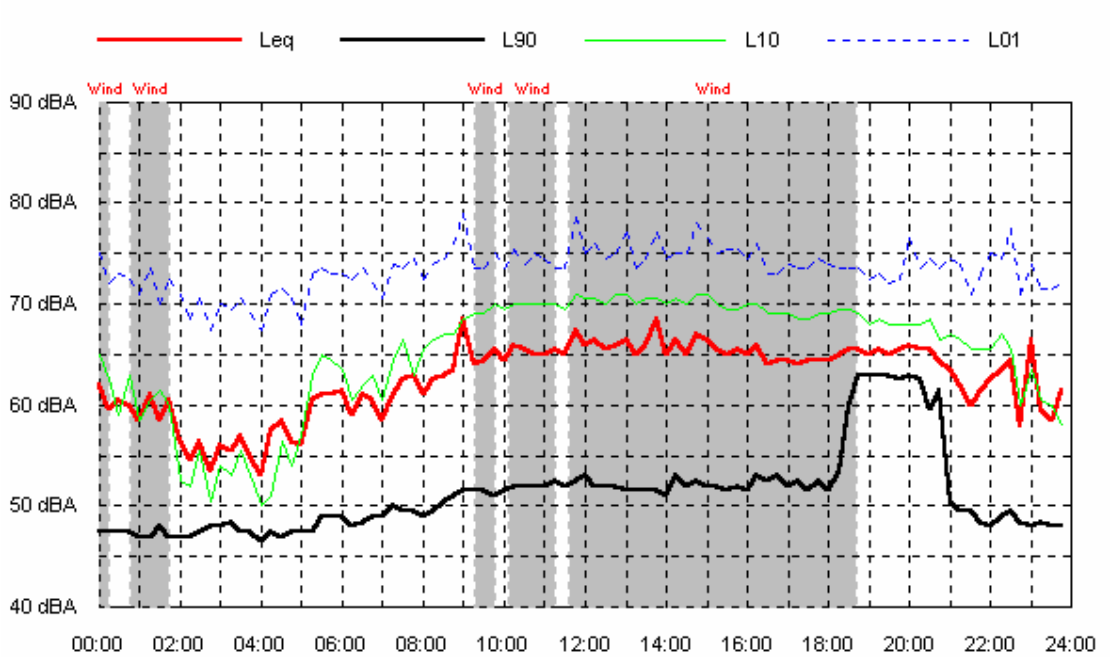
Location: Denison Street

Data shaded: Wind; Rain

Sat 13 Apr 02



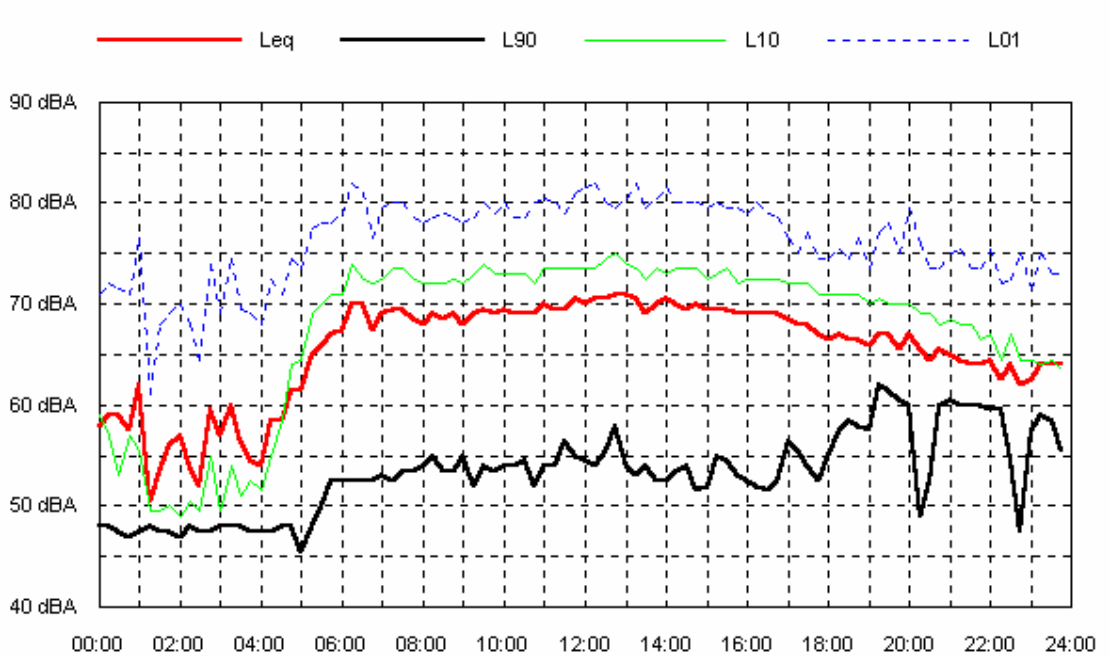
Sun 14 Apr 02



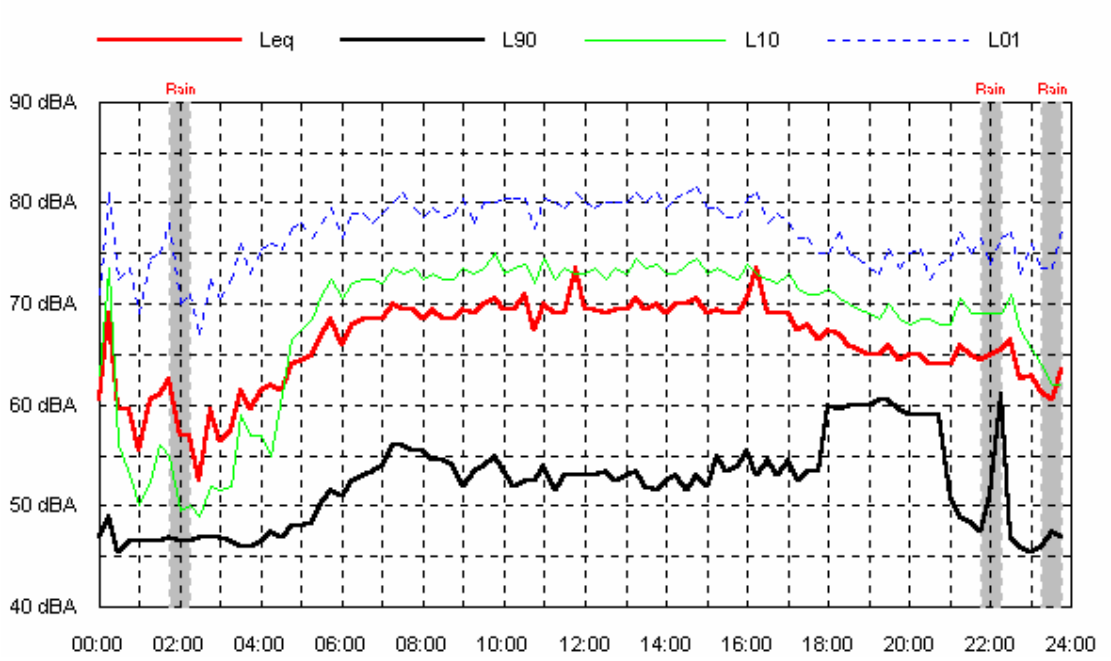
Location: Denison Street

Data shaded: Wind; Rain

Mon 15 Apr 02



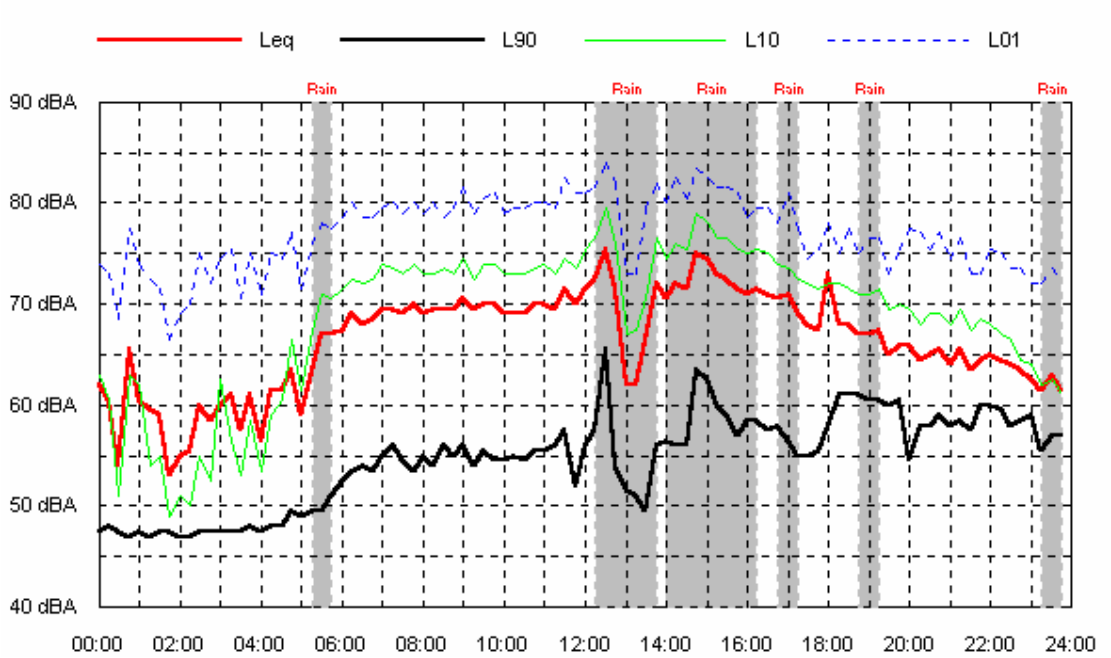
Tue 16 Apr 02



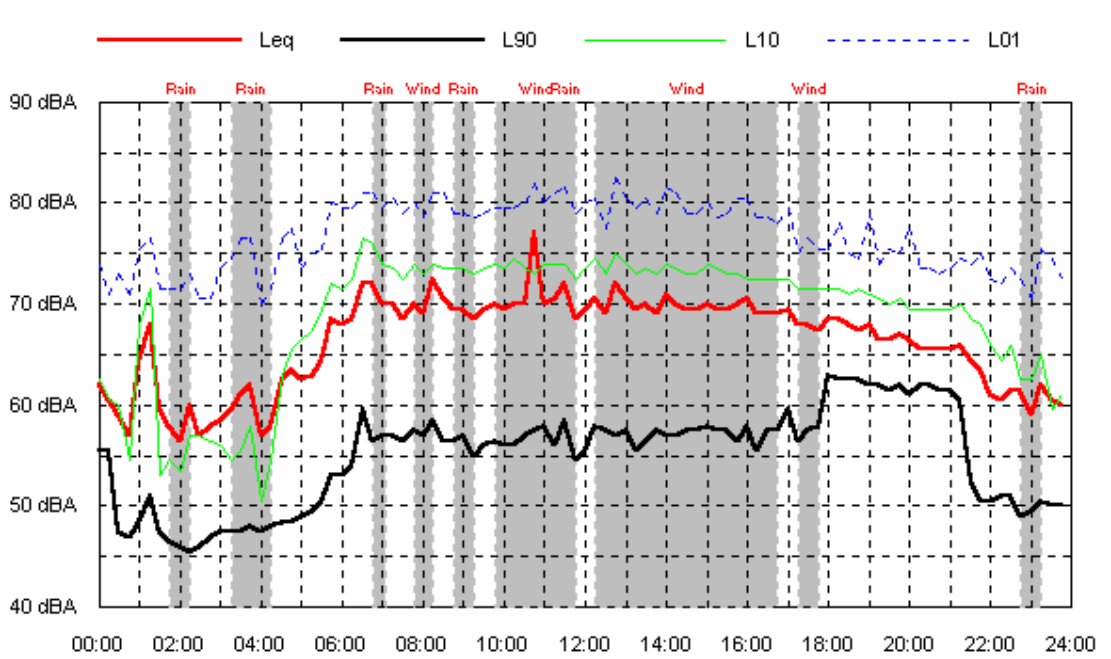
Location: Denison Street

Data shaded: Wind; Rain

Wed 17 Apr 02



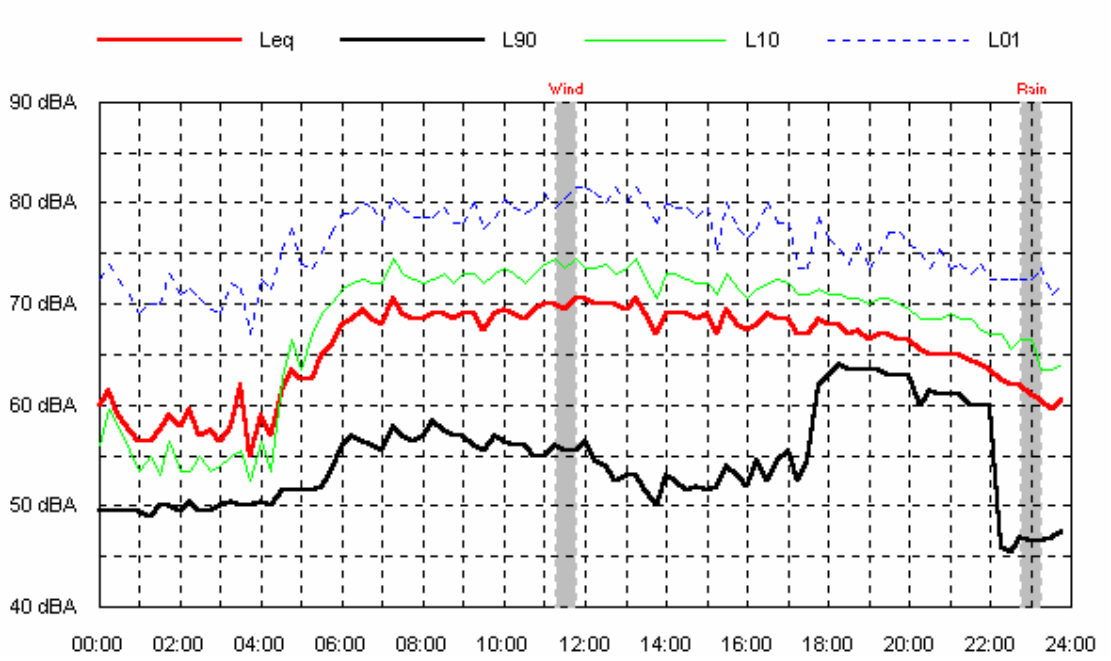
Thu 18 Apr 02



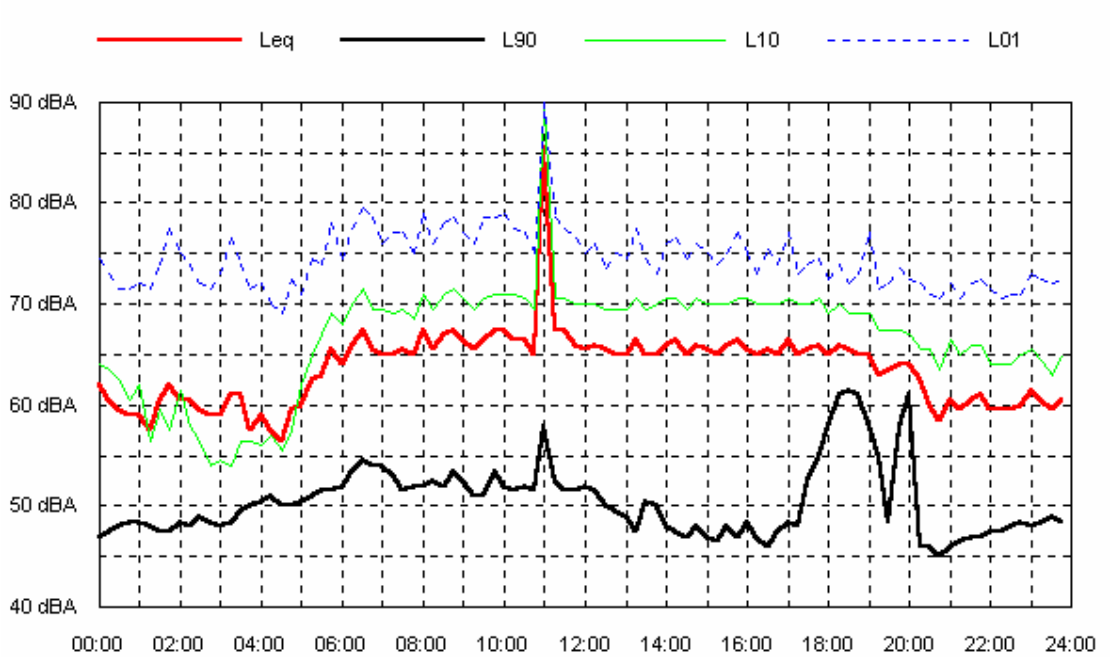
Location: Denison Street

Data shaded: Wind; Rain

Fri 19 Apr 02



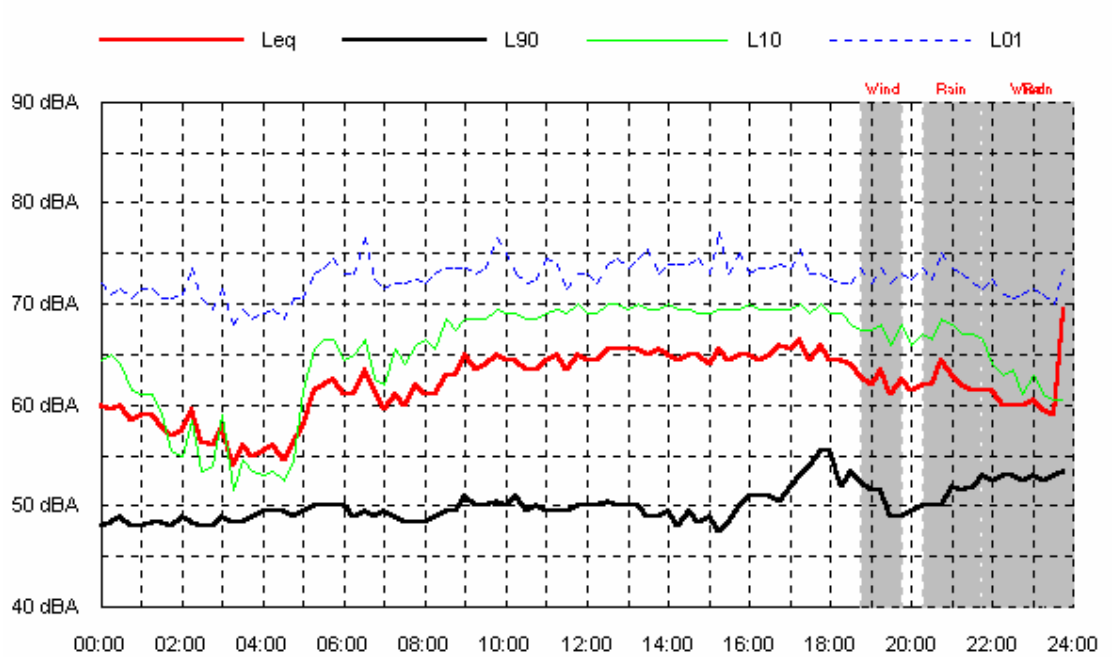
Sat 20 Apr 02



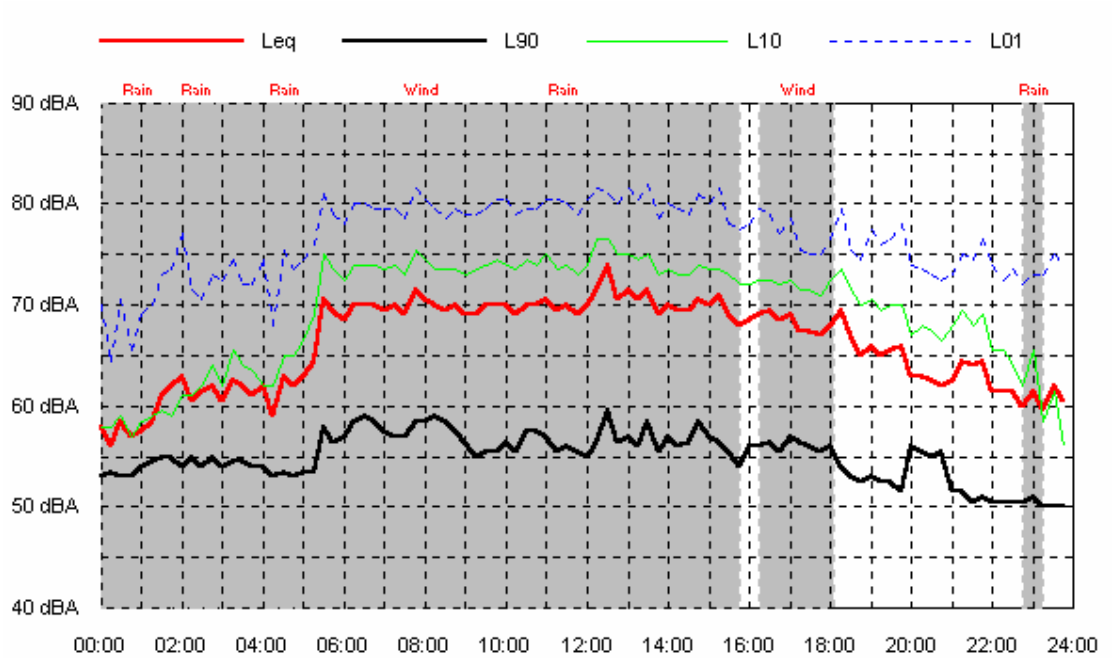
Location: Denison Street

Data shaded: Wind; Rain

Sun 21 Apr 02



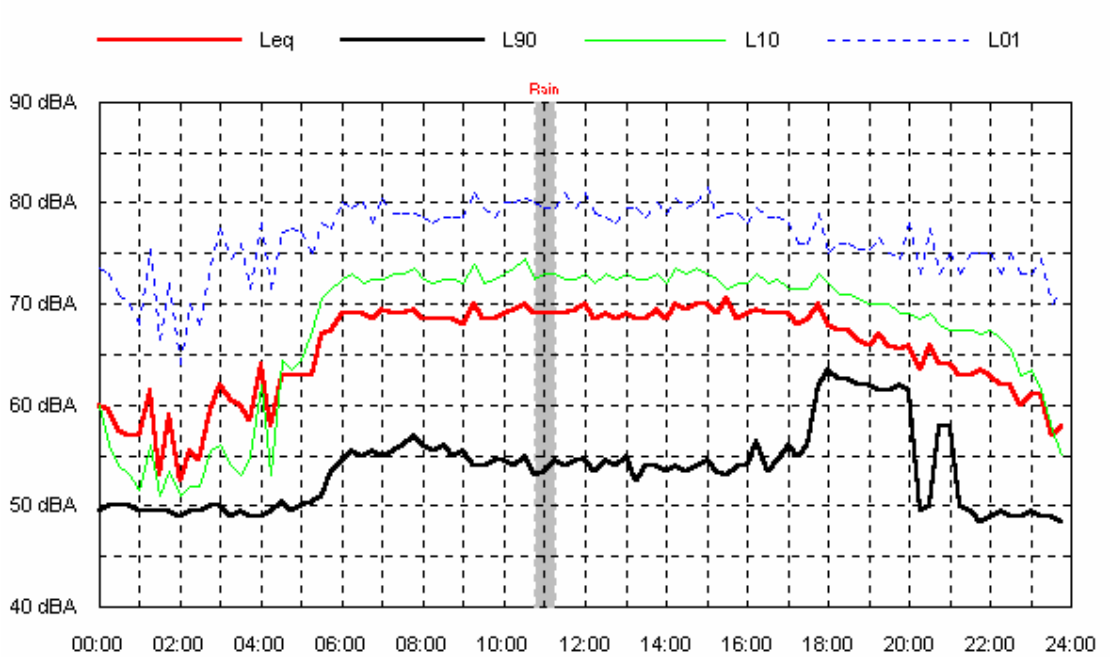
Mon 22 Apr 02



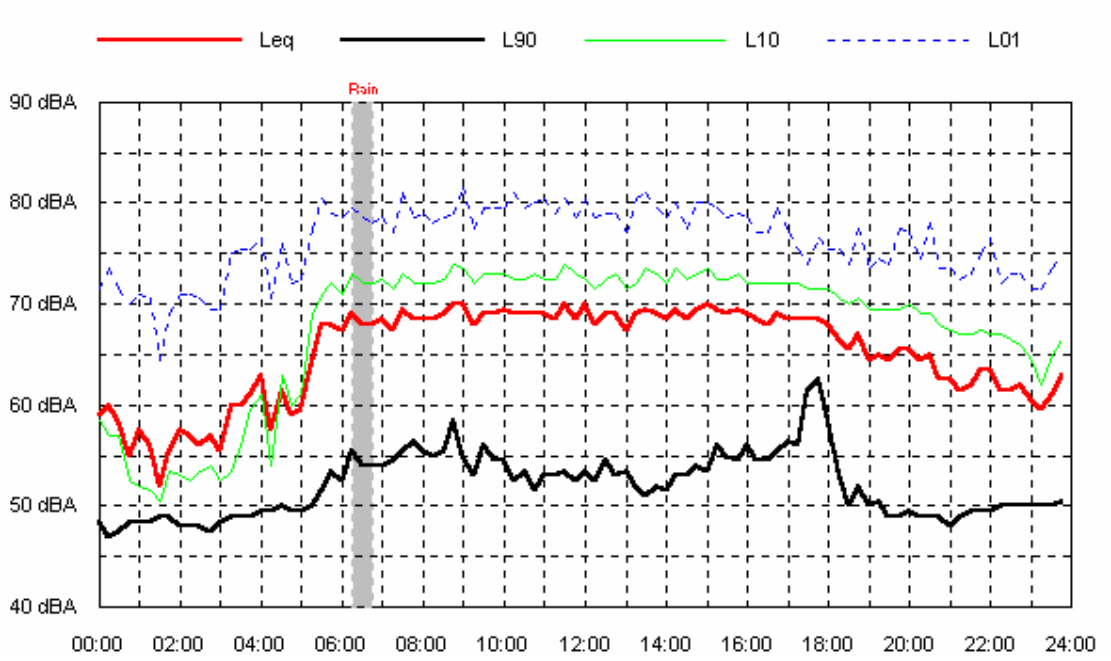
Location: Denison Street

Data shaded: Wind; Rain

Tue 23 Apr 02



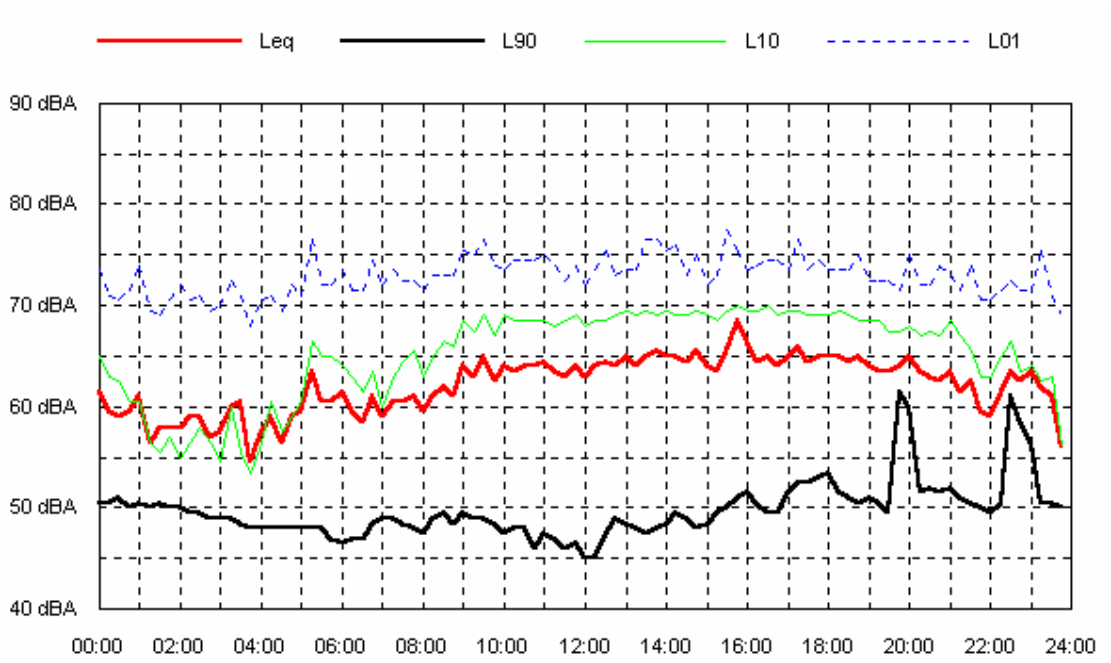
Wed 24 Apr 02



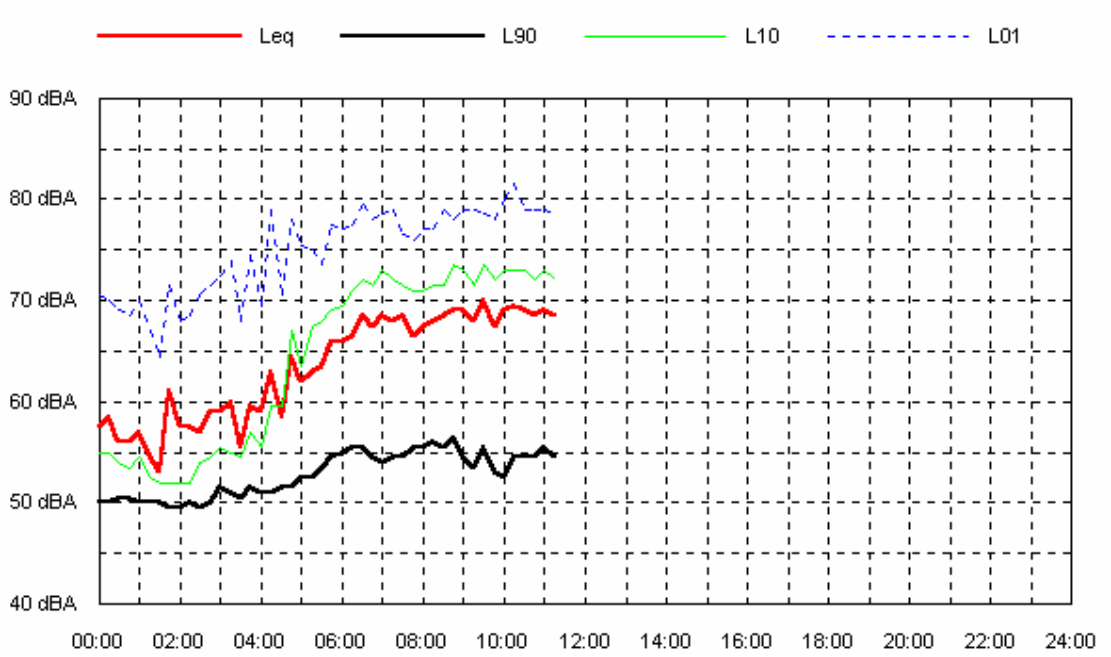
Location: Denison Street

Data shaded: Wind; Rain

Thu 25 Apr 02



Fri 26 Apr 02



APPENDIX C

SUMMARY OF DAILY BACKGROUND NOISE LEVELS

Location: Chelmsford Avenue

Data shaded: Wind; Rain

Shaded values are invalid under data exclusion rules

Summary of Measured Noise Levels: L90 ABL/RBL

Day Group	Day	Evening	Night
10 Apr 02	46.0	43.0	35.8
11 Apr 02	43.5	43.0	37.0
12 Apr 02	45.5	44.3	37.5
13 Apr 02	41.9	45.0	36.1
14 Apr 02	47.9	48.6	35.5
15 Apr 02	48.2	44.8	33.5
16 Apr 02	49.7	45.7	33.8
17 Apr 02	48.0	46.0	38.5
18 Apr 02	57.3	47.5	36.5
19 Apr 02	46.9	42.5	37.5
All	48.9	44.8	35.8

Location: 34 Dent Street

Data shaded: Wind; Rain

Shaded values are invalid under data exclusion rules

Summary of Measured Noise Levels: L90 ABL/RBL

Day Group	Day	Evening	Night
09 Apr 02		42.4	39.5
10 Apr 02	45.9	42.8	34.0
11 Apr 02	44.6	41.8	37.5
12 Apr 02	47.0	42.0	38.5
13 Apr 02	42.0	43.0	40.0
14 Apr 02	49.9	48.6	36.0
15 Apr 02	47.8	44.5	38.3
16 Apr 02	49.7	47.0	38.0
17 Apr 02	49.0	46.5	41.6
18 Apr 02	57.7	45.0	36.0
19 Apr 02	49.0	42.0	36.6
20 Apr 02	46.7	39.8	35.0
21 Apr 02	42.2	54.8	
22 Apr 02	59.0	45.3	36.5
23 Apr 02	51.5		
All	47.2	43.0	36.5

Location: 42 Jennings Street

Data shaded: Wind; Rain

Shaded values are invalid under data exclusion rules

Summary of Measured Noise Levels: L90 ABL/RBL

Day Group	Day	Evening	Night
10 Apr 02	40.5	39.5	35.5
11 Apr 02	38.5	39.0	37.5
12 Apr 02	39.2	39.5	38.0
13 Apr 02	39.4	40.3	42.0
14 Apr 02	45.9	44.1	42.3
15 Apr 02	39.5	35.8	39.1
16 Apr 02	40.0	37.5	40.8
17 Apr 02	44.5	40.0	43.0
18 Apr 02	49.8	47.0	47.0
19 Apr 02	43.0	38.0	38.1
20 Apr 02	38.7	34.0	41.8
21 Apr 02	39.8	45.6	
22 Apr 02	50.0	46.0	44.0
23 Apr 02	46.0		
All	39.7	39.0	40.4

Location: Banksmeadow Golf Course

Data shaded: Wind

Shaded values are invalid under data exclusion rules

Summary of Measured Noise Levels: L90 ABL/RBL

Day Group	Day	Evening	Night
16 Oct 01		52.0	44.3
17 Oct 01	56.7	49.5	41.5
18 Oct 01	58.0	52.3	41.8
19 Oct 01	61.5		43.5
20 Oct 01	57.5	51.4	41.3
21 Oct 01	50.0	49.5	44.8
22 Oct 01	57.5	49.4	47.0
23 Oct 01	58.0	49.4	46.3
24 Oct 01	59.0	51.0	40.5
25 Oct 01	60.0	53.4	43.0
26 Oct 01	59.0	53.8	43.0
27 Oct 01	54.0	49.8	49.5
All	57.3	50.4	43.0

Location: Australia Avenue

Data shaded: Wind

Shaded values are invalid under data exclusion rules

Summary of Measured Noise Levels: L90 ABL/RBL

Day Group	Day	Evening	Night
16 Oct 01		14.5	46.5
17 Oct 01	42.5	40.0	41.5
18 Oct 01	45.0	46.5	46.5
19 Oct 01	49.7		47.0
20 Oct 01	49.5	47.4	43.0
21 Oct 01	42.5	39.0	42.5
22 Oct 01	41.0	38.4	38.0
23 Oct 01	40.6	39.4	38.0
24 Oct 01	40.5	41.5	42.3
25 Oct 01	42.5	43.4	44.3
26 Oct 01	41.0	47.5	43.5
27 Oct 01	45.0	40.8	42.8
28 Oct 01	39.5	41.3	38.0
29 Oct 01	46.0	39.8	44.3
30 Oct 01	45.7	45.5	41.0
31 Oct 01	47.5		44.5
31 Dec 02			
All	42.5	40.4	42.5

Location: Military Road

Data shaded: Wind

Shaded values are invalid under data exclusion rules

Summary of Measured Noise Levels: L90 ABL/RBL

Day Group	Day	Evening	Night
16 Oct 01	12.0	46.1	44.8
17 Oct 01	46.5	46.8	46.0
18 Oct 01	46.2	46.3	41.8
19 Oct 01	48.7		43.0
20 Oct 01	47.5	39.0	35.0
21 Oct 01	37.7	45.0	47.0
22 Oct 01	49.2	46.5	45.3
23 Oct 01	48.0	46.4	44.5
24 Oct 01	47.0	48.0	46.8
25 Oct 01	46.2	46.9	42.8
26 Oct 01	46.5	46.0	44.0
27 Oct 01	44.4	39.0	41.8
28 Oct 01	43.5	48.9	47.5
29 Oct 01	45.7	42.8	39.0
30 Oct 01	48.5	45.0	45.8
31 Oct 01	49.2		
All	46.2	46.0	44.6

Location: 36 Beauchamp Road

Data shaded: Wind; Rain

Shaded values are invalid under data exclusion rules

Summary of Measured Noise Levels: L90 ABL/RBL

Day Group	Day	Evening	Night
10 Apr 02	49.2	43.5	39.0
11 Apr 02	47.1	43.3	39.5
12 Apr 02	47.7	44.0	39.0
13 Apr 02	45.9	45.3	43.6
14 Apr 02	46.9	46.6	41.8
15 Apr 02	50.2	43.5	42.0
16 Apr 02	50.2	45.7	41.5
17 Apr 02	51.5	46.5	44.5
18 Apr 02	54.5	49.5	44.1
19 Apr 02	49.5	43.5	42.5
20 Apr 02	47.5	40.8	41.0
All	50.2	43.5	41.9

Location: 1424 Botany Road

Data shaded: Wind; Rain

Shaded values are invalid under data exclusion rules

Summary of Measured Noise Levels: L90 ABL/RBL

Day Group	Day	Evening	Night
09 Apr 02		49.3	44.8
10 Apr 02	57.9	49.0	40.5
11 Apr 02	58.0	48.0	43.3
12 Apr 02	58.0	47.0	43.0
13 Apr 02	49.5	44.5	36.5
14 Apr 02	45.4	43.0	32.8
15 Apr 02	56.7	46.0	35.7
16 Apr 02	56.2	47.0	35.8
17 Apr 02	56.1	41.6	37.6
18 Apr 02	59.0	44.3	36.5
19 Apr 02	56.5	50.0	37.5
20 Apr 02	48.7	43.3	35.0
21 Apr 02	45.2	48.6	
22 Apr 02	59.5	43.5	34.5
23 Apr 02	57.5	43.5	37.7
24 Apr 02	57.5	47.5	38.5
25 Apr 02	45.7	44.3	
All	56.2	45.3	37.5

Location: Denison Street

Data shaded: Wind; Rain

Shaded values are invalid under data exclusion rules

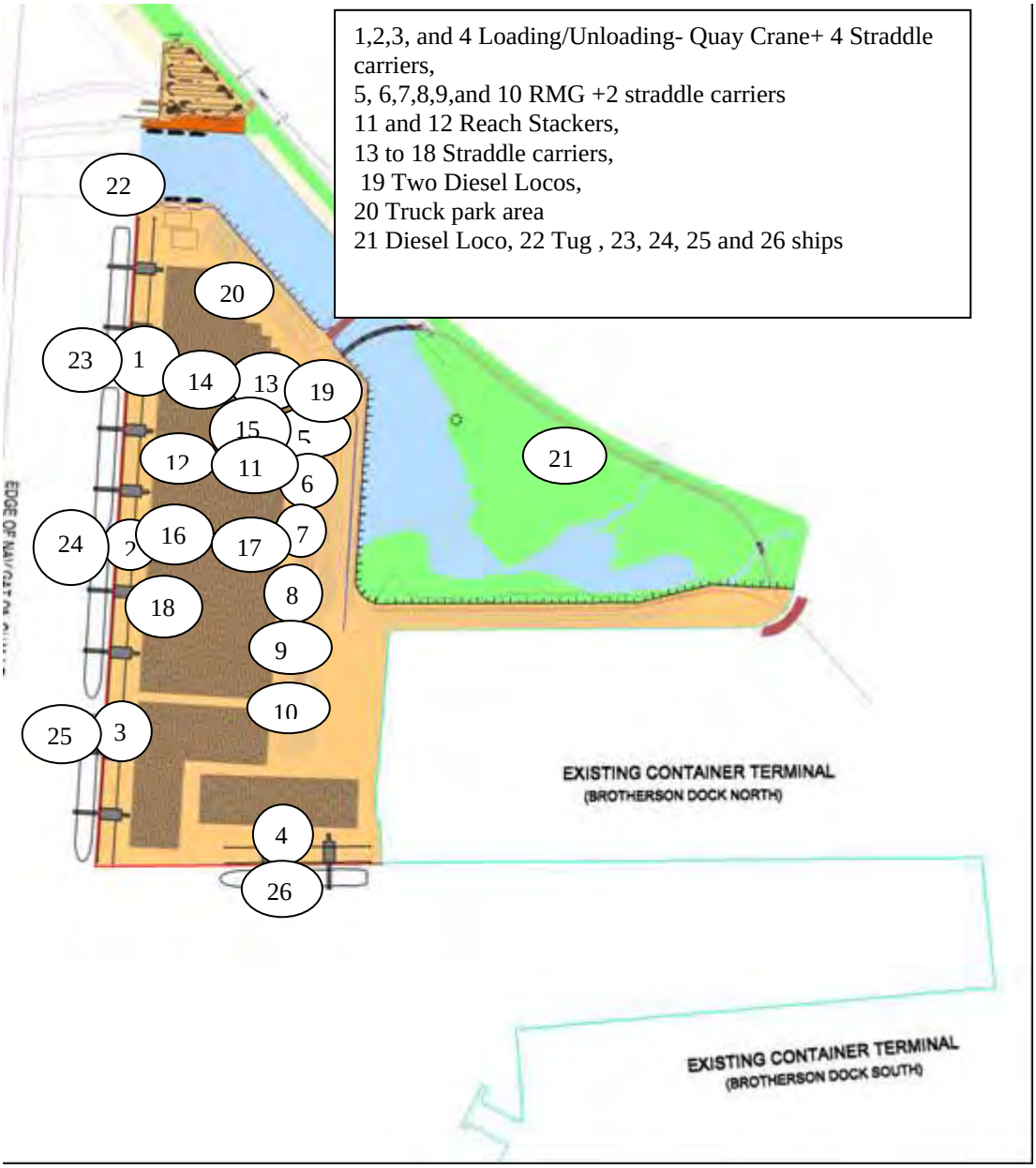
Summary of Measured Noise Levels: L90 ABL/RBL

Day Group	Day	Evening	Night
09 Apr 02	53.3	50.0	46.8
10 Apr 02	52.5	50.0	45.3
11 Apr 02	51.5	49.0	46.8
12 Apr 02	52.0	48.5	47.5
13 Apr 02	48.9	48.3	47.0
14 Apr 02	49.0	49.5	47.5
15 Apr 02	52.0	53.8	46.5
16 Apr 02	52.0	53.4	47.0
17 Apr 02	54.0	57.6	47.1
18 Apr 02	55.8	56.5	49.5
19 Apr 02	52.0	60.0	47.1
20 Apr 02	47.0	46.0	48.0
21 Apr 02	48.5	52.4	
22 Apr 02	56.0	51.2	49.1
23 Apr 02	53.5	49.5	48.0
24 Apr 02	52.2	49.0	47.5
25 Apr 02	46.7	50.3	49.8
26 Apr 02	53.4		
All	52.0	50.0	47.5

APPENDIX D

NOISE SOURCES AND THEIR LOCATIONS

INCLUDED IN NOISE MODEL


1,2,3, and 4 Loading/Unloading- Quay Crane+ 4 Straddle carriers,
5, 6,7,8,9,and 10 RMG +2 straddle carriers
11 and 12 Reach Stackers,
13 to 18 Straddle carriers,
19 Two Diesel Locos,
20 Truck park area
21 Diesel Loco, 22 Tug , 23, 24, 25 and 26 ships
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20
23
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EXISTING CONTAINER TERMINAL
(BROTHERSON DOCK NORTH)
EXISTING CONTAINER TERMINAL
(BROTHERSON DOCK SOUTH)

APPENDIX E

TEMPERATURE INVERSION

The Table below shows the levels predicted for the port expansion at residential receivers for temperature inversions and temperature inversion with a drainage 2m/s wind from the NW.

Temperature inversions would be expected to occur up to approximately 25% of nights during the winter period and for a lower proportion of time during other seasons. Whilst the northwestern drainage breeze often occurs with temperature inversions, it should be noted that the combination of a temperature inversion with this drainage would occur even less than 25% of the time in winter.

Predicted L_{Aeq} Levels for Proposed New Container Terminal Operations Only at Residential Receivers

Location		L_{Aeq} Predicted Noise Level (dBA)			
		Barrier Option			
		No barrier (No Noise Controls)	Barrier 1 + Noise controls	Barriers 2 and 3 + Noise Controls	Criterion
Location 1					
Chelmsford Avenue	Temperature inversion +wind	44	38	39	40
	Temperature inversion	46	45	46	40
Location 2					
Dent Street	Temperature inversion +wind	50	45	46	40
	Temperature inversion	51	48	50	40
Livingstone Avenue					
	Temperature inversion +wind	47	41	42	40
	Temperature inversion	49	47	48	40
Tupa Street					
	Temperature inversion +wind	47	42	43	40
	Temperature inversion	49	48	49	40
Waratah Road					
	Temperature inversion +wind	48	43	44	40
	Temperature inversion	50	48	49	40
Location 3					
Jennings Street	Temperature inversion +wind	36	36	35	39
	Temperature inversion	34	34	34	39
Location 4					
North of Golf Course	Temperature inversion +wind	52	48	50	40
	Temperature inversion	51	48	50	40

Location		L_{Aeq} Predicted Noise Level (dBA) Barrier Option			
		No barrier (No Noise Controls)	Barrier 1 + Noise controls	Barriers 2 and 3 + Noise Controls	Criterion
Location 5					
Australia Avenue	Temperature inversion +wind	38	34	38	38
	Temperature inversion	35	31	35	38
Location 6					
Military Road	Temperature inversion +wind	41	41	41	40
	Temperature inversion	38	38	38	40

Predicted L_{Aeq} Levels for the Proposed New Container Terminal Operations at Non Residential Receivers

Location		L_{Aeq} Predicted Noise Level (dBA) Barrier Option			
		No barrier	Barrier 1 +Noise Controls	Barriers 2 and 3 + Noise Controls	Criterion
Church, Hannon					
	Temperature inversion +wind	39	38	39	50 (1)
	Temperature inversion	46	45	46	50 (1)
Church, Rancon Street					
	Temperature inversion +wind	46	42	43	50 (1)
	Temperature inversion	48	46	48	50 (1)
Banksmeadow Primary School					
	Temperature inversion +wind	47	44	46	55 (1)
	Temperature inversion	47	46	47	55 (1)
Matraville Primary School					
	Temperature inversion +wind	34	35	34	55 (1)
	Temperature inversion	33	34	33	55 (1)
Church, Bunnerong Road					
	Temperature inversion +wind	35	35	34	50 (1)
	Temperature inversion	34	34	33	50 (1)
Sir Josephs Banks Park/Golf Course	Temperature inversion +wind	52	47	48	50 (2)
	Temperature inversion	53	49	50	50 (2)

Note: (1) External noise criterion
(2) Criterion is 55dBA for golf course

Report Addendum

Addendum

WILKINSON MURRAY

ACOUSTICAL CONSULTANTS

21 October 2003

Ref: 02053/SPC211003BM
E-mail: MCalfas@sydneyports.com.au
cc: Csams@sydneyports.com.au

Ms Marika Calfas
Sydney Ports Corporation
207 King Street
SYDNEY NSW 2138

Dear Madam

Re: Port Botany Container Terminal Expansion
Alternative Rail Siding

Sydney Ports Corporation have requested consideration of an alternative length of rail siding at the proposed Port Botany Container Terminal expansion.

Wilkinson Murray Report No. 02053 addressed the noise impact associated with the proposed container terminal expansion and this report assumes that the rail siding would be of length 600m. An alternative rail siding of 400m in length is here considered.

This alternative rail siding would result in some minor changes in respect of those issues that may affect the noise impact:

- trains to and from the new terminal would be 400m long instead of 600m
- the trains would have one locomotive on each end, rather than the assumed two locomotives at one end (on the northern end of the train when at the siding).
- there would be a maximum of 19 trains per day accessing the new terminal, rather than the originally assumed 18 trains.

- the maximum number of trains accessing the port area per day would not change from the predicted 54. Given the reduced train length referred to above for trains accessing the new terminal, there would be a slightly reduced noise impact associated with rail movements on the rail network leading to the port.

Based on this information, I have given consideration to the effect of the alternative siding upon the noise impact. I have addressed noise from the site as well as noise associated with rail movements on the rail network leading to Port Botany.

Site Noise Impact

The original assessment of site L_{Aeq} noise assumed two locomotives idling at the terminal, being located near the northern part of the terminal. With the alternative proposal, there would still be two locomotives idling, but one locomotive would be to the north and one to the south. This is in addition to a locomotive assumed to be on the passing loop at the same time.

Whilst this has the potential to reduce the noise impact, the effect would be insignificant in relation to the total noise level, given the low noise emission level of an idling locomotive.

The original report also addressed the L_{A1} noise level resulting from trains accessing the terminal. Given that the trains would still use two locomotives, the L_{A1} noise level would be expected to remain at the estimated 46dBA at the most affected residence.

Overall, the alternative siding would not result in a noise impact change in relation to site operations.

Noise Impact Off the Site

Rail noise outside of the terminal has been addressed by RIC and supplemented by the original noise assessment report.

As indicated above, with no change in the total maximum of 54 trains servicing the port area and with some of these trains being reduced in length, there would be a slightly reduced noise impact generally along the rail network.

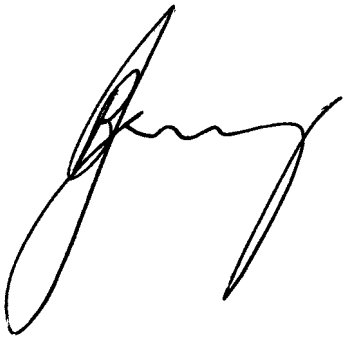
However, over the short section where the rail system will service the new terminal, the maximum number of trains would increase from 18 to 19, whilst these trains would be shorter. The net result (given that the same number of containers would be transported by rail) is that overall rail noise levels along this section of the network would not change.

Overall, the noise impact adjacent to relevant parts of the rail network associated with Port Botany operations would be either the same as or less than that described in the original noise report.

Conclusion

The alternative 400m long rail siding would generally result in no change in the site noise impact as described in the EIS. However, there may be a small reduction in predicted rail noise impact associated with some parts of the rail network servicing Port Botany.

Yours faithfully



Barry Murray
Director

Port Botany Freight Rail Project Stage 4
Marrickville Junction to Port Botany
Noise Impact Assessment
(Noise Data & Mapping)

Prepared for
Rail Infrastructure Corporation

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April 2002

Report Number 03-20033

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Definitions and Abbreviations

A-weighting – a weighting applied to a noise measurement that makes an adjustment to reflect the frequency response of the human ear.
EPA - Environment Protection Authority.
Attended measurement – noise measurements carried out while an observer located with the sound level meter notes the noise sources and other details at the time of measurement.
LA90,15 - know as the background noise level, it is the average of the minimum noise levels and is mathematically the noise level exceeded for 90% of the measurement time (which is 15 minutes).
LAmax – the maximum A-weighted noise level.
LAE - the single event noise level and is used to assess the LAeq,24hr.
LAeq,24hr – the energy average noise level calculated for the accumulated amount of noise energy from all trains over a 24 hour period.
NDO (Noise Design Objective) - a level used in this document to define target levels for rail noise for residential receivers as 85 dB(A) LAmax and 60 LAeq,24hr.
Noise map – a map of noise contours of an area.
REF - Review of Environmental Factors, a document assessing the overall environmental impact of the proposal.
RIC - Rail Infrastructure Corporation
Unattended measurement – noise measurement carried out using a noise data logger without an observer to record details of noise events.
SPC - Sydney Ports Corporation
Stage 4 Duplication - a term used in the assessment to describe the rail corridor that is proposed for duplication between Ewan Street Mascot and Banksia Street Botany.
TEU - Twenty-foot Equivalent Units - a standard unit of measurement of the size of shipping containers used to describe quantities of container movements.

Executive Summary

The Port Botany Freight Rail Project is being undertaken to increase the capacity of the rail corridor to handle expected future growth in rail traffic.

Stage 4 of the project, the subject of this assessment, extends between the Cooks River Yard near Qantas Drive through to the Botany Yard at Botany. The actual duplication of the line will occur between Ewan Street Mascot and Banksia Street Botany.

This environmental noise assessment was prepared to obtain a variation to an Environment Protection Authority (EPA) licence (EPA licence number 3142) to carry out the proposed work. The assessment examines current and future rail traffic volumes and operations to determine the nature of the existing and future noise environment adjacent to the rail corridor and any changes in noise levels due to projected rail traffic activity.

The upgrading works assessed in this report will involve the duplication of the line between Ewan Street Mascot and Banksia Street Botany together with other associated work including new bridges, a pedestrian bridge, the installation of a higher-standard track, new signalling and other related works.

The assessment process involved a noise measurement program using attended and unattended noise monitors producing over 3 weeks of noise data. This data together with other information regarding future modes of operation of the proposed duplication were used in computer modelling to determine noise levels due to train movements within areas near the rail corridor.

Data collected on the existing noise environment along the corridor indicated that the line passed through mixed industrial areas of high background noise due to sources such as road traffic and aircraft through to low to medium density residential precincts with lower levels of background noise.

Noise design objectives (NDO) were used as assessment criteria for residential receivers. These were 85 dB(A) LAmax (maximum noise level) and 60 LAeq,24hr (energy average noise level over 24 hours).

Noise maps of the proposed route were prepared to assess the noise levels at the facades of residences near the corridor. Maps were prepared for the present (Y2001) and for Y2020. Noise maps were also made of changes in noise levels due to rail operations between Y2001 and Y2020.

Since the noise maps provide noise levels at ground level, assessments were also made of noise levels for different floors of existing multi-storey buildings.

The assessment found that the LAmax levels for Y2020 changed only marginally from the existing levels since trains (ie locomotives, the source of the LAmax) over the study period are not expected to be significantly different from noise levels experienced today.

Changes were expected with LAeq,24hr, since the calculation of this noise index depends on the train speed (which will change due to changes in operations), the number of trains (which is expected to increase) and the train length (which is also expected to increase in some cases). The expected increases in LAeq,24hr are approximately 3 to 5 dB which equates broadly to a doubling of the quantity of rail traffic.

The extent of noise impacts at houses behind the rows of dwellings facing the rail corridor was evaluated by using a wide study corridor either side of the rail corridor. This wide corridor was needed particularly in Sector 4 where houses and units are located at larger distances from the rail line.

Generally in locations where dwellings facing the rail corridor approached or exceeded the NDOs, dwellings located immediately behind benefited from the barrier effect of the front row of houses or units. As a result these second-row buildings satisfied the NDOs.

An assessment of noise levels was carried out for buildings from 2 to 4 storeys high along the route. It was found that noise levels generally increased with increasing height (generally up to level 2). Then they decreased at higher floor levels. In some cases noise levels were within the NDOs at ground level and marginally exceeded the NDOs at mid-level floor levels.

Noise mapping indicated that 5 dwellings were above the LAeq,24hr criterion in 2001 and 23 dwellings were above the criterion for Y2020.

For future rail operations, locations that were found that may exceed the NDOs along the route were:

- Four residences in Baxter Road were found to marginally exceed 60 LAeq,24hr;
- A block of new units on the corner of Botany Road and Wentworth Avenue and some houses at the southern end of McBurney Avenue exceeded 60 LAeq,24hr;
- The LAeq,24hr NDO was exceeded for dwellings on the northern side of the corridor between Bay and Banksia Streets. For units between

Banksia and Morgan Streets, lower floor levels met the LAeq,24hr NDO and upper floor levels marginally exceeded the LAeq,24hr NDO.

Over the length of the route the expected changes to the operation of trains and the upgrade of the track would be expected to produce some benefits that should reduce certain types of train noise. The duplication will minimise the need for trains to stop and start at intersections and crossings resulting in less noise from acceleration of locomotives and the stretching and bunching noises from wagons. One significant benefit will be from the reduction in the use of train horns at all locations along the route.

For areas that were identified as exceeding the NDOs, a measurement-based review of noise levels is suggested once the duplication is constructed and operating in its long-term mode.

1 Introduction

This environmental noise assessment is for Stage 4 of the proposed duplication of the Port Botany Line which runs approximately between Ewan Street Mascot near the airport through to Banksia Street Botany. The assessment was prepared for the Investment and Environmental Appraisal Unit of the Rail Infrastructure Corporation.

RIC holds an Environment Protection Authority (EPA) licence (EPA licence number 3142) for its rail operations. Where certain upgrades and additions to infrastructure are proposed, a variation to the licence is required.

In seeking a variation, RIC is required to evaluate environmental effects including any acoustical impacts and to include the findings in a Review of Environmental Factors (REF). This noise assessment comprises part of the REF prepared by RIC.

2 Project Background

The Port Botany Freight Rail Stage 4 project is part of a state and nationally significant program to expand the Brotherson Dock at Port Botany to handle the anticipated worldwide increases in container freight movements. A predicted growth rate of over 5% per annum will see an increase from 0.87 million TEU (Twenty-foot Equivalent Units) in 2001 to 2.3 million TEU by 2020. Sydney Ports Corporation (SPC) has announced a $260 million expansion of the dock to be completed by 2008 and further expansion and improvements are to be made to Enfield Marshalling Yards to provide for the increasing demand.

Currently rail handles 25% of the container traffic through Port Botany and the remainder is road freight. This is a significant increase from 15% in 1996. However, the SPC expects rail to handle 40% of the total Port Botany TEU market trade by 2010. This means 0.925 million TEU by rail by 2020.

The Rail Infrastructure Corporation (RIC) is undertaking the work in four stages:

Stage 1 - Capacity increase for the Port Botany Yard.
Stage 2 - Duplication of the track from Shea's Creek to Marrickville (by April 2002).
Stage 3 - Bi-directional signalling for the stage 2 works (April 2002).
Stage 4 - Duplication of the track from Shea's Creek (Alexandra Canal) to Port Botany with bidirectional signalling and modifications to Port Botany and Cooks River Yards.

3 Project Objectives

The objective of Stage 4 is to increase the operational capacity between Marrickville and Port Botany including Botany Yard to handle the anticipated increases in container freight movement worldwide.

At the predicted growth rate of 5.3% per annum the current throughput of 0.87 million TEU in 2001 will increase to 2.3 million TEU by 2020. The Stage 4 works are an essential part of the expansion works to accommodate the increase in container traffic handled by rail, which is forecast by Sydney Ports Corporation to expand to 40% (0.925 million TEU) of the total Port Botany trade by 2020.

4 Project Scope of works

By 2005 and with the duplication of the Botany Goods Line, 18 x 300m, 5 x 600m and 1 x 1200m length trains will use the line each day. It will provide the essential infrastructure for an increase to 18 x 300m, 8 x 600m and 2 x 1200m train lengths by 2010, and an increase to 18, 14 and 3 respectively by 2020, equivalent to the 0.925 million TEU target of Sydney Ports Corporation (SPC).

The works will include the following:

- Duplication of the existing mainline track from the Princes Highway to Botany Road, south of Port Botany Yard.
- Installation of a bidirectional signal system on the duplicated and some existing track with signal operation controlled from Sydenham and Port Botany as applicable.
- Modification and additions to the existing Port Botany Yard tracks and signal system.
- Modification and additions to the existing Cooks River shunt yard tracks and signal systems.
- Upgrading existing mainline track to meet current class 1 standards.
- Installation of appropriate yard security and lighting systems at Cooks River and Port Botany Yards.
- Improvements to corridor security.
- Installation of appropriate noise mitigation measures.
- Removal of at grade crossings at General Holmes Drive and Bank sia Street.

5 Objectives of the Noise Assessment

Background to the noise assessment
As part of its statutory operating requirements, RIC holds an Environment Protection Authority (EPA) licence (EPA licence number 3142). The licence provides for the operation of the railway system subject to the issuing of a variation to the licence for certain types of upgrades and additions.

Where a licence variation is needed, RIC is required to evaluate environmental effects including any acoustical impacts and to include the findings in a Review of Environmental Factors (REF). This noise assessment which includes noise maps of present and future operations, comprises part of the REF prepared by RIC.

Condition A1.4 of the EPA licence 3142 states the following in relation to works that require a variation to the licence.

> *Except as expressly provided by another condition of this licence, this licence does not authorise any of the following activities in relation to the NSW rail network being an activity that would constitute the beginning of, or any subsequent step in:*
>
> *(a) the extension of the NSW rail network beyond the land on which the Rail Undertaking is being undertaken as at the date of issue of this licence by the laying of track or;*
>
> *(b) the duplification of track laid in a residential area which is on land on which the Rail Undertaking is being undertaken within the NSW rail network as at the date of issue of this licence.*
>
> *The removal of a length of track and its replacement by another length of track in the same location does not constitute the beginning of, or any subsequent step in an activity referred to in paragraph (a) or (b).*
> *The construction of any of the following:*
> - *cross-over*
> - *siding*
> - *turnout*
> - *yard*
> - *loops*
> - *refuges*
> - *relief lines*

or the reopening of disused lines beyond the land on which the Railway Undertaking is being undertaken at the date of issue of this licence does not constitute the beginning of, or any subsequent step in, an activity referred to in paragraph (a) except where it will result in significant noise impacts in residential areas.

Noise Assessment Objectives

The objectives of the noise assessment were to:

- prepare the noise assessment so that it could form part of the REF assessment for the duplication;
- examine in a quantitative and qualitative way the current noise levels produced by trains using the corridor and the way they relate to train operating factors such as speeds and grades;
- carry out detailed monitoring of train noise along the entire length of the corridor and particularly where noise may impact on residen tial dwellings;
- document existing noise issues related to the operation of trains;
- use computer modelling and noise mapping to assess noise levels from existing and future operations and to assess any expected changes in overall rail noise levels due to the added capacity of the duplication;
- assess the measured and modelled noise levels against noise design objectives (NDOs).

Although the assessment provides details of noise levels at all types of buildings that are adjacent to the corridor, the assessment and NDOs are intended only for residential properties.

LAmax is the maximum noise level of a train passby at a given location. LAeq,24hr is the amount of noise energy produced by the total number of trains passing in a 24 hour period.

Noise Design Objectives

Noise design objectives (NDOs) have been used to identify locations where noise impacts may occur in residential locations. These noise level objectives were selected to be 85 dB(A) LAmax and 60 LAeq,24hr.

LAmax is defined as the maximum noise level and LAeq,24hr is the amount of noise energy produced over a 24 hour period.

6 Rail Corridor Description

The rail corridor in this noise assessment extends approximately from Ewan Street Mascot, adjacent to Qantas Drive through to Banksia Street Botany.

An additional area, the marshalling yard to the south of Banksia Street and finishing at the road overpass at Page Street, was included in the assessment. This added area is not part of the duplication work and therefore is not the subject of the licence variation.

For the purpose of classifying and assessing the noise environments along the corridor, four sectors have been defined (see figure 6.1). The first sector is from the northern end of the Stage 4 corridor adjacent to Qantas Drive Mascot through to the eastern end of Baxter Road Mascot.

The second sector is from the eastern end of Baxter Road through to McBurney Avenue Mascot. The third sector is from McBurney Avenue through to Bay Street Botany and the fourth sector is from Bay Street to the Page Street Botany road overpass.

For the purpose of classifying and assessing the noise environments along the corridor, four sectors have been defined.

The rail corridor passes through a mixture of land use types including commercial, transport-related, industrial, residential and recreational areas. In the northern part of the corridor, residences are mixed with commercial, transport-related, storage and industrial premises.

At the southern end of the corridor, surrounding areas are substantially residential with a mixture of medium and low-density residential uses. Midway along the corridor, the adjoining land use is open space with a golf course, a public swimming pool and some light industry and storage businesses.

At the northern end the corridor passes through a commercial-industrial area between Ewan Street and the O'Riordan Street rail overbridge. A hotel and an office building are adjacent to the rail corridor in the area bounded by O'Riordan Street and Qantas Drive. In Ewan Street a house is located with partial direct line-of-sight to the rail line.

The rail corridor continues south between Joyce Drive and Baxter Road towards the container terminal. Baxter Road has a mixture of residences together with light industry. Most dwellings are single storey and some are of lightweight construction.

At the eastern end of Baxter Road, some dwellings are two storey and the rear of these properties face the corridor. On the western side of the corridor are Joyce Drive, General Holmes Drive and the airport.

Further south from the eastern end of Baxter Road, the corridor passes a multi-level parking station and then a level crossing used by light and heavy vehicles. Near Botany Road the corridor is parallel to a small number of residences located close to commercial premises and some church buildings. A block of residential units is adjacent to Wentworth Avenue.

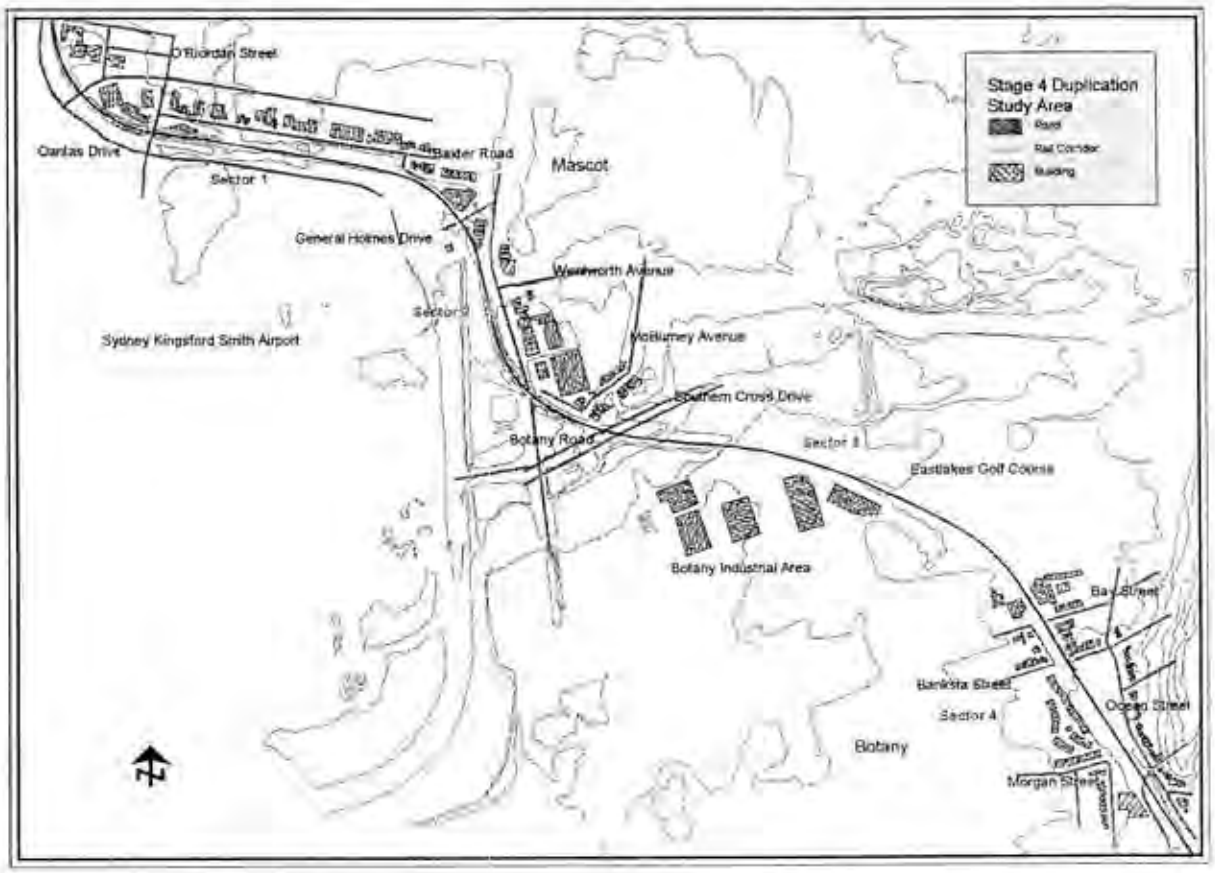


Figure 6.1 – Stage 4 study area.

The church and houses in this area have been insulated against aircraft noise since they are under the flightpath for landing aircraft using Runway 25 and aircraft taking off on Runways 07 and 34R. A block of residential units on the corner of Botany Road and Wentworth Avenue has been insulated against external noise.

Further south from Botany Road the line passes over the Southern Cross Drive, the Mill Pond, the Eastlakes Golf Club and some light industry and storage buildings through to the residential area near Bay Street Botany.

From Bay Street the line passes a higher density residential area including Bay, Banksia, Ellis, Ocean and Morgan Streets Botany though to the Botany Yard.

7 Description of the Existing Acoustical Environment

Noise environments along the corridor

The northern end of the corridor (first and second sectors) passes through areas of very high transportation activity. Noise sources include aircraft landing and taking off with some departing aircraft producing high levels of noise. Road traffic on the major surrounding roads including General Holmes Drive, Botany Road and the Southern Cross Drive carry large volumes of both cars and heavy vehicles. Rail traffic also contributes noise to the environment.

Both these sectors have significant levels of noise including high levels of background noise due largely to road traffic.

Unattended noise monitoring was carried out in Baxter Road to assess the overall noise levels (see Figure 7.1 and Appendix B). Background noise levels were as high as 60 dB(A) during the morning peak hours. In the early morning the background noise levels dropped to approximately 40 dB(A). The source of maximum (LAmax) noise levels can be either close noises such as nearby birds or more distance sources such as aircraft flying over the site.

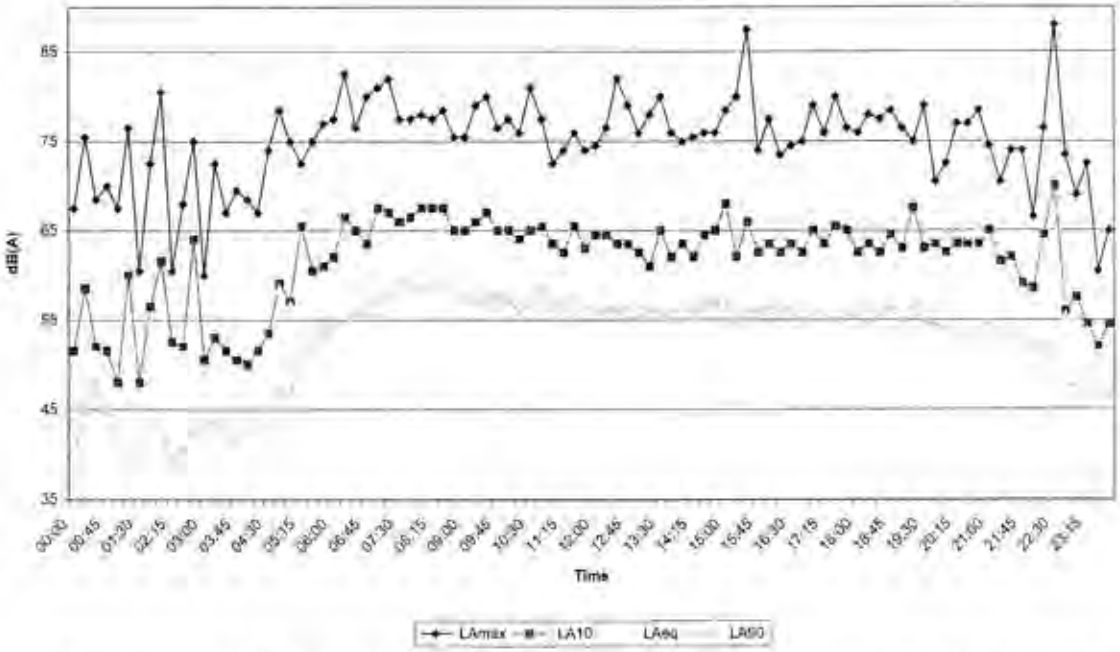


Figure 7.1 – Unattended noise monitor results, Baxter Road - Sector 1, October 5, 2001

Noise from the airport included aircraft taking off and landing and the noise from the reverse thrust of landing aircraft. From 11pm to 6am the airport curfew applies and so noise is limited to that from lighter aircraft allowed to operate during those hours.

Road traffic in the first two sectors comprise cars and light vehicles travelling between areas south of the airport to areas south of the CBD, the CBD and other northern destinations. Heavy vehicles travel between southern and western areas to Port Botany and other destinations south of the CBD where there are transport, storage and cargo handling activities associated with the airport and the Port.

The third sector of the corridor is bounded by McBurney Avenue and extends through to Bay Street to the south. This area combines a wet-land and recreation land uses with a golf course to the east and a public swimming pool to the west of the corridor. The noise environment is significantly quieter than the first two sectors although it includes the distant noise from traffic, overflying aircraft and freight trains.

Along parts of the corridor some dwellings have been insulated against aircraft and in some cases traffic noise.

McBurney Avenue is substantially residential and the dwellings are mostly of lightweight construction. The houses in McBurney Avenue are located under the flightpath for aircraft arriving on Runway 25 or departing aircraft on Runway 07. Aircraft departing on Runway 34R also pass over the area. Departing 34R aircraft create high noise levels in the first three sectors and moderate noise levels in the fourth sector. Most of the houses in McBurney Avenue have been insulated against aircraft noise.

The rail line is elevated on an embankment at this location which provides an effective noise barrier against road traffic travelling on Southern Cross Drive.

The fourth sector at the southern part of the corridor is substantially residential with various housing densities comprising single dwellings, town houses and multi-storey units. Two unattended noise monitors were located in the residential areas either side of the corridor to obtain noise data to provide information about overall noise levels and noise events.

Figures 7.2 and 7.3 show details of the variation of noise over a typical day. They illustrate the low background noise levels particularly during the night and early morning with levels going down to 35 dB(A). The LAmax noise levels are individual events such as people or birds close to the noise meter or the noise from train horns or train passbys. Further details about the unattended monitoring follow and measured data is in Appendix B.

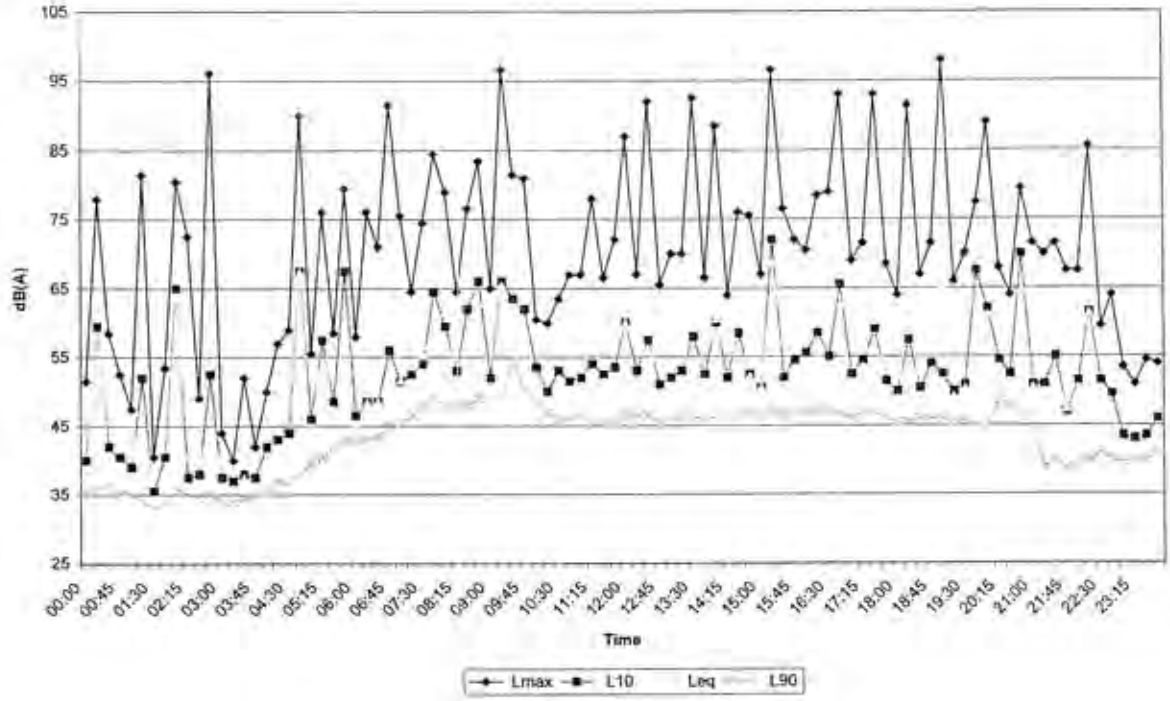


Figure 7.2 – Unattended noise profiles, Banksia Street (south) - Sector 4, September 5, 2001

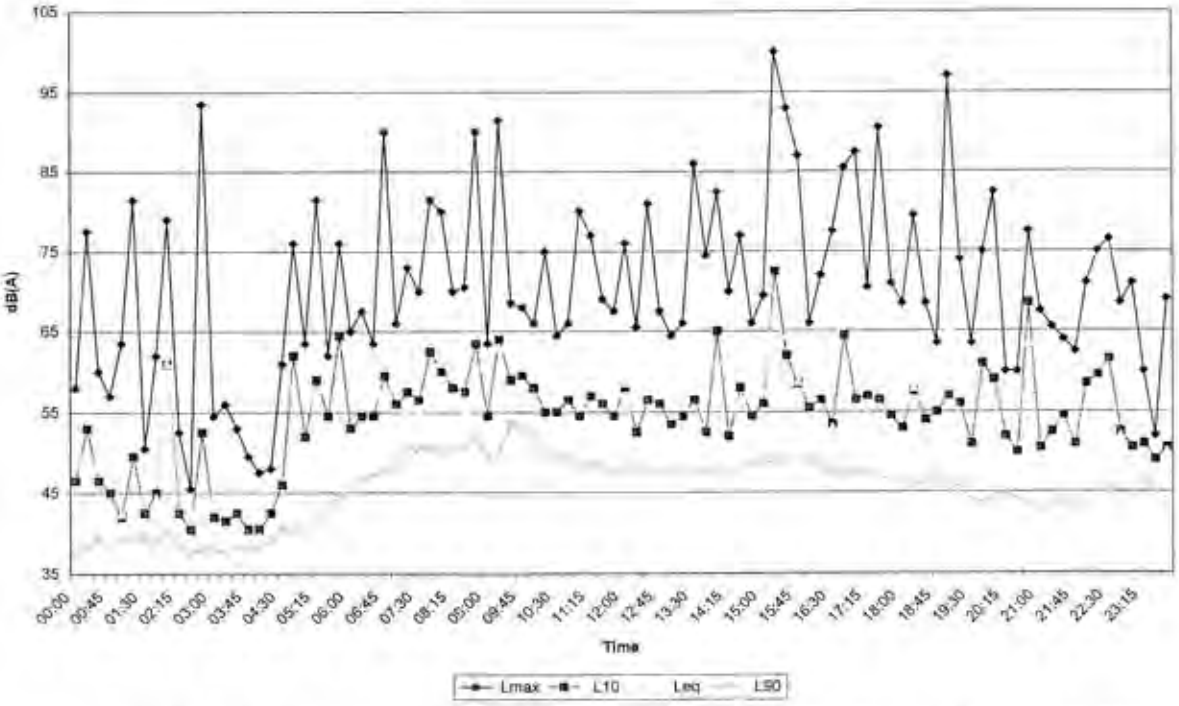


Figure 7.3 – Unattended noise profiles, Banksia Street (north) - Sector 4, October 5, 2001

Assessing the existing acoustical environment

Attended and unattended noise monitoring was carried out at 12 locations adjacent to the rail corridor to describe and quantify the existing noise environment. Over 500 hours of unattended monitoring was carried out at 3 locations and over 160 hours of attended monitoring was undertaken at 9 locations.

The three unattended monitoring locations were sampled simultaneously for a week. Two types of monitors were used. Two monitors accumulated noise data over successive 15 minute periods for the week. The other monitor collected data for each second of the entire week. The latter monitor produced data that allowed for the identification of individual events as well as data in 15-minute averages similar to the other two monitors.

Attended and unattended noise monitoring was carried out at 12 locations adjacent to the rail corridor to describe and quantify the existing noise environment.

The two 15 minute averaging noise monitors were located in the front yard of a house in Baxter Road and in the rear yard of a town house at Banksia Street (north). The noise monitor that produced data every second was located on a second storey balcony of a unit facing the corridor at Banksia Street (south). Appendix B contains the daily profiles produced for these sites.

Existing rail noise issues

Current rail noise issues for the four defined sections of track are as follows.

Sector 1- Qantas Drive/Ewan Street - Baxter Road

Houses in Baxter Road have direct line-of-sight to the rail line. West moving trains travelling from Botany Yard tend to accelerate along the track to ensure that they clear the level crossing between General Holmes Drive and Botany Road as quickly as possible. This can cause added noise in the Baxter Road area of possibly 10 or more dB. The level crossing and the grade of the line together with safety considerations results in the acceleration and deceleration of trains. It is expected with the removal of the level crossing that the need for trains to stop will be minimised resulting in less noise from the acceleration. For trains travelling east, the removal of the level crossing will allow trains to continue without stopping. This will result in less noise from wagon bunching (caused by trains decelerating and wagons impacting) or stretching (the opposite of bunching) and will remove the need for train drivers to sound horns when approaching the crossing.

Under investigation are the options of closing the General Holmes Drive level crossing or providing grade separation for road and rail traffic.

Sector 2 - Baxter Road – McBurney Avenue
This sector contains a mixture of a small number of single houses, a block of units, church buildings and some retail premises. There are considerable road traffic flows on Botany Road, General Holmes Drive, Wentworth Avenue and Southern Cross Drive.

Apart from general noise from the trains, the use of train horns occurs due to the need to warn traffic at the General Holmes Drive level crossing. Braking and acceleration noises occur (due to locomotives and bunching and stretching) as a result of the need to stop at the crossing. The elimination of the crossing will reduce the noise from these sources.

Train horns are regularly used when approaching pedestrian and level crossings. Elimination of crossings will remove the need for drivers to sound horns.

Trains heading east will generally slow in this area to meet a speed restriction that begins near McBurney Avenue.

Sector 3 - McBurney Avenue – Bay Street
Open space characterises this area as it includes the Eastlakes Golf Cub and the Mill Pond wetland. Houses at the southern end of McBurney Avenue are close to the rail corridor.

Trains travelling east reduce speed to approximately 30km/h while trains travelling west will generally increase speed from 30 km/h to 50 km/h. Noise from train horns can be heard as trains travel east and pass through the level crossing near Botany Road.

Sector 4 - Bay Street – Page Street Overpass
Near Myrtle Street the line passes some warehouses and then a residential area for the remainder of the route. Trains at this point decelerate when heading towards the Botany Terminal and may periodically stop to wait for changes to points. Trains travelling north away from the terminal will tend to accelerate to approximately 30 km/h.

Horns are regularly used to warn pedestrians at the crossing at Banksia Street. The construction of a pedestrian overpass (or underpass) will remove the need for drivers to sound horns.

8 Noise Monitoring Program

Measurement goals
Goals for the noise measurement program were:

- Measure and document rail noise details and associated operations for locations along the Stage 4 corridor;
- Qualitatively assess and document potential noise issues at the monitoring locations;
- Use rail noise measurement data to compare and calibrate the noise model used to map existing and future rail traffic scenarios;
- Gain an on-site understanding of existing rail operations and factors that contribute to noise issues;
- Obtain noise data to provide an indication of background noise levels.

Measurement sites
Sixteen measurement sites were selected along the corridor. They were located near residences so that measurement data could be assessed for all residential areas along the corridor. Measurement sites are shown in Figure 8.1.

Sites were located at distances of between 15 and 40 metres from the centre line of the existing track. Where background noise levels were low, some sites were located at distances of up to 40 metres from the track. For noisier areas, sites were located at 15 metres from the track. The aim was to ensure that for train passby events that only train noise was measured and not noise from other sources.

Measurement methods
Two types of measurement procedures were used - attended and un-attended monitoring. Unattended monitors were located to collect data continuously over a week. Three of these monitors were located near the corridor-facing facades of residences.

Two of the unattended noise monitors were operated to log noise data for 15 minute periods and the third monitor provided logging for any selected period during analysis from 1 second upwards.

All unattended monitors were set with the same time base so that data for the respective time periods could be compared.

Attended monitoring involved an operator being present to operate the sound level meter on the approach of a train and to stop the meter once the train had passed. The operator also recorded on a pro-forma, information about the train type, number of wagons, noise sources from the train and other details.

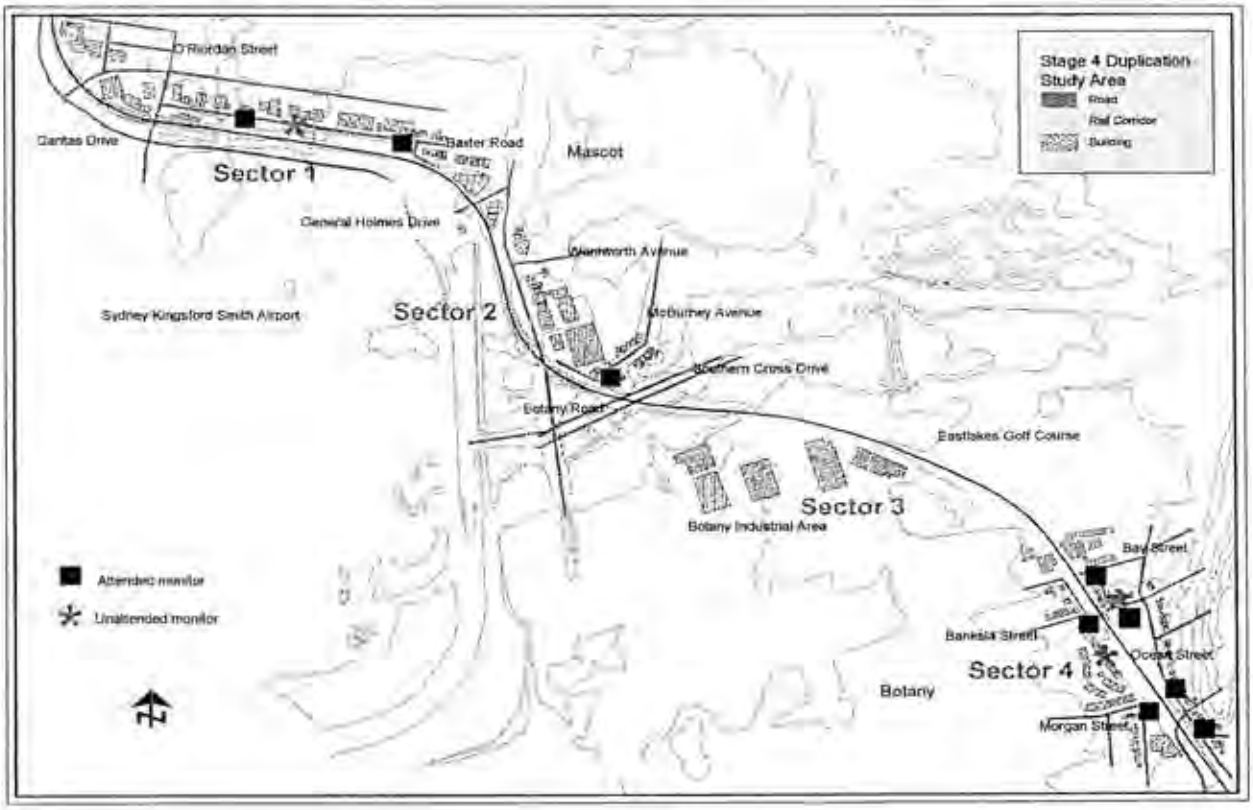


Figure 8.1 – Locations of noise monitoring sites for attended and unattended monitors

For attended monitoring, a Bruel & Kjaer 2260 Type 1 (NATA calibrated) precision sound level meter was used with an extension cable. To ensure accuracy of the measurements, the axis perpendicular to the microphone diaphragm was directed towards the rail noise source.

The sound level meter provided a time history of the train passby based on 1-second intervals. An example of the time history of a passby event is shown in Figure 8.2. Starting with the left side of the figure, the graph shows the train approaching then moving past the measurement location. The first part of the graph is the generally higher noise level from the engine and exhaust of the locomotive. As the train passes the clattering noise from the wagons becomes dominant. As shown in the graph, this

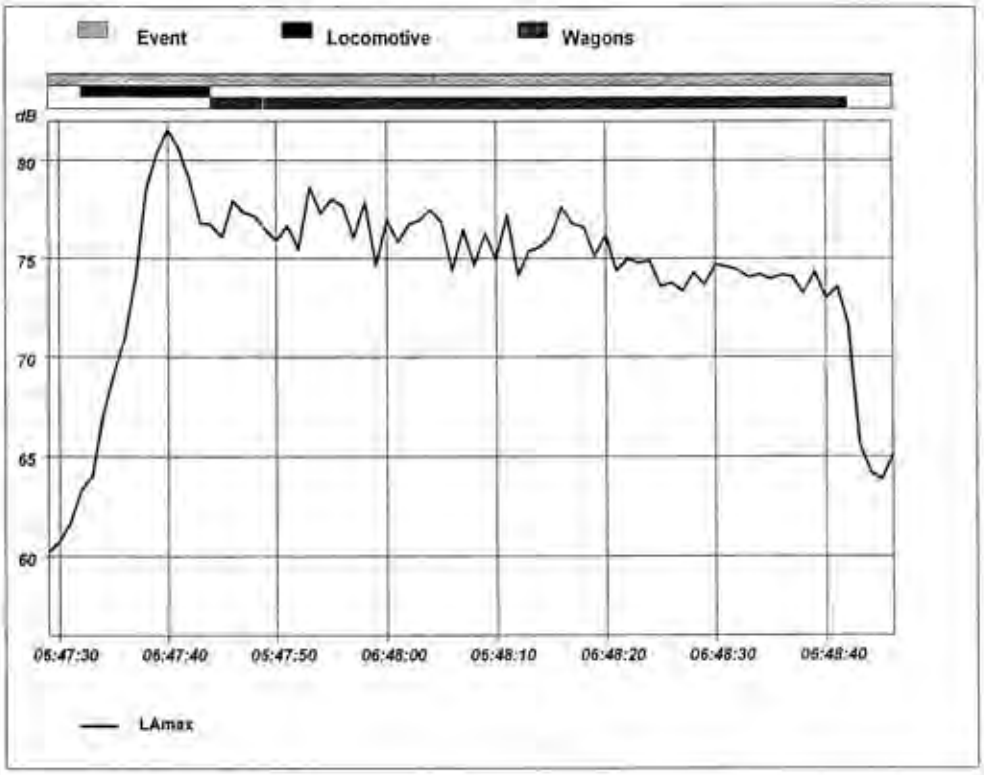


Figure 8.2 – Time history of a train passby

type of noise can be irregular depending on the significance of the impact noises genered from wagons and their couplings and other noises from the interaction of the wheels on the rail.

The graph shows that once the train passes, noise levels then drop back to background noise levels.

The train noise signature is used to assess the total noise energy from the passby event as well as the LAmax noise level.

Data processing
Coding of the noise events allowed for the analysis of the events against parameters such as location and type of train. Section 9 contains a review and analysis of the data using this coding method.

Instrumentation
A NATA calibrated Bruel & Kjaer 2260 Type 1 precision sound level meter was used for the attended monitoring. A Bruel & Kjaer 4231 calibrator was used before, during and after the measurements sequences to ensure that there was no substantial change in calibration.

The unattended monitors were Type 1 and 2 InfoByte monitors.

Measurement conditions
Attended measurements were carried out in generally fine conditions. When weather conditions deteriorated due to high winds, rain or thunderstorms, monitoring sessions were abandoned.

Data collected during adverse weather by unattended monitors was not used. On some ocassions, the presence of storms resulted in stopping measurement because of concern about lightning striking the microphone. On other ocassions, testing was stopped due to rain even though the microphone was fitted with a rain hat to prevent rain settling on the microphone diaphragm. There were no events where testing was stopped due to high winds. High wind conditions can affect noise readings by creating noise due to turbulence around the microphone.

Measurement program
Table 8.1 contains details of the scheduling of measurement times for unattended and attended measurements. The table contains locations, date of testing and the duration of testing.

Location	Type of monitoring	Measurement date	Duration
Baxter Road (west)	*Attended*	*22/10/01*	*4 hrs*
Baxter Road (east)	*Attended*	*12 & 13/10/01*	*24 hrs*
Baxter Road (west)	*Unattended*	*6 to 12/10/01*	*7 days*
McBurney Avenue	*Attended*	*20 & 21/10/01, 21/2/02*	*30 hrs*
Bay Street (north)	*Attended*	*18 & 19/10/01*	*24 hrs*
Banksia Street (north)	*Attended*	*4/10/01*	*6 hrs*
Banksia Street (north)	*Unattended*	*5 to 11/10/01*	*7 days*
Banksia Street (south)	*Attended*	*8 & 9/10/01*	*24 hrs*
Banksia Street (south)	*Unattended*	*5 to 11/9/01*	*7 days*
Ocean Street (north)	*Attended*	*3 & 4/10/01*	*24 hrs*
Ocean Street (south)	*Attended*	*9 & 10/10/01*	*12 hrs*
Morgan Street	*Attended*	*21/10/01*	*12 hrs*

Table 8.1 – Summary of the measurement program for attended and unattended sites

9 Review of Noise Monitoring Results

Unattended noise monitoring

The unattended monitoring results comprise 24-hour noise profiles for the three sites. As unattended measurements, these cannot be used as a means of unambiguously defining the different noise sources that occurred during measurement.

Measurment results confirmed that traffic noise raised the overall noise levels over large areas and aircraft noise produced the highest levels of all three sources - road, rail and aircraft.

However, in the analysis, some conclusions have been made of the likely sources of noise events using unattended monitors since the experience of nearby attended monitoring provided insights into the timing and levels of noise from various noise sources.

Comparison of the Baxter Road and Banksia Street noise profiles illustrated significant noise level differences in Sectors 1 and 2 compared to Sectors 3 and 4. Sectors 1 and 2 are areas with high levels of transportation noise.

High average continuous noise levels are due to road traffic. In addition, aircraft contribute to high periodic maximum noise levels. The maximum noise levels in the noise profile for Baxter Road would be expected to be aircraft noise while the high levels of background noise would be largely due to road traffic on General Holmes Drive (Joyce Drive).

The maximum noise levels in the Banksia Street (north) noise profiles would be expected to be passing trains (apart from the possibility of noise from people near the monitor).

It is important to note that the background noise levels (LA90,15) for Banksia Street are substantially lower than those for Baxter Road.

Attended noise monitoring

From an analysis of the coded attended noise data collected on occasions when train noise measurements were being made, road traffic noise was found to contribute to the highest number of extraneous sources (86%) while aircraft contributed to approximately 14%.

Of all the noise sources occurring during the actual measurement periods (for each train this varies from 1 to 3 or 4 minutes), the most frequent noise was from train horns (30%), while traffic noise contributed to approximately 28% of the noise events. A ranking of the events is shown in Table 9.1.

Noise	**% occurrence without train horn**	**% occurrence with train horn**
Train horn		30
Road traffic	42.7	28
Wheel/brake defect	32.8	21.5
Aircraft	7	4.5
Wagon bunching	7	4.5
Train acceleration	4.5	3
Other	6	4

Table 9.1 – Occurrence of noises during train measurement

The results from the attended monitoring provided time histories of train passbys. An example of one train passby is shown in Figure 8.2. From these time history profiles, important information for the modelling was extracted including the LAmax, duration and the LAE (noise energy from the total train - LAE is the single event noise level and is used to assess the LAeq,24hr). During the analysis of the time history data it was possible to eliminate the contribution of extraneous noise sources such as train horns or in some cases, road traffic noise.

10 Noise Mapping Assessment

Noise maps and their use

Noise maps of areas adjacent to the rail corridor have been prepared and are shown in Appendix A. These maps show computer calculated noise levels over the defined area in a colour coded format.

The noise levels shown in the maps are those that are due to trains only and no other noise sources are included such as road traffic, aircraft or industry. The calculations assume that weather conditions are fine with no wind.

Noise maps of the route corridor were prepared to show current and future noise levels from trains. These are in Appendix A.

Each noise map contains a colour key showing noise levels generally in 5 dB bands. A scale and north-direction indicator are also shown on the map.

The noise level contours vary according to the distance from the trains, the topography of the land and the noise-barrier effect of embankments, houses and buildings.

A substantial mapping area involving an extended distance from the rail line was defined for the entire rail corridor to assess noise levels at locations both close to and more distant from the rail corridor. Locations of up to 200 metres from the rail line were mapped.

Noise mapping method and software

Since the noise assessment process requires the use of the two part noise descriptor, LAmax and LAeq,24hr, the Nordic rail noise model was used together with Soundplan, an acoustical modelling program, to determine existing and future noise levels from trains.

The Nordic model uses train lengths and speeds to calculate noise emissions from trains. Soundplan takes the noise emission data from the Nordic model and estimates noise levels in grids over the area adjoining the corridor. Calibration of the model is required and this was undertaken using the attended noise measurement data.

The computer model assumes that buildings reflect noise and that noise levels in front of buildings may be 3 dB higher due to acoustical reflection.

Noise modelling and mapping data

The four sectors of the Stage 4 corridor were used as a basis for noise mapping.

Modelling was carried out for the year 2001 (Y2001) and for the year 2020 (Y2020).

As part of the modelling process, trains were grouped into three classes of train lengths - 300, 600 and 1200 metres. Train speeds were also categorised according to the existing and expected speeds in each of the sectors. The movement of locomotives without wagons was included for the Y2001 and not for Y2020 since locomotive-only movements are not expected once the duplication is operating.

For each sector different train operating modes were applied depending on factors such as grades, proximity to points and crossings.

The train speeds appropriate for each of the sectors were used for both the current and future operations. Table 10.1 shows the speeds used in the model for different sectors. For example, the Baxter Road sector assumed a maximum speed of 50 km/h. The sector between Bay Street and Page Street assumed a speed of 20 km/h. It is important to note that the modelling used the worst case maximum speeds for all trains over the 24-hour period. In reality trains travel at various speeds and it would be expected that this variation for trains that are moving and not stopping could be as much as 15 km/h.

Once the duplication is operating, train speeds should be more constant than they are at present since the need for stopping at crossings will be eliminated.

For the Y2001, a single track was assumed and for projections for future years, it was assumed that two tracks were operating as proposed.

Sector	Description	Train Speed km/h	
		Y2001	Y2020
1	Qantas Dr/Ewan St to Baxter Road (east)	40	50
2	Baxter Road (east) to McBurney Ave	25	50
3	McBurney Ave to Bay St	25	25
4	Bay St to Page St	20	20

Table 10.1 – Train speeds for sectors used in noise mapping

Rail traffic volumes

For the purpose of noise modelling the existing noise levels from trains, existing rail activity, train types and quantities were identified and categorised. Rail traffic volumes projected for Y2020 and used in modelling future noise levels were supplied by RIC. These are shown in Table 10.2.

	Train length and round trips			Total
Year	300 m	600 m	1200 m	
2001	10	5	1	16
2020	18	14	3	35

Table 10.2 – Train round trips used for noise modelling

Other noise mapping data inputs

No modifications were made in the noise modelling for wheel squeal since the phenomenon was not observed to be significant at any of the attended monitoring locations. It would not be expected to be significant once the duplication was completed. Lubrication of the track at appropriate locations is expected to be improved with the duplication.

Noise mapping scenarios

For every scenario and each of the four sectors, two noise maps were prepared to describe the two main noise descriptors. One map shows the maximum noise level (LAmax) and the other shows the 24 hour average noise energy index (LAeq,24hr). The noise maps are shown in Appendix A.

Noise levels and train speeds

To evaluate the effect of train speeds on noise levels, modelling of noise levels at different train speeds and for locations along all sectors was carried out. Single receiver calculations were made for a selection of residential buildings adjacent to the corridor and for single and multi-storey buildings.

Identification of potential noise impacts

Potential noise impacts were assessed in terms of the NDO levels previously described. Appendix A contains noise maps for all four sectors. These maps have bands of noise contours that allow identification of noise levels across the study area in 5 dB increments and NDO levels. Generally the areas coloured green are within the respective LAmax and LAeq,24hr NDO levels.

Comparisons were also made of existing and projected noise levels to assess the magnitude of changes in noise levels for LAmax,24hr. Appendix A contains maps for all four sectors that show the expected differences in noise levels due to the changes in rail volumes and operations once the duplication is completed and operating.

Noise impacts for existing multi-storey buildings were also evaluated. Information regarding the noise levels at various floor heights are provided in the noise maps in Appendix A and are discussed below.

11 Review of Noise Mapping Results

Existing noise levels along the corridor (Y2001)

Using the noise maps together with information collected during noise surveys of the sectors, the following conclusions regarding the existing noise environment were made.

Sector 1 – Qantas Dr/Ewan St to Baxter Road (East)
There are no residential buildings within the existing 60 LAeq,24hr contour over the length of this sector. A part of the Stamford Hotel and some commercial premises are within the 60 LAeq,24hr contour. Houses in Baxter Road tend to have LAeq,24hr values up to approximately 55 dB(A). A wall at the eastern end of Baxter Road that separates the rear of the properties from an access road to a parking station protects houses from train noise. These houses fall within the 55 LAeq,24hr contour.

Similarly for LAmax, there are no residential buildings currently within the 85 contour although some commercial buildings and the hotel are within the contour. LAmax levels at the Baxter Road houses were found to be approximately 75 to 80 dB(A). Houses adjacent to the corridor at the eastern end of Baxter Road are protected from LAmax levels by the wall mentioned above, reducing noise levels for ground level floors to approximately 70 to 75 dB(A).

Sector 2 - Baxter Road (East) – McBurney Avenue
Only one dwelling (at the southern end of McBurney Avenue) lies within the 60 to 65 LAeq,24hr contour. The same house is also within the 80 to 85 LAmax contour. For other parts of this sector, houses and commercial premises are generally further away from the rail corridor largely due to the location of Botany Road between the rail line and buildings.

Residences on Botany Road (on the southern side of Wentworth Avenue) are within the 50 to 55 LAeq,24hr contour and are at the lower end of the 75 to 80 LAmax contour.

A residential unit block on the corner of Botany Road and Wentworth Avenue was within the 55 to 60 LAeq,24hr contour on the most exposed side of the building and was within the 75 to 80 LAmax contour.

Sector 3 - McBurney Avenue – Bay Street
Apart from the McBurney Avenue house there were no dwellings that were found to be affected along this sector. Commercial buildings are distant from the corridor and generally fall within the 50 to 55 LAeq,24hr contour. The facades of some commercial premises are within the 55 to 60 LAeq,24hr contour. In terms of LAmax, the most exposed commercial

premises are within the 75 to 80 LAmax contour.

Sector 4 - Bay Street – Page Street Overpass
Between Bay and Banksia Streets and on the northern side of corridor, some dwellings are currently estimated to be at the lower limit of the 60 to 65 LAeq,24hr contour. The 60 to 65 LAeq,24hr contour starts at the facades of these buildings.

On the opposite side in Ellis Street, residential properties are approximately 55 LAeq,24hr since they are substantially within the 50 to 55 LAeq,24hr contour and the facades are at the lower end of the 55 to 60 LAeq,24hr band.

For LAmax, the facades of the first row of houses nearest the corridor on the northern side of the rail corridor between Bay and Banksia Streets are at the lower limit of the 80 to 85 LAmax contour. There are no other dwellings in Sector 4 that closely approach or exceed the LAmax NDO.

For this assessment, noise design objectives (NDO) for residential premises were used and are 60 LAeq,24hr and 85 LAmax.

Units on the southern side of the corridor between Banksia and Morgan Streets are in part within the 50 to 55 LAeq,24hr contour. Elsewhere they are at the lower limit of the 55 to 60 LAeq,24hr contour. LAmax levels at the facades of these units are within the 75 to 80 LAmax contour.

As with other sectors, houses located behind the front row of dwellings benefit from the noise-barrier effect of these front row houses and structures. Note the substantial shielding provided by the multi-storey units between Banksia and Morgan Streets. Maximum noise levels are attenuated below 60 dB(A) and the LAeq,24hr was below 40.

Houses in Ocean Street and facing the park were within the 50 to 55 LAeq,24hr contour at the southern end and were within the 40 to 45 LAeq,24hr contour at the northern end. LAmax values ranged from 70 at the southern end to 40 to 45 at the northern end.

Projected noise levels along the corridor (Y2020)

Sector 1 – Qantas Dr/Ewan St to Baxter Road

With increased rail traffic expected in Y2020, a small number of houses were assessed to be at the lower limit of the 60 to 65 LAeq,24hr contour while most others in the same street were within the 55 to 60 LAeq,24hr contour. The house in Ewan Street was shielded by an adjacent building and was within the 55 to 60 LAeq,24hr contour. The Stamford Hotel was within the 65 to 70 LAeq,24hr contour together with some other commercial buildings located close to the rail corridor.

Houses at the eastern end of Baxter Road were within the 55 to 60 LAeq,24hr contour due partly to the high masonry wall located adjacent to the car park access road between the houses and the rail line.

Generally houses are distant enough to be below the 85 LAmax NDO level. The dwellings at the eastern end of Baxter Road are again protected from train noise by a high wall separating the residences from a driveway for the parking station.

Properties located in Robey Street (parallel to Baxter Road and to the north) are shielded by the front row of buildings and are within NDOs.

Properties located in Robey Street (parallel to Baxter Road and to the north) are shielded by the front row of buildings and are within the NDO level.

To assess noise levels for two storey dwellings at the eastern end of Baxter Road, the noise model produced the following results for the dwelling closest to the rail line. These noise levels were assessed as point receivers adjacent to the building and facing the rail corridor.

Level	LAeq,24hr	LAmax
Ground	48.1	66.1
First	50.5	68.4

Table 11.1 – Noise levels for 2-storey dwelling, Baxter Road (east)

The results indicate that the first floor noise level is approximately 2 dB higher than the ground floor level. Due to the effect of the masonry wall, both levels of any 2-storey building in this area would be expected to be within the NDOs.

Sector 2 - Baxter Road – McBurney Avenue
With the added rail traffic an additional two houses in McBurney Avenue were assessed to fall within the 60 to 65 LAeq,24hr contour and more houses fall within the 55 to 60 LAeq,24hr contour. The closest residence is within the 65 to 70 LAeq,24hr contour. With LAmax, two houses facing the rail corridor are within the 80 to 85 LAmax contour.

A block of units in Botany Road (corner of Wentworth Avenue) was at the lower limit of the 60 to 65 LAeq,24hr contour while other dwellings to the south along Botany Road were within the 55 to 60 LAeq,24hr contour. The car park and a commercial premises were within the 70 to 75 LAeq,24hr contour.

To assess noise levels for the home units on the corner of Botany Road and Wentworth Avenue, as part of the modelling, point receivers were placed at the facade of the building and the noise model produced the following results.

Level	LAeq,24hr	LAmax
Ground	57.6	77
First	61.2	80.7
Second	62	81.4

Table 11.2 – Noise levels for multi-storey home units, Botany Road

The results indicated that noise levels increased for each added floor level. While the ground floor level conforms with NDOs, the second and third floor levels marginally exceed the LAeq,24hr NDO. All floors comply with the LAmax NDO.

These units have been noise insulated and treated with heavier glazing in doors and windows to reduce traffic and other sources of noise.

Sector 3 - McBurney Avenue – Bay Street
Apart from the McBurney Avenue dwellings discussed above there are no other dwellings affected along this sector. There are no noise goals that apply in this assessment to the commercial and open space areas.

Within the Botany industrial area shown on the noise map, noise levels at the facades of some industrial buildings were within the 55 to 60 LAeq,24hr contour and were within 75 to 80 LAmax.

Assessed increases in noise levels between 2001 and 2020 are shown in Appendix A. For most areas including the Mill Pond and the Eastlakes Golf Course, typical increases in noise levels are 3 to 5 dB for LAeq,24hr and 1 to 3 dB for LAmax. The increase in LAeq,24hr is expected due to the projected increase in rail traffic.

The LAeq,24hr noise level varies according to the speed, train length and train volumes over a 24 hour day. With LAmax, the maximum noise level would tend to be similar over the study timeframe since the single-event noise-producing mechanism for LAmax (eg exhaust and engine noise from a locomotive) would be similar with the same types of locomotives over the study period.

Sector 4 - Bay Street – Page Street Overpass
With the additional trains for the projected Y2020 rail traffic, houses directly facing the rail corridor between Banksia Street and Bay Street (northern side) are expected to be within the 60 to 65 LAeq,24hr contour and within the 80 to 85 LAmax contour.

Changes in noise levels of approximately 2 dB in LAmax for most of the sectors apply with some increases of up to 3 to 4 dB in LAeq,24hr.

Second row houses are within the 50 to 55 LAeq,24hr contour and 70 to 75 LAmax contour. The façade of a new unit development in Bay Street is within the 55 to 60 LAeq,24hr contour.

The 55 to 60 LAeq,24hr contour also extends to some house facades in Ocean Street and to a greater extent to dwellings in Ellis Street as well as the residential complex between Banksia and Morgan Streets. At these locations (for ground floors) the levels are below the NDO of 60 LAeq,24hr. The 85 LAmax NDO is not exceeded at these locations.

Changes in noise levels shown in the 'difference' noise maps in Appendix A, indicate changes of approximately 1 to 2 dB in LAmax for most of the sector with some increases of up to 3 dB in the area close to the corridor between Bay and Banksia Streets (northern side).

To assess noise levels for multi-storey houses and home units, the noise model produced the following results presented in Table 11.3.

Level	LAeq,24hr	LAmax
Ground	62.4	79.0
First	65.8	83

Table 11.3 – Noise levels for multi-storey dwellings, Bay to Banksia Streets

The results indicated that noise levels marginally increased with increasing height. Both ground and first floor levels exceeded the LAeq,24hr NDO and both complied with the LAmax NDO.

Facades of units between Banksia and Morgan Streets (see Table 11.4) produced maximum noise levels within the NDO of 85 dB(A). For the LAeq,24hr NDO, the ground and first floors complied while the second and third floors were marginally above the 60 dB(A) NDO.

Houses in Morgan and Victoria Streets satisfied both the LAeq,24hr and LAmax NDOs.

Level	LAeq,24hr	LAmax
Ground	55.9	72.5
First	57.6	74
Second	60.1	76.5
Third	60.5	76.9

Table 11.4 – Noise levels for multi-storey dwellings, Banksia to Morgan Streets

Changes in noise levels – Y2001 to Y2020

Details of projected changes in LAmax and LAeq,24hr noise levels between Y2001 and Y2020 are shown in noise maps in Appendix A. Over the entire corridor route the changes are generally increases of 1 to 3 dB for LAmax and increases of 3 to 5 for LAeq,24hr.

Table 11.5 uses LAeq,24hr to show the number of dwellings, either single houses or home units, and the expected changes in noise levels at the facades of those properties. The overall numbers of dwellings with façade levels above the 60 LAeq,24hr is small. There are a total of 5 dwellings, 3 houses and 2 home units that are presently above the 60 LAeq,24hr criterion.

With increased rail freight traffic expected in Y2020, the numbers of dwellings above the 60 LAeq,24hr NDO was estimated to be 23, comprising 11 houses and 12 home units.

Sector 1 (Baxter Road Mascot) currently has no dwellings within 60 LAeq,24hr and by Y2020 it is estimated that 4 houses will exceed the level. In Sector 2, one house in McBurney Avenue exceeds 60 LAeq,24hr while the Y2020 estimates increase the number to 10, comprising 4 houses in McBurney Avenue and 6 units on Botany Road.

Sector 3 is largely open space with some light industry and no dwellings. Sector 4 has the largest concentration of residential buildings. There are 4 buildings estimated to currently be over the 60 LAeq,24hr and it is estimated that 9 dwellings will be over the NDO. Three houses and 6 units are estimated to exceed the 60 LAeq,24hr in Y2020.

	Y2001		Y2020	
	Number of single houses 60+ LAeq,24hr	Number of home units 60+ LAeq,24hr	Number of single houses 60+ LAeq,24hr	Number of home units 60+ LAeq,24hr
Sector 1	0	0	4	0
Sector 2	1	0	4	6
Sector 3	0	0	0	0
Sector 4	2	2	3	6
Total	3	2	11	12

Table 11.5 – Number of residential dwellings exposed to levels of LAeq,24hr

Noise levels at elevated locations (units and 2 storey houses)

An assessment of noise levels at elevated locations was made at the facades of units and at the first levels of 2 storey houses to examine the relationship of noise levels with height. It was found that noise levels generally increased with increasing height up to a limit then decreased with further height. In some cases where levels were less than the NDO at ground level, the NDO was exceeded at higher floor levels.

Noise levels and train speeds

Table 11.6 contains data from the modelling of point receiver locations at two places along the route to assess the effect that changes in train speed would have at ground and first floor levels.

Three train speeds were modelled, 40, 45 and 50 km/h. These were chosen as they represent the range of speeds likely to be experienced in Sector 1. Trains operating in other sectors will be at slower speeds.

The modelling concluded that increases in speed of 5 km/h for increases from 40 to 45 and 45 to 50 km/h increased the LAmax,24hr by an average of approximately 1 dB.

For LAmax noise levels, the average noise level increases were more with an average of 2 dB differences for speeds between 40 and 45 and a similar difference for speed changes from 45 to 50 km/h.

The findings of this assessment are significant in the sense that for properties that were assessed to be on the margin of the NDO, it would be expected that the actual noise level might be lower since the modelled speeds were at 'worst case' maximum levels.

Not all trains would be operating at the specified modelled maximum speeds and so it would be expected that a reduction of at least 1 dB for both NDOs would be appropriate.

Receiver	Floor	Speed km/h	LAeq,24hr	LAmax	Increase in speed	LAeq,24hr increase	LAmax increase
House in Baxter Rd	1	40	47.1	67.9			
		45	48.4	69.4	40-45	1.3	1.5
		50	49.4	72.6	45-50	1	3.2
	2	40	54.8	75.4			
		45	56	76.9	40-45	1.2	1.5
		50	57	80.3	45-50	1	3.4
Units in Botany Road	1	40	54.6	77.1			
		45	55.8	78.2	40-45	1.2	1.1
		50	56.9	80.1	45-50	1.1	1.9
	2	40	55.7	78.1			
		45	57	79.6	40-45	1.3	1.5
			58	81.1	45-50	1	1.5
	3	40	56.3	78.7			
		45	57.5	81.6	40-45	1.2	2.9
		50	58.5	81.7	45-50	1	0.1
Average						1.1	1.8
Average 40-45 km/h						1.2	1.7
Average 45-50 km/h						1.0	2.0

Table 11.6 – Assessed changes in noise levels with train speeds.

12 Summary of Key Assessment Results

Findings for the sectors

The analysis of future rail operations in this assessment concluded the following in relation to projected rail noise levels.

Sector 1- Qantas Drive/Ewan Street - Baxter Road

Four residences in Baxter Road were found to marginally exceed the 60 LAeq,24hr (by 1 or 2 dB) at the facades of the dwellings for Y2020. LAmax levels were sometimes between 75 and up to 82 LAmax at residential premises.

At the Stamford Hotel, the adjacent office building and at a commercial premises in Baxter Road, LAmax and LAeq,24hr were over 85 and 65 respectively.

Noise levels for 2 storey dwellings were found be approximately 70 LAmax and 50 LAeq,24hr.

Sector 2 - Baxter Road – McBurney Avenue

Two locations along this sector were assessed to be within the 60 to 65 LAeq,24hr contour. These were a block of new units on the corner of Botany Road and Wentworth Avenue and some houses at the southern end of McBurney Avenue. LAmax levels were approximately between 75 and 80.

While LAeq,24hr levels at the ground floor of the Botany Road units were found to be below 60, the higher floors marginally exceeded this level.

Sector 3 - McBurney Avenue – Bay Street

There are no residential premises in this sector. Increases in noise levels in this sector are not expected to affect the open space and industrial land uses.

Sector 4 - Bay Street – Page Street Overpass

This sector has the largest number of residences compared to the other sectors.

A total of 9 dwellings were found to be above 60 LAeq,24hr, 3 single dwellings and 6 units. Dwellings between Bay and Banksia Streets on the north side of the corridor exhibited LAeq,24hr above 60 dB(A) for both ground and first floor levels. LAmax levels were just below or above the 85 dB(A). Only the front row of houses were above 60 LAeq,24hr and those behind tended to be within the 50 to 55 contours.

Properties in Ellis Street were assessed to be below 60 LAeq,24hr and were within 75 to 80 LAmax contours.

Units between Banksia and Morgan Streets were within the 50 to 60 LAeq,24hr contours at ground level and sometimes slightly exceeded 60 at the higher floor levels. These properties were within 75 to 80 LAmax contours.

A small number of properties in Ocean Street were within the 55 to 60 LAeq,24hr contours with the remainder exhibiting levels of between 50 to 55. For LAmax, the levels at some properties were within the 75 to 80 contours and the remainder were in the below 70.

In Victoria Street, LAeq,24hr levels were assessed to be 40 to 45 and the LAmax contour was below 70.

It is important to note that this sector will have reduced use of train horns as a result of the construction of a grade-separated pedestrian crossing at Banksia Street.

Another important benefit will be the reduced frequency of idling trains near the units since the duplication will allow the continuous flow of rail traffic.

Other findings and issues

For the entire route the noise impacts at houses behind the first rows of dwellings facing the rail corridor was evaluated by using a wide study corridor either side of the rail corridor. This wide corridor was needed particularly in Sector 4 where houses and units are located at larger distances from the rail line. The dispersed nature of housing also suggested that houses and units away from the front-row needed to be included.

Generally, in locations where dwellings facing the rail corridor approached or exceeded the NDOs, other dwellings located immediately behind benefited from the barrier effect of the front row.

Changes in noise levels were assessed using the noise maps by subtracting the existing noise levels from the projected noise levels (Y2020-Y2001). In general the LAmax levels changed only marginally from the existing levels since trains (ie locomotives, the source of the LAmax) over the study period are not expected to be different from the noise levels experienced today.

For LAeq,24hr, changes are to be expected since the calculation of this index depends on the train speed (which will change due to changes in operations), the number of trains (which is expected to increase) and the train length (which is also expected to increase in some cases). The

expected increases in LAeq,24hr are approximately 3 to 5 dB which equates broadly to a doubling of the quantity of rail traffic.

The assessment of noise levels for buildings from 2 to 4 storeys found that noise generally increased with increasing height up to a level (then decreased with increasing height) and in some cases where levels were below NDOs at ground level, noise levels marginally exceeded the NDOs at higher floor levels.

14 Conclusions

The Port Botany Freight Rail Project is being undertaken to increase the capacity of the rail corridor to handle expected future growth in rail traffic.

This assessment examines current and future rail traffic volumes and operations to determine the nature of the existing and future noise environment adjacent to the rail corridor and any changes in noise levels due to projected rail traffic activity.

Data collected on the existing noise environment along the corridor indicated that the line passed through mixed industrial areas. These exhibited levels of high background noise from sources such as road traffic and aircraft. Low to medium density residential precincts generally had lower levels of background noise.

The assessment of the potential rail noise levels due to rail corridor upgrading between Mascot and Botany found the following:

- Four residences in Baxter Road were found to marginally exceed 60 LAeq,24hr;
- A block of new units on the corner of Botany Road and Wentworth Avenue and some houses at the southern end of McBurney Avenue exceeded 60 LAeq,24hr;
- The 60 LAeq,24hr was exceeded for dwellings on the northern side of the corridor between Bay and Banksia Streets. For units between Banksia and Morgan Streets, lower floor levels were below 60 LAeq,24hr goal and upper floor levels marginally exceeded the 60 LAeq,24hr.

Generally in locations where dwellings facing the rail corridor approached or exceeded the NDOs, other dwellings located immediately behind benefited from the barrier effect of the front row of houses.

Changes in noise levels were assessed (Y2020-Y2001). The LAmax levels on average changed only marginally (1 to 3 dB) from the existing levels over the study period.

For LAeq,24hr, expected increases are approximately 3 to 5 dB which generally equates to a doubling of the quantity of rail traffic.

An assessment of noise levels was carried out for buildings from 2 to 4 storeys. It was found that noise levels generally increased with increasing height and in some cases where levels complied at ground level, noise levels marginally exceeded the NDO at higher floor levels.

Appendix A

Noise Mapping

Sector 1
Y2001: LAeq,24hr
Y2020: LAeq,24hr
Y2020-Y2001: LAeq,24hr
Y2001: LAmax
Y2020: LAmax

Sector 2
Y2001: LAeq,24hr
Y2020: LAeq,24hr
Y2020-Y2001: LAeq,24hr
Y2001: LAmax
Y2020: LAmax

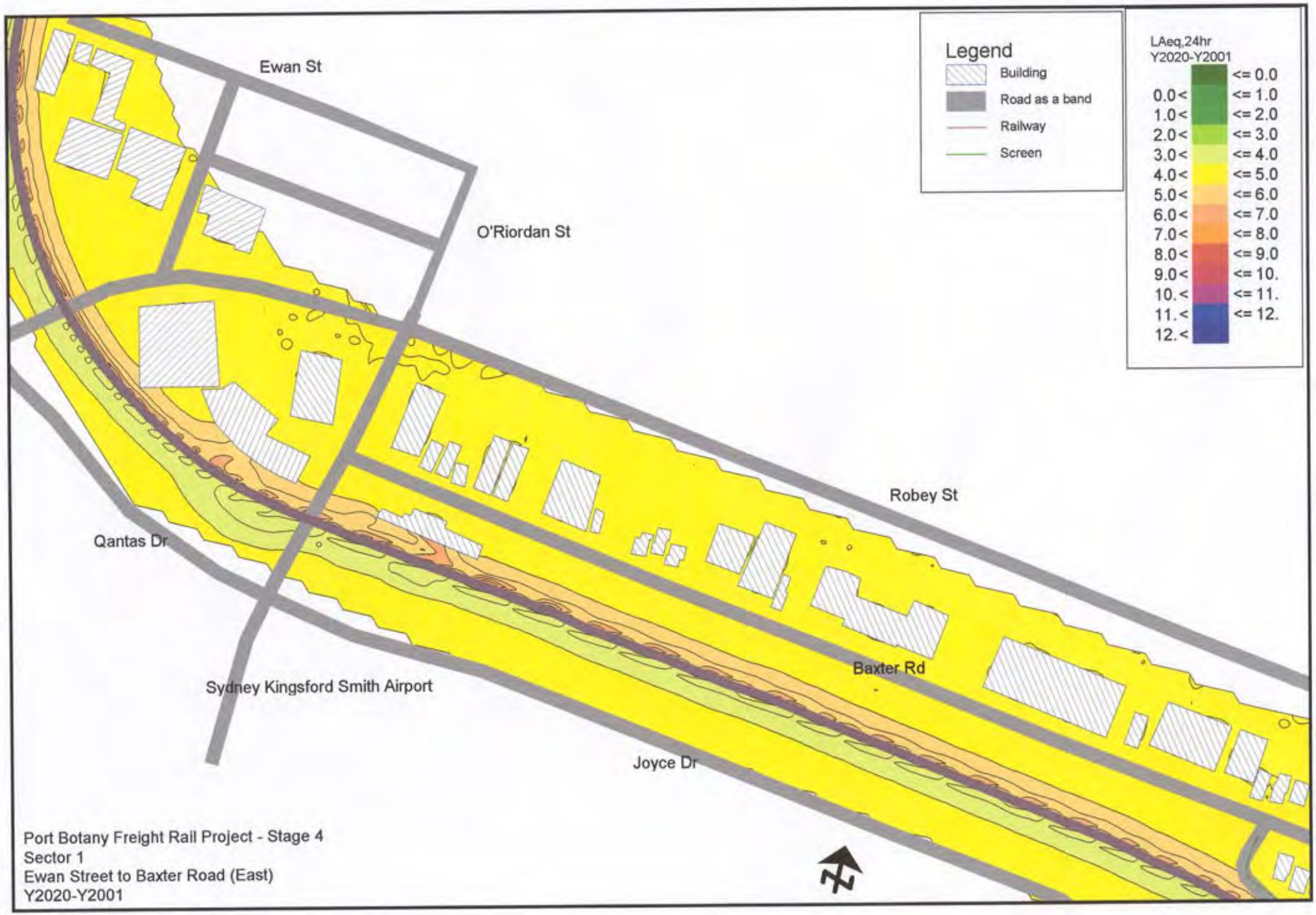
Sector 3
Y2001: LAeq,24hr
Y2020: LAeq,24hr
Y2020-Y2001: LAeq,24hr
Y2001: LAmax
Y2020: LAmax

Sector 4
Y2001: LAeq,24hr
Y2020: LAeq,24hr
Y2020-Y2001: LAeq,24hr
Y2001: LAmax
Y2020: LAmax

Multi-storey building noise levels


Legend
Building
Road as a band
Railway
Screen
Noise level
LAeq24hr
in dB(A)
<= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 < <= 75
75 <
Ewan St
O'Riordan St
Robey St
Qantas Dr
Baxter Rd
Sydney Kingsford Smith Airport
Joyce Dr
Port Botany Freight Rail Project - Stage 4
Sector 1
Ewan Street to Baxter Road (East)
Y2020

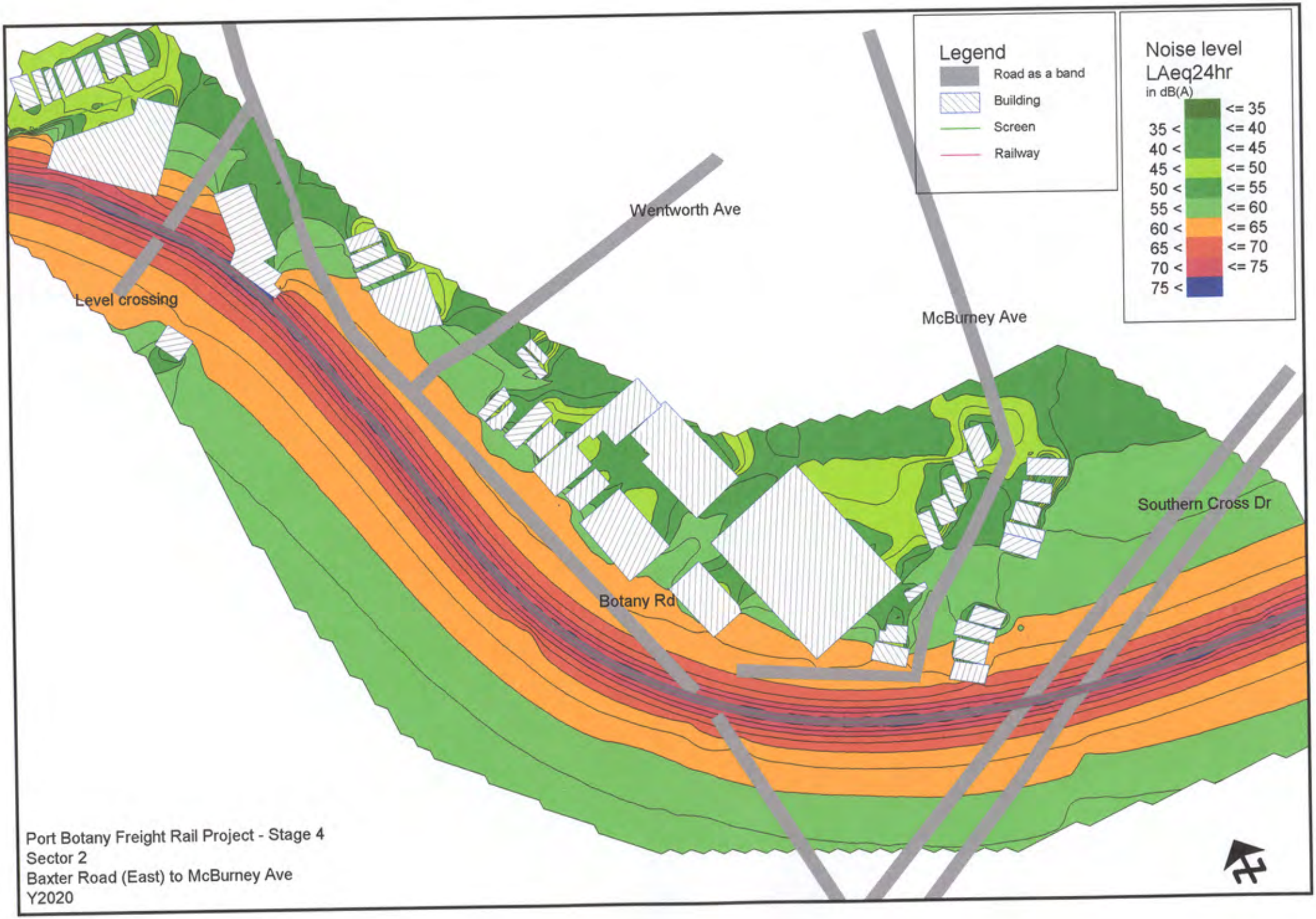

Ewan St
O'Riordan St
Robey St
Qantas Dr
Baxter Rd
Sydney Kingsford Smith Airport
Joyce Dr
Legend
Building
Road as a band
Railway
Screening
Attended noise monitor
Unattended noise monitor
Noise level LAeq24hr
in dB(A)
<= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 < <= 75
75 <
Port Botany Freight Rail Project Stage 4
Sector 1
Ewan Street to Baxter Road (East)
Y2001

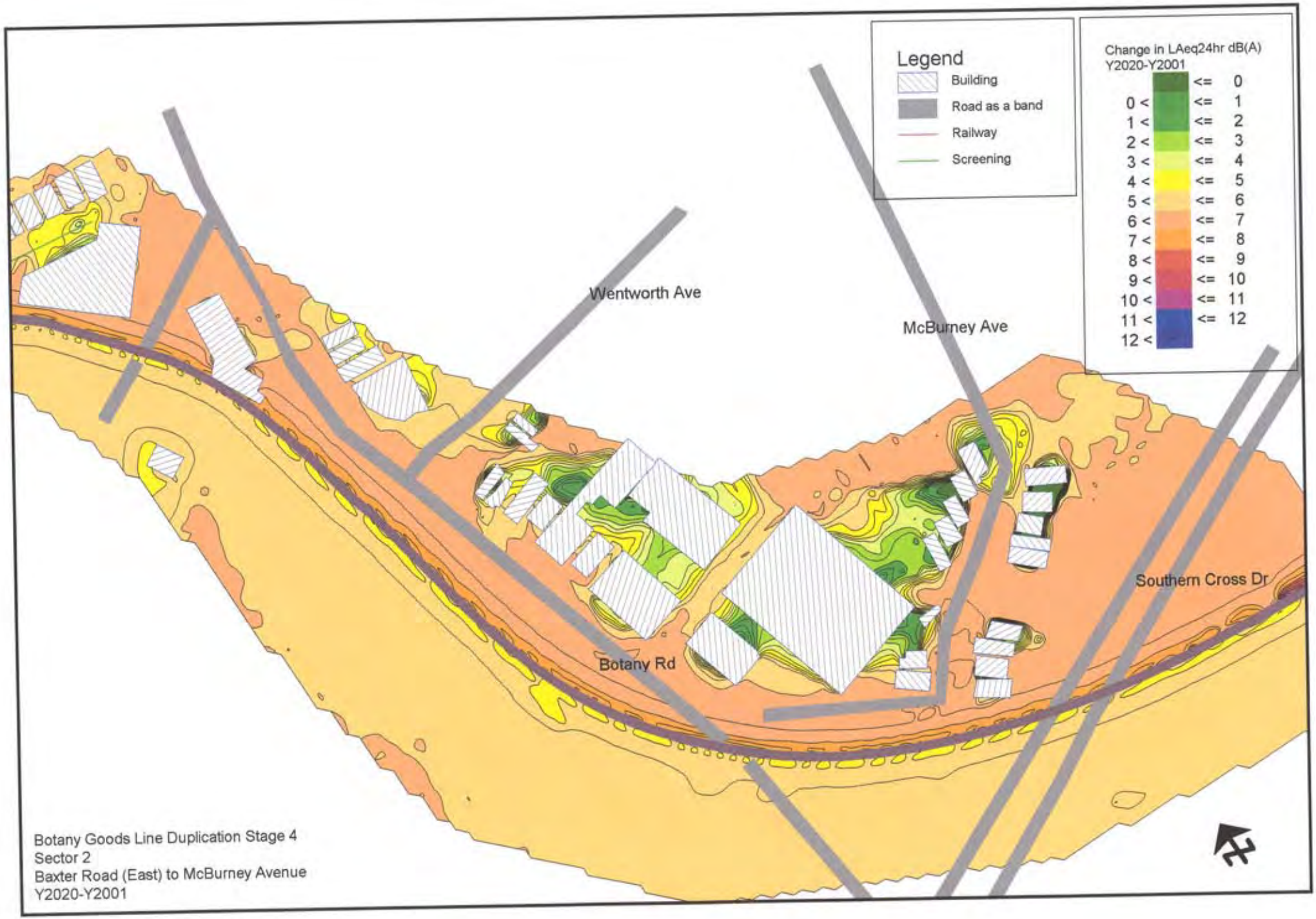

Legend
Building
Road as a band
Railway
Screen
LAeq,24hr
Y2020-Y2001
<= 0.0
0.0< <= 1.0
1.0< <= 2.0
2.0< <= 3.0
3.0< <= 4.0
4.0< <= 5.0
5.0< <= 6.0
6.0< <= 7.0
7.0< <= 8.0
8.0< <= 9.0
9.0< <= 10.
10.< <= 11.
11.< <= 12.
12.<
Ewan St
O'Riordan St
Robey St
Qantas Dr
Baxter Rd
Sydney Kingsford Smith Airport
Joyce Dr
Port Botany Freight Rail Project - Stage 4
Sector 1
Ewan Street to Baxter Road (East)
Y2020-Y2001


Ewan St
O'Riordan St
Robey St
Qantas Dr
Baxter Rd
Sydney Kingsford Smith Airport
Joyce Dr
Legend
Building
Road as a band
Railway
Screen
Noise level
LAmax
in dB(A)
<= 70
70 < <= 75
75 < <= 80
80 < <= 85
85 < <= 90
90 < <= 95
95 < <= 100
100 < <= 105
105 < <= 110
110 <
Port Botany Freight Rail Project - Stage 4
Sector 1
Ewan Street to Baxter Road (East)
Y2020


Ewan St
O'Riordan St
Robey St
Qantas Dr
Baxter Rd
Sydney Kingsford Smith Airport
Joyce Dr
Legend
Building
Road as a band
Railway
Screen
Noise level
LAmax
in dB(A)
<= 70
70 < <= 75
75 < <= 80
80 < <= 85
85 < <= 90
90 < <= 95
95 < <= 100
100 < <= 105
105 < <= 110
110 <
Port Botany Freight Rail Project - Stage 4
Sector 1
Ewan Street to Baxter Road (East)
Y2020

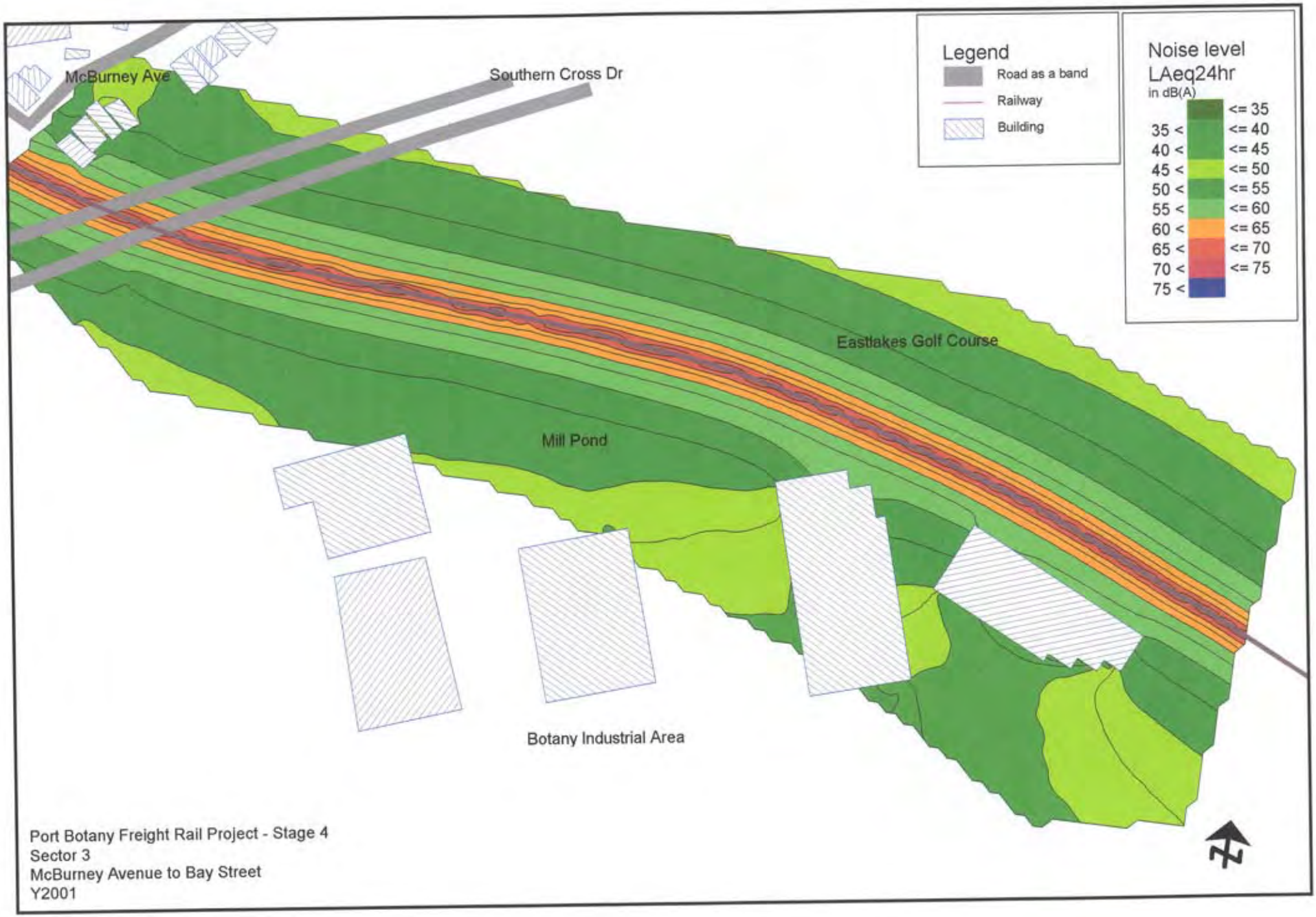

Legend
Road as a band
Screening
Railway
Building
Attended noise monitor
Noise level LAeq24hr
in dB(A)
<= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 < <= 75
75 <
Wentworth Ave
McBurney Ave
Level crossing
Southern Cross Dr
Botany Rd
Port Botany Freight Rail Project - Stage 4
Sector 2
Baxter Road (East) to McBurney Ave
Y2001

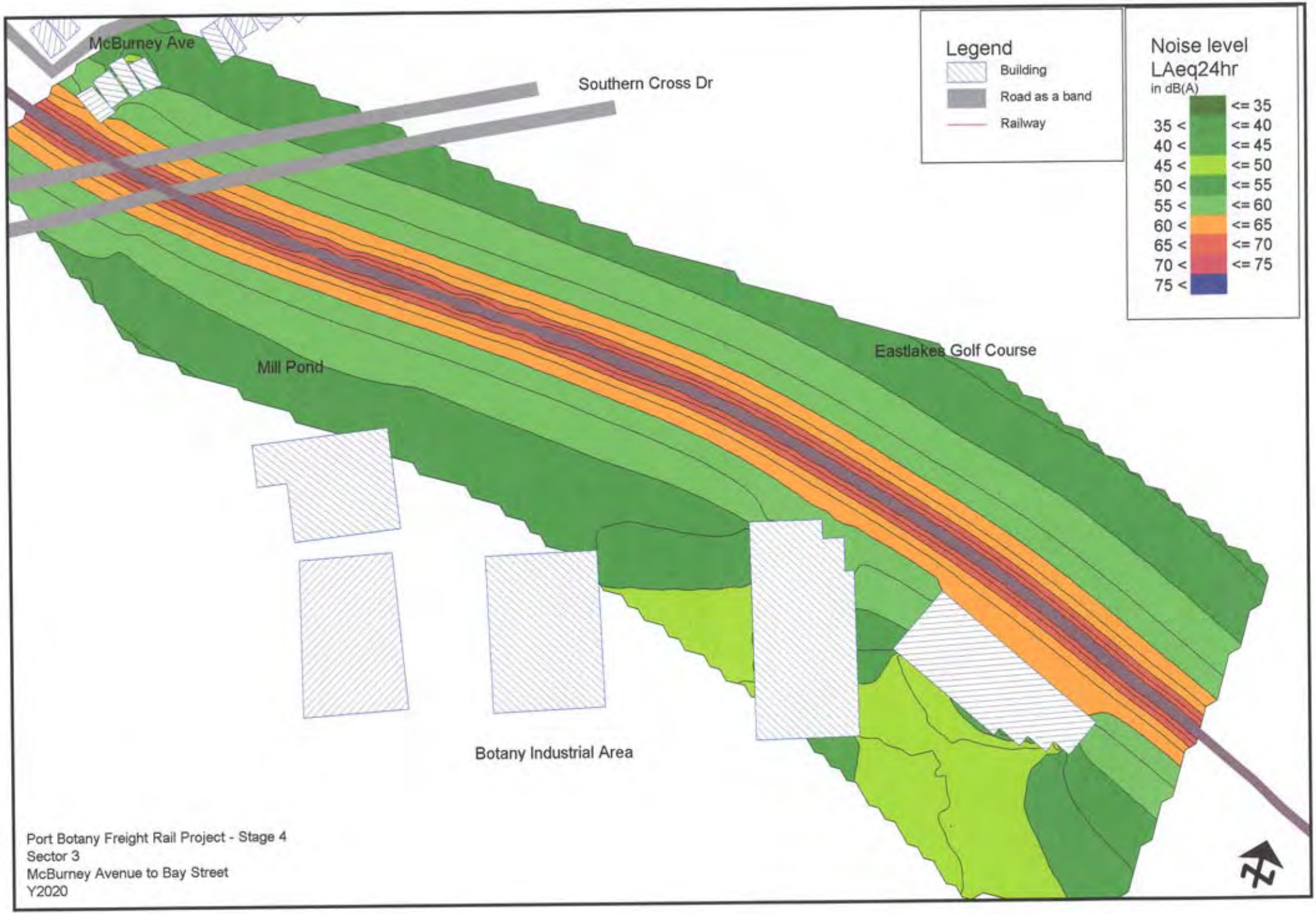

Legend
Road as a band
Building
Screen
Railway
Noise level
LAeq24hr
in dB(A)
<= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 < <= 75
75 <
Wentworth Ave
Level crossing
McBurney Ave
Southern Cross Dr
Botany Rd
Port Botany Freight Rail Project - Stage 4
Sector 2
Baxter Road (East) to McBurney Ave
Y2020

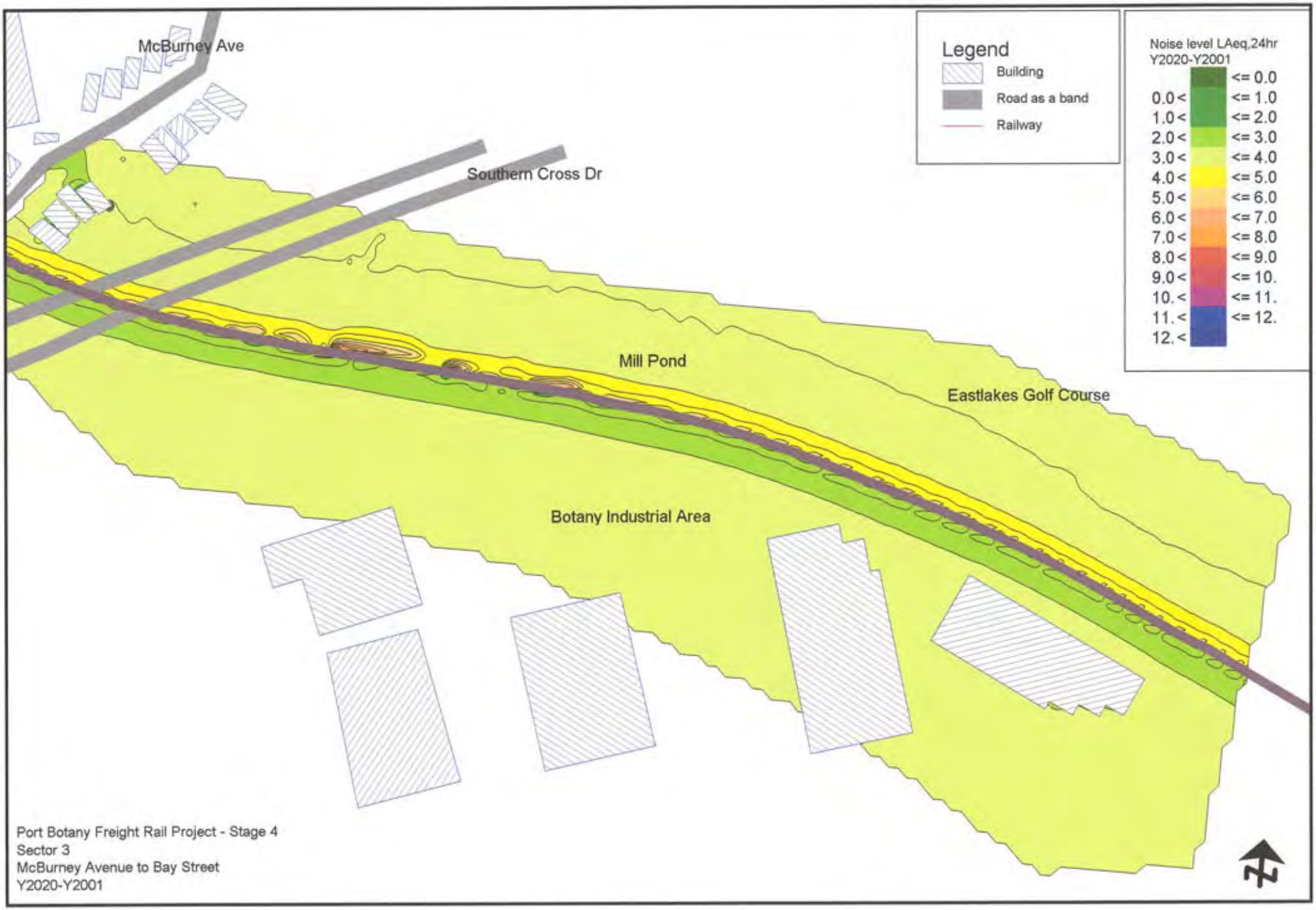

Legend
Building
Road as a band
Railway
Screening
Change in LAeq24hr dB(A)
Y2020-Y2001
<= 0
0 < <= 1
1 < <= 2
2 < <= 3
3 < <= 4
4 < <= 5
5 < <= 6
6 < <= 7
7 < <= 8
8 < <= 9
9 < <= 10
10 < <= 11
11 < <= 12
12 <
Wentworth Ave
McBurney Ave
Botany Rd
Southern Cross Dr
Botany Goods Line Duplication Stage 4
Sector 2
Baxter Road (East) to McBurney Avenue
Y2020-Y2001


Legend
Road as a band
Building
Screen
Railway
Attended noise monitor
Noise level LAmax
in dB(A)
<= 70
70 < <= 75
75 < <= 80
80 < <= 85
85 < <= 90
90 < <= 95
95 < <= 100
100 < <= 105
105 < <= 110
110 <
Wentworth Ave
McBurney Ave
Level crossing
Southern Cross Dr
Botany Rd
Port Botany Freight Rail projecy - Stage 4
Sector 2
Baxter Road (East) to McBurney Ave
Y2001


Legend
Road as a band
Building
Screen
Railway
Noise level
LAmax dB(A)
<= 70
70 < <= 75
75 < <= 80
80 < <= 85
85 < <= 90
90 < <= 95
95 < <= 100
100 < <= 105
105 < <= 110
110 <
Level crossing
Wentworth Ave
McBurney Ave
Southern Cross Dr
Botany Rd
Port Botany Freight Rail Project - Stage 4
Sector 2
Baxter Road (East) to McBurney Ave
Y2020

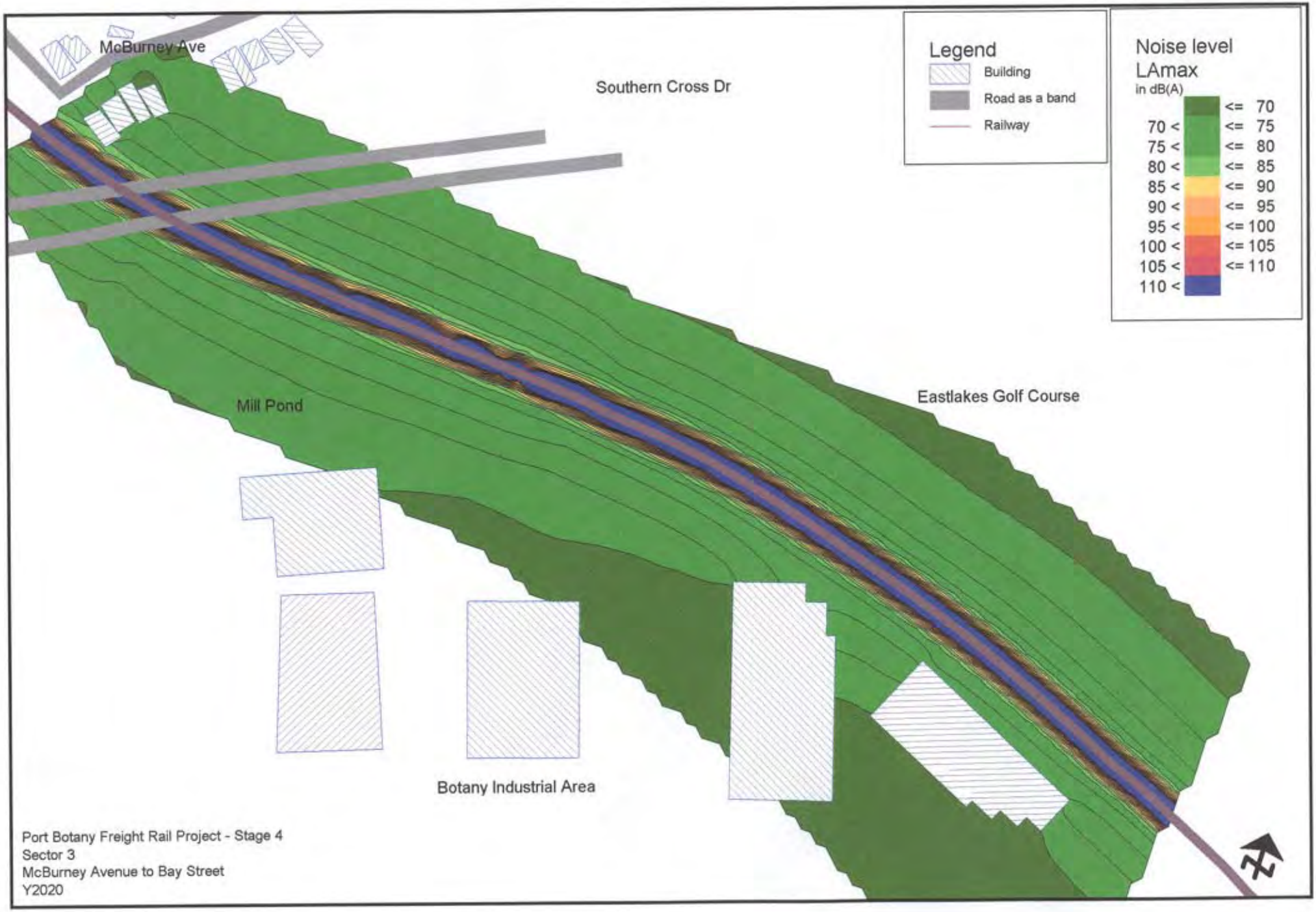

McBurney Ave
Southern Cross Dr
Legend
Road as a band
Railway
Building
Noise level
LAeq24hr
in dB(A)
<= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 < <= 75
75 <
Eastlakes Golf Course
Mill Pond
Botany Industrial Area
Port Botany Freight Rail Project - Stage 4
Sector 3
McBurney Avenue to Bay Street
Y2001


McBurney Ave
Southern Cross Dr
Legend
Building
Road as a band
Railway
Noise level
LAeq24hr
in dB(A)
<= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 < <= 75
75 <
Mill Pond
Eastlakes Golf Course
Botany Industrial Area
Port Botany Freight Rail Project - Stage 4
Sector 3
McBurney Avenue to Bay Street
Y2020


McBurney Ave
Southern Cross Dr
Mill Pond
Eastlakes Golf Course
Botany Industrial Area
Legend
Building
Road as a band
Railway
Noise level LAeq,24hr
Y2020-Y2001
<= 0.0
0.0 < <= 1.0
1.0 < <= 2.0
2.0 < <= 3.0
3.0 < <= 4.0
4.0 < <= 5.0
5.0 < <= 6.0
6.0 < <= 7.0
7.0 < <= 8.0
8.0 < <= 9.0
9.0 < <= 10.
10. < <= 11.
11. < <= 12.
12. <
Port Botany Freight Rail Project - Stage 4
Sector 3
McBurney Avenue to Bay Street
Y2020-Y2001


Legend
Road as a band
Building
Railway
Noise level
LAmax
in dB(A)
<= 70
70 < <= 75
75 < <= 80
80 < <= 85
85 < <= 90
90 < <= 95
95 < <= 100
100 < <= 105
105 < <= 110
110 <
McBurney Ave
Southern Cross Dr
Mill Pond
Eastlakes Golf Course
Botany Industrial Area
Port Botany Freight Rail Project - Stage 4
Sector 3
McBurney Avenue to Bay Street
Y2001


Legend
Road as a band
Building
Railway
Noise level
LAmax
in dB(A)
<= 70
70 < <= 75
75 < <= 80
80 < <= 85
85 < <= 90
90 < <= 95
95 < <= 100
100 < <= 105
105 < <= 110
110 <
McBurney Ave
Southern Cross Dr
Mill Pond
Eastlakes Golf Course
Botany Industrial Area
Port Botany Freight Rail Project - Stage 4
Sector 3
McBurney Avenue to Bay Street
Y2001

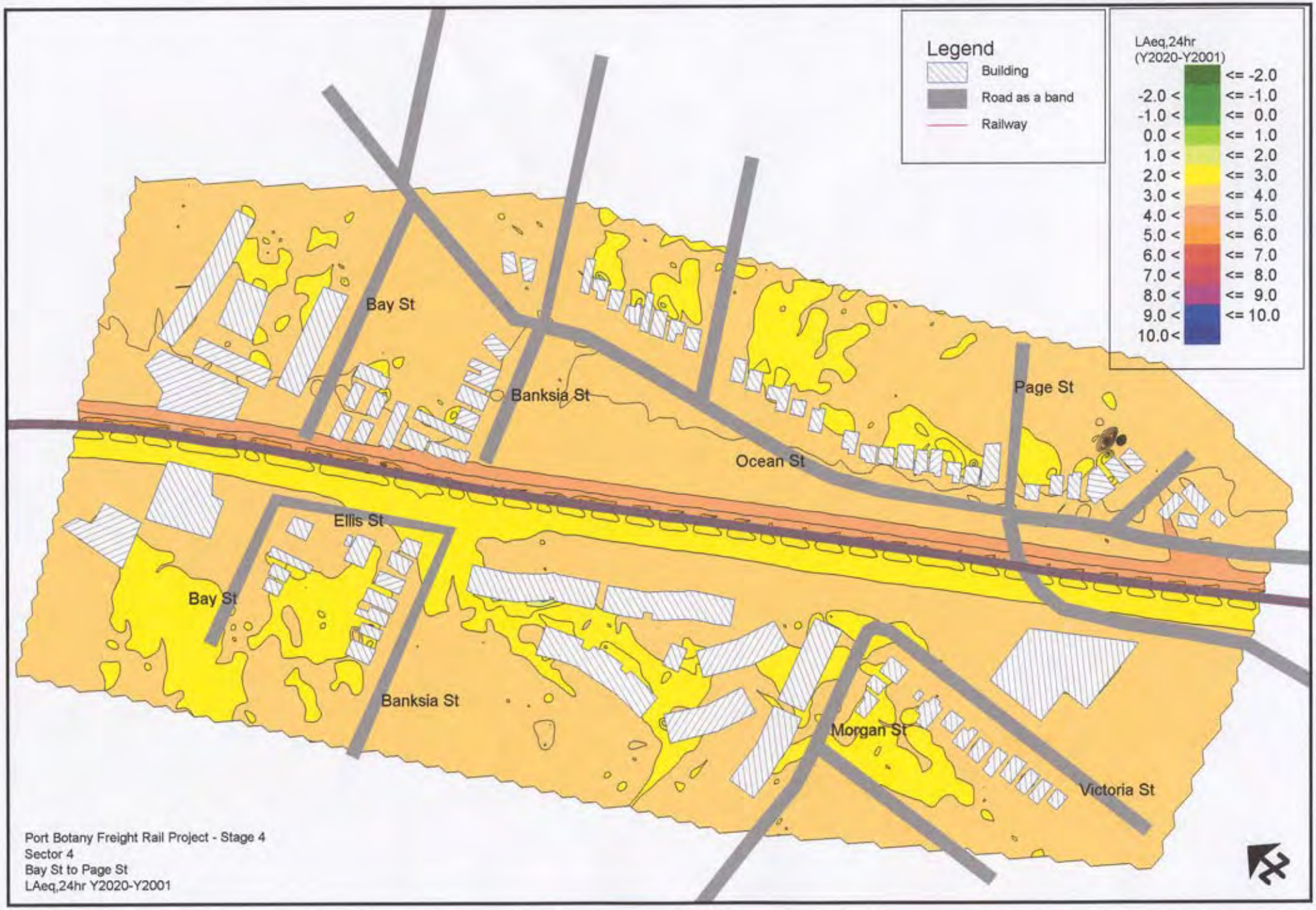

McBurney Ave
Southern Cross Dr
Legend
Building
Road as a band
Railway
Noise level
LAmax
in dB(A)
<= 70
70 < <= 75
75 < <= 80
80 < <= 85
85 < <= 90
90 < <= 95
95 < <= 100
100 < <= 105
105 < <= 110
110 <
Mill Pond
Eastlakes Golf Course
Botany Industrial Area
Port Botany Freight Rail Project - Stage 4
Sector 3
McBurney Avenue to Bay Street
Y2020


Legend
Building
Road as a band
Railway
Attended noise monitor
Unattended noise monitor
Noise level LAeq24hr
in dB(A)
<= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 < <= 75
75 <
Bay St
Banksia St
Ocean St
Page St
Ellis St
Bay St
Banksia St
Morgan St
Victoria St
Port Botany Freight Rail Project - Stage 4
Sector 4
Bay Street to Page Street
Y2001


Legend
Building
Road as a band
Railway
Noise level
LAeq24hr
in dB(A)
<= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 < <= 75
75 <
Bay St
Banksia St
Page St
Ocean St
Ellis St
Bay St
Banksia St
Morgan St
Victoria St
Port Botany Freight Rail Project - Stage 4
Sector 4
Bay Street to Page Street
Y2020

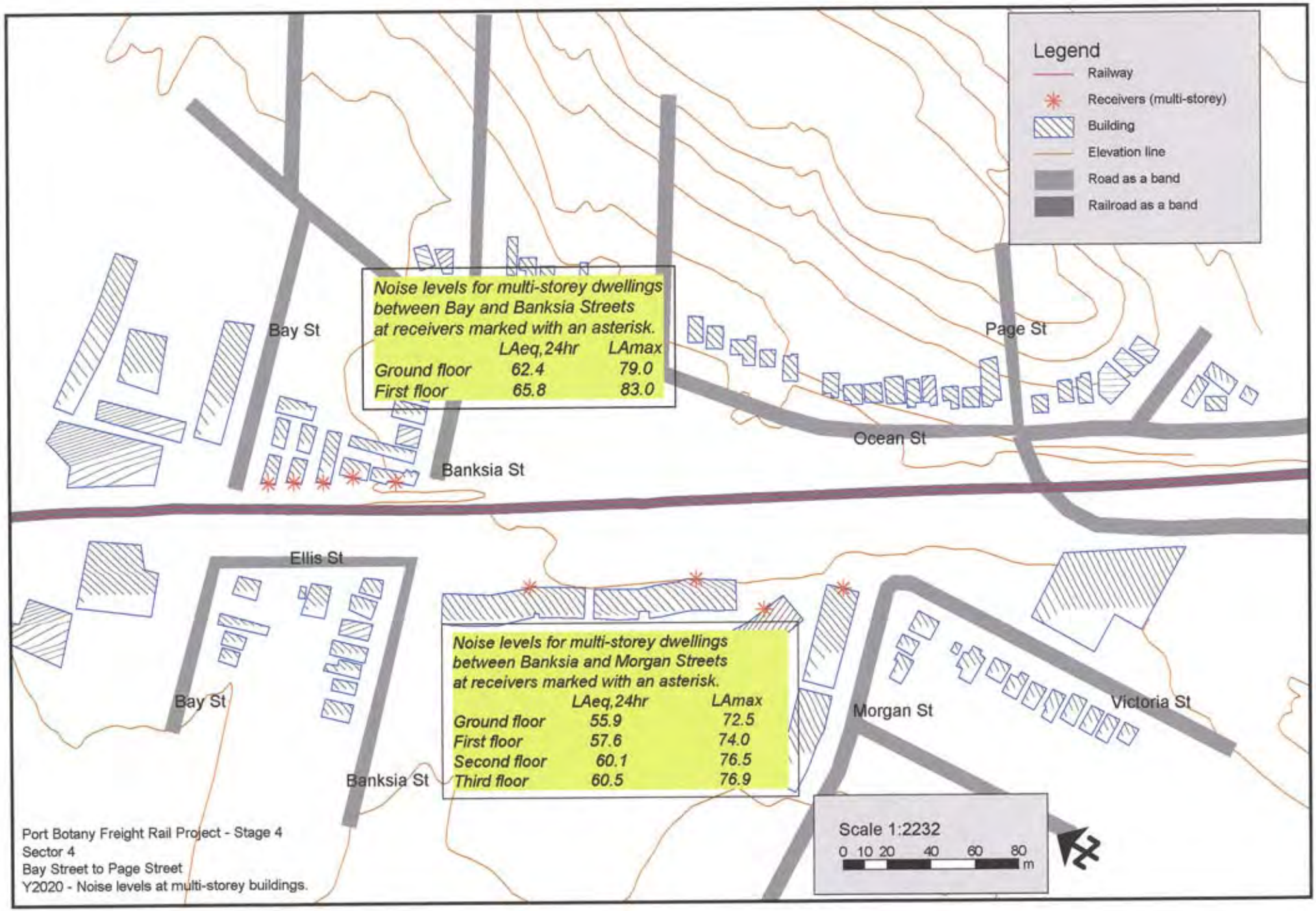

Legend
Building
Road as a band
Railway
Noise level
LAeq24hr
in dB(A)
<= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 < <= 75
75 <
Bay St
Banksia St
Page St
Ocean St
Ellis St
Bay St
Banksia St
Morgan St
Victoria St
Port Botany Freight Rail Project - Stage 4
Sector 4
Bay Street to Page Street
Y2020


Legend
Building
Road as a band
Railway
Noise level
LAeq24hr
in dB(A)
<= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 < <= 75
75 <
Bay St
Banksia St
Page St
Ocean St
Ellis St
Bay St
Banksia St
Morgan St
Victoria St
Port Botany Freight Rail Project - Stage 4
Sector 4
Bay Street to Page Street
Y2020


Legend
Building
Road as a band
Railway
LAeq,24hr
(Y2020-Y2001)
<= -2.0
-2.0 < <= -1.0
-1.0 < <= 0.0
0.0 < <= 1.0
1.0 < <= 2.0
2.0 < <= 3.0
3.0 < <= 4.0
4.0 < <= 5.0
5.0 < <= 6.0
6.0 < <= 7.0
7.0 < <= 8.0
8.0 < <= 9.0
9.0 < <= 10.0
10.0 <
Bay St
Banksia St
Page St
Ocean St
Ellis St
Bay St
Banksia St
Morgan St
Victoria St
Port Botany Freight Rail Project - Stage 4
Sector 4
Bay St to Page St
LAeq,24hr Y2020-Y2001


Legend
Building
Road as a band
Railway
Attended noise monitor
Unattended noise monitor
Noise level LAmax in dB(A)
<= 70
70 < <= 75
75 < <= 80
80 < <= 85
85 < <= 90
90 < <= 95
95 < <= 100
100 < <= 105
105 < <= 110
110 <
Bay St
Banksia St
Page St
Ocean St
Ellis St
Bay St
Banksia St
Morgan St
Victoria St
Port Botany Freight Rail Project - Stage 4
Sector 4
Bay Street to Page Street
Y2001


Legend
Building
Road as a band
Railway
Noise level
LAmax
in dB(A)
<= 70
70 < <= 75
75 < <= 80
80 < <= 85
85 < <= 90
90 < <= 95
95 < <= 100
100 < <= 105
105 < <= 110
110 <
Bay St
Banksia St
Page St
Ocean St
Ellis St
Bay St
Banksia St
Morgan St
Victoria St
Port Botany Freight Rail Project - Stage 4
Sector 4
Bay Street to Page Street
Y2020


Legend
Railway
Receivers (multi-storey)
Building
Elevation line
Road as a band
Railroad as a band
Noise levels for multi-storey dwellings between Bay and Banksia Streets at receivers marked with an asterisk.
LAeq,24hr LAmax
Ground floor 62.4 79.0
First floor 65.8 83.0
Noise levels for multi-storey dwellings between Banksia and Morgan Streets at receivers marked with an asterisk.
LAeq,24hr LAmax
Ground floor 55.9 72.5
First floor 57.6 74.0
Second floor 60.1 76.5
Third floor 60.5 76.9
Bay St
Banksia St
Ellis St
Page St
Ocean St
Morgan St
Victoria St
Scale 1:2232
0 10 20 40 60 80 m
Port Botany Freight Rail Project - Stage 4
Sector 4
Bay Street to Page Street
Y2020 - Noise levels at multi-storey buildings.

Appendix B

Unattended Noise Monitoring

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Baxter Road - October 8, 2001 59
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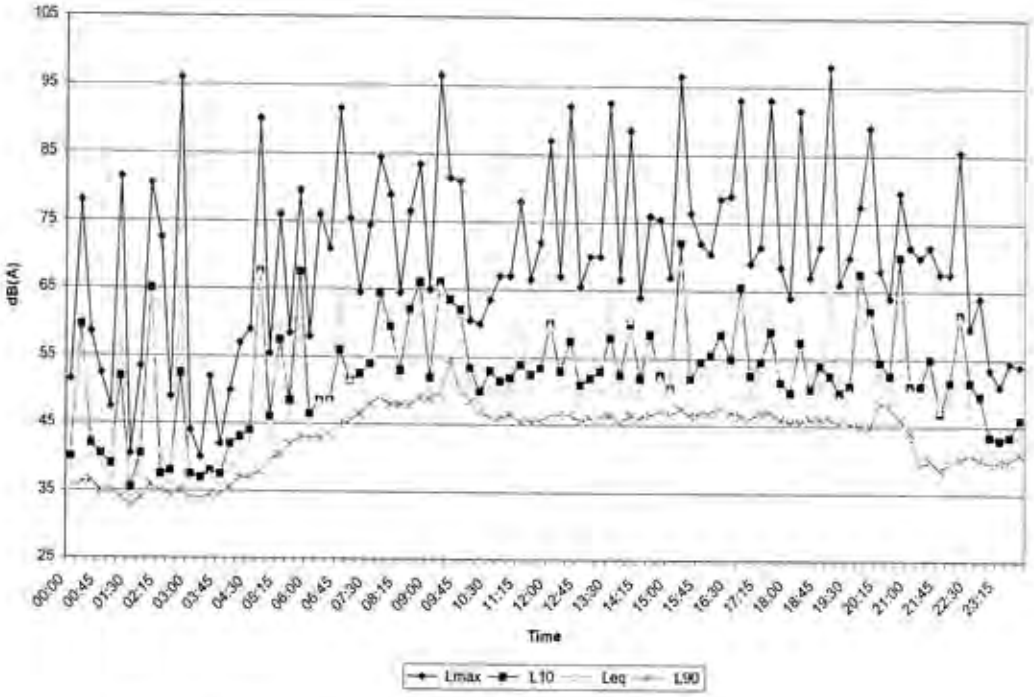
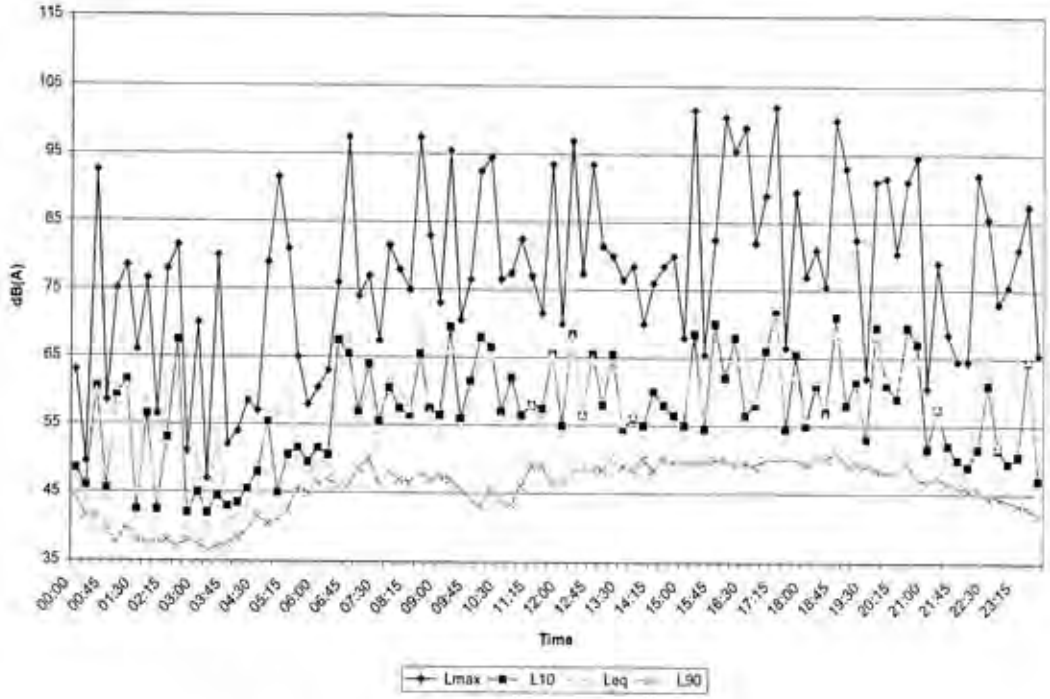
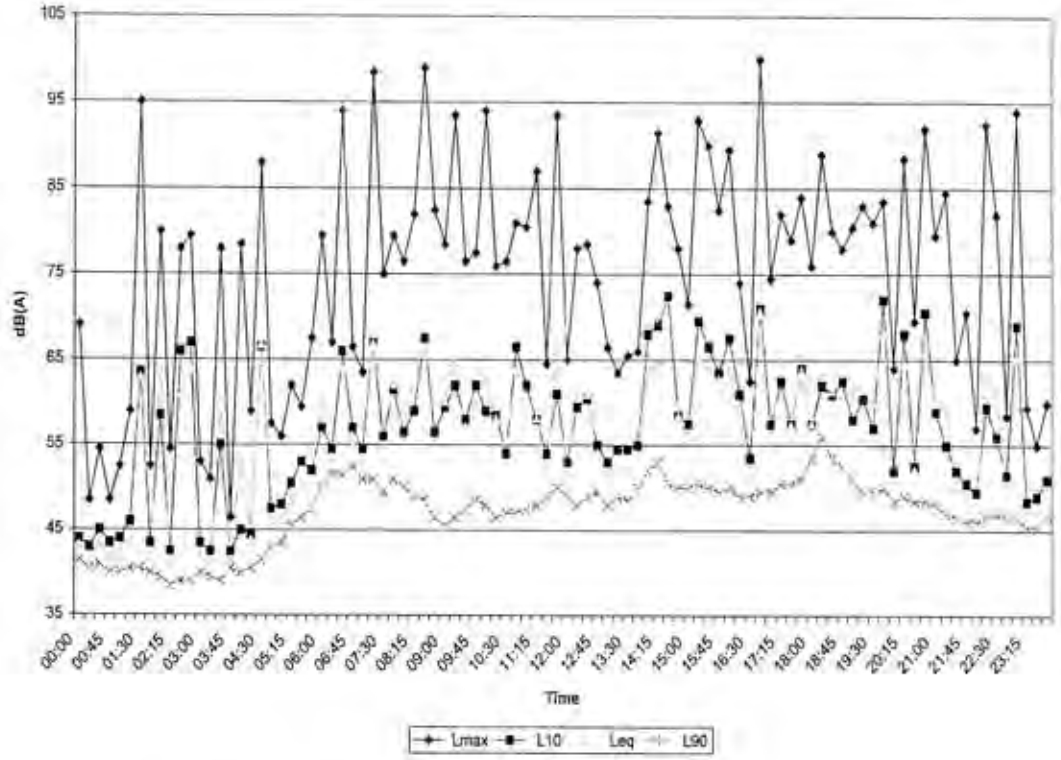


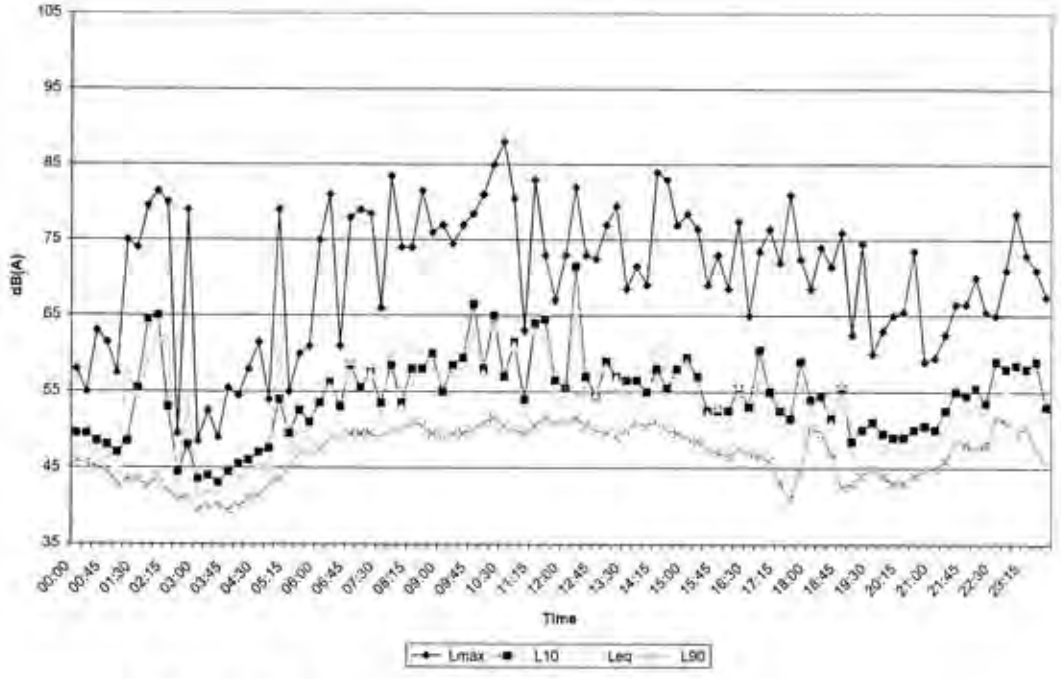
Banksia Street (south) - September 5, 2001



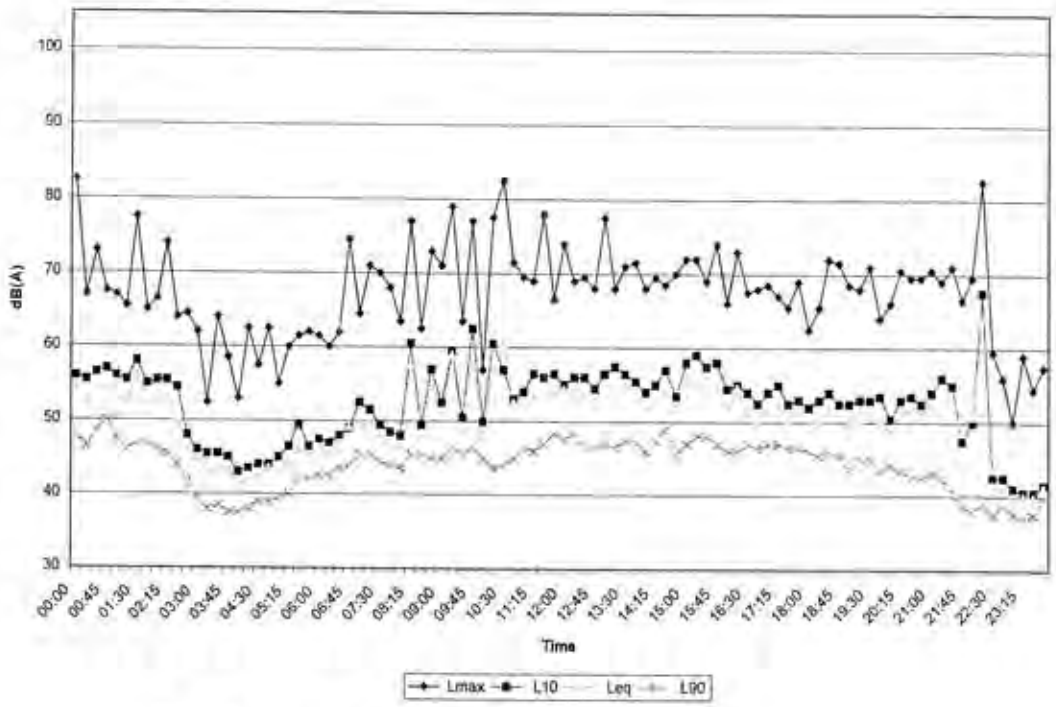
Banksia Street (south) - September 6, 2001



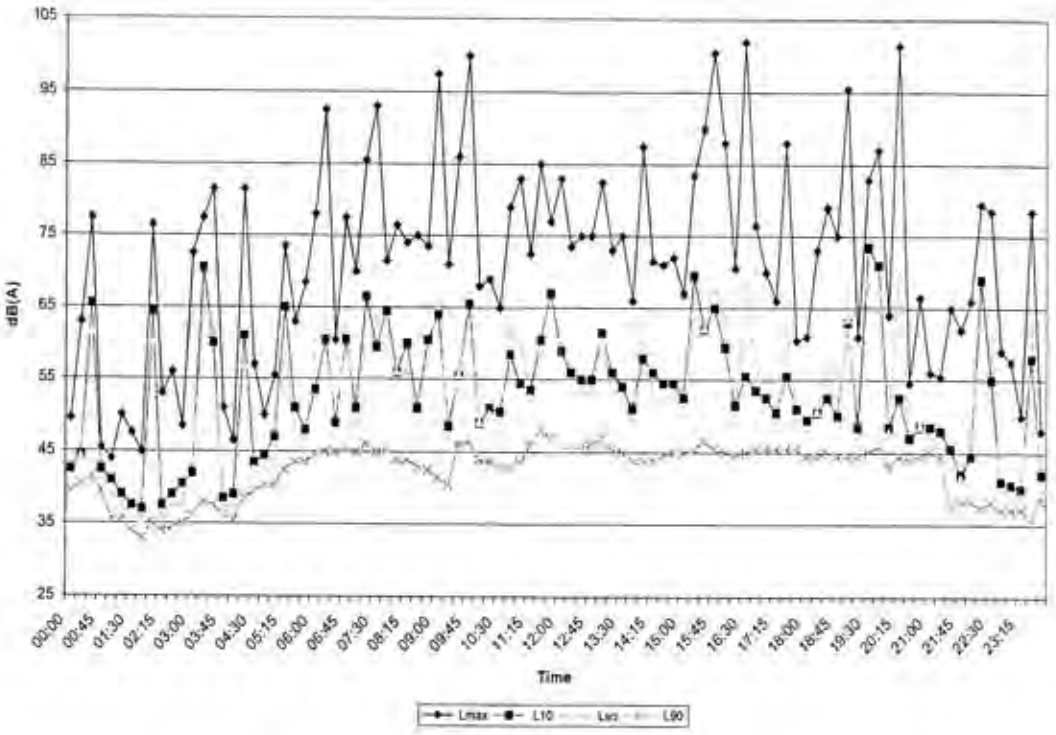
Banksia Street (south) - September 7, 2001



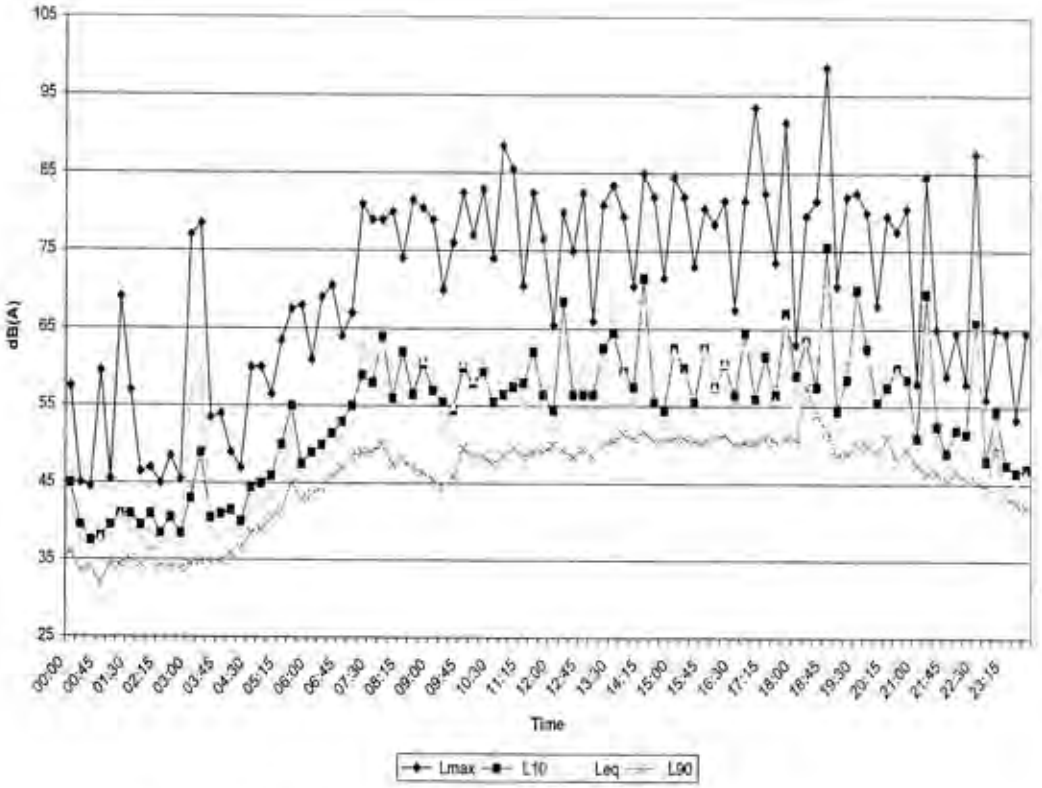
Banksia Street (south) - September 8, 2001



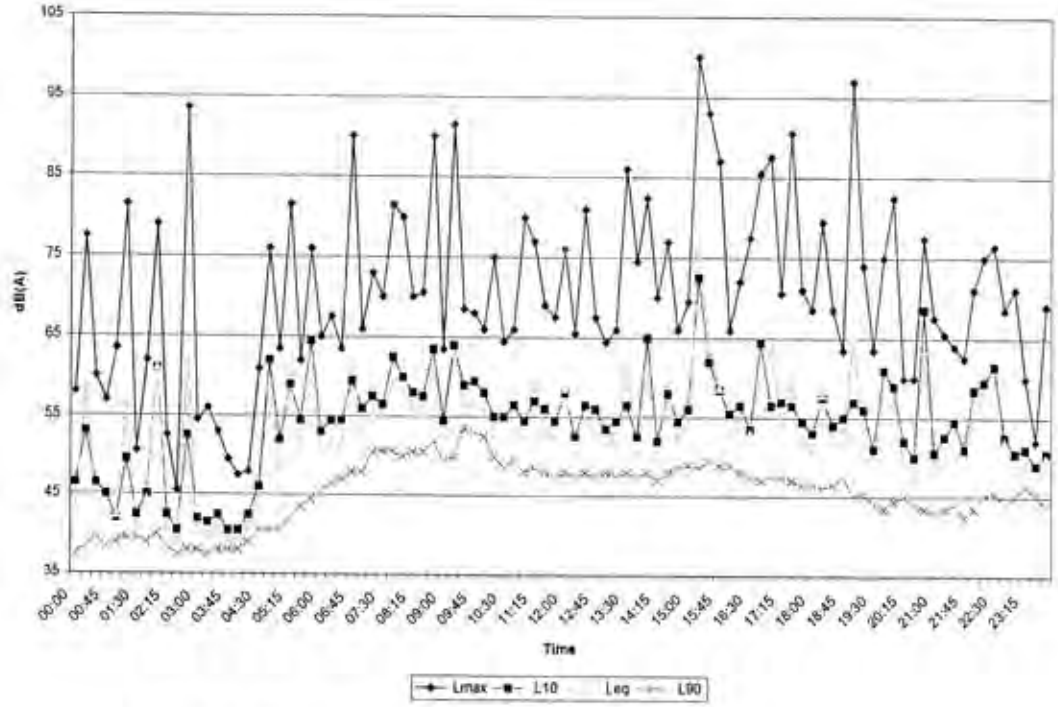
Banksia Street (south) - September 9, 2001



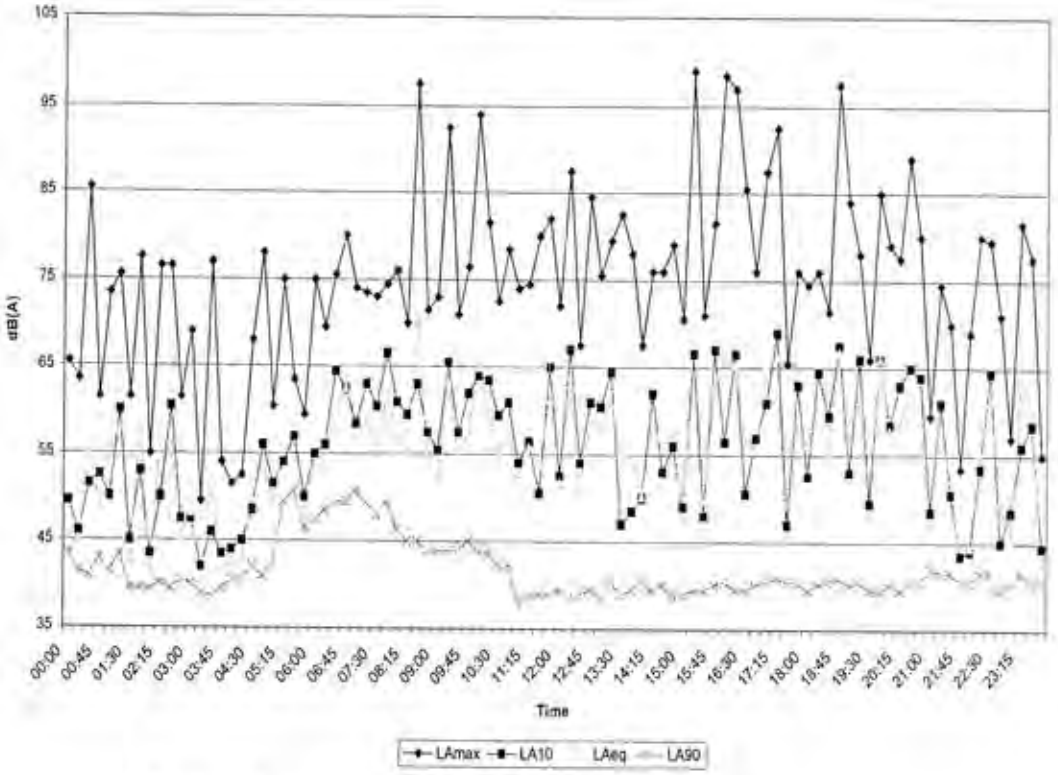
Banksia Street (south) - September 10, 2001



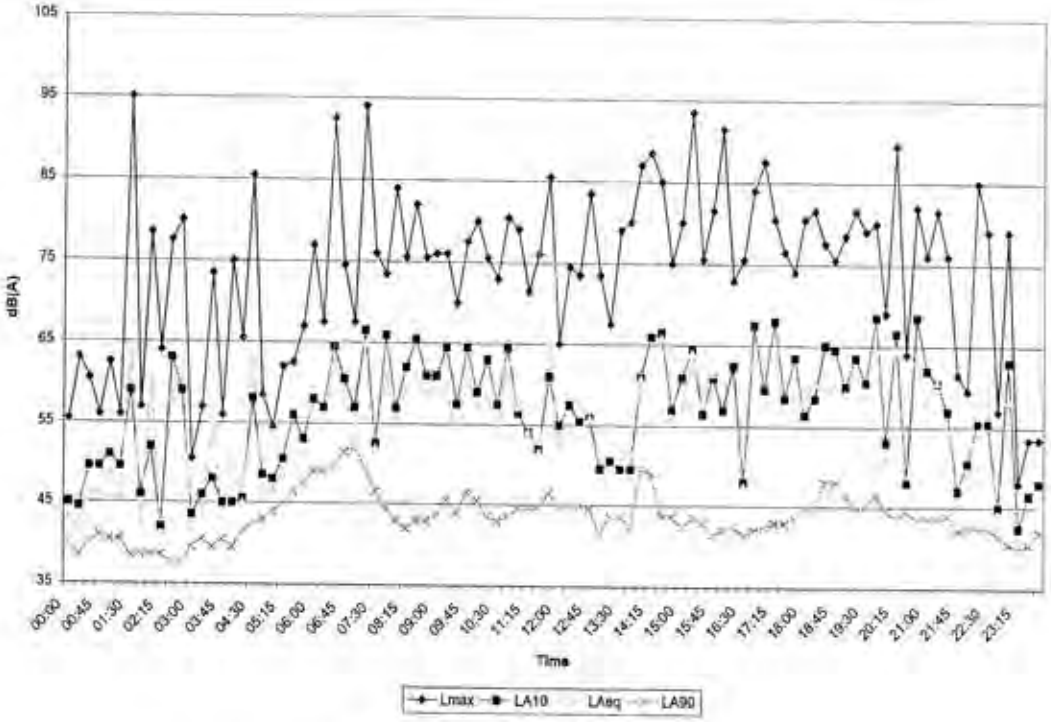
Banksia Street (south) - September 11, 2001



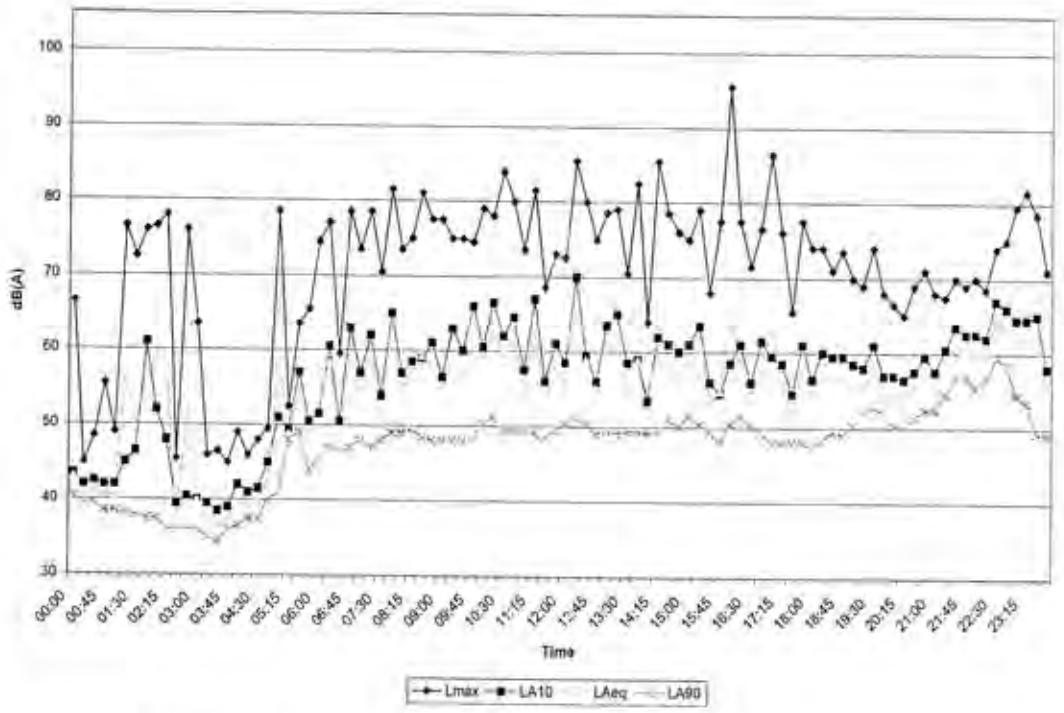
Banksia Street (north) - October 5, 2001



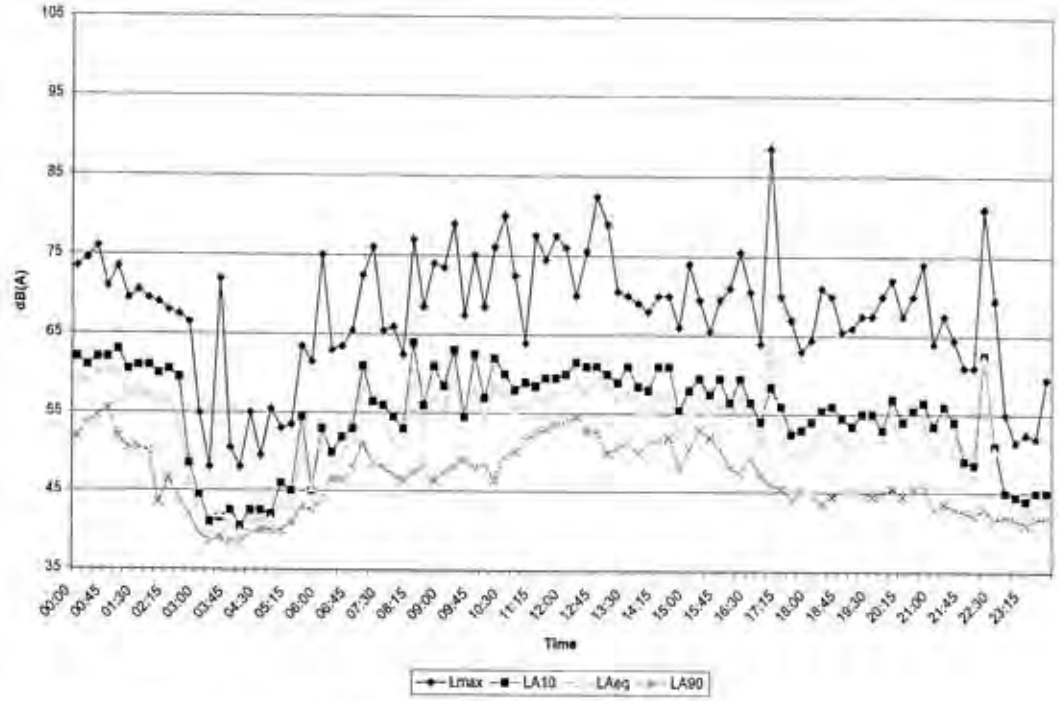
Banksia Street (north) - October 6, 2001



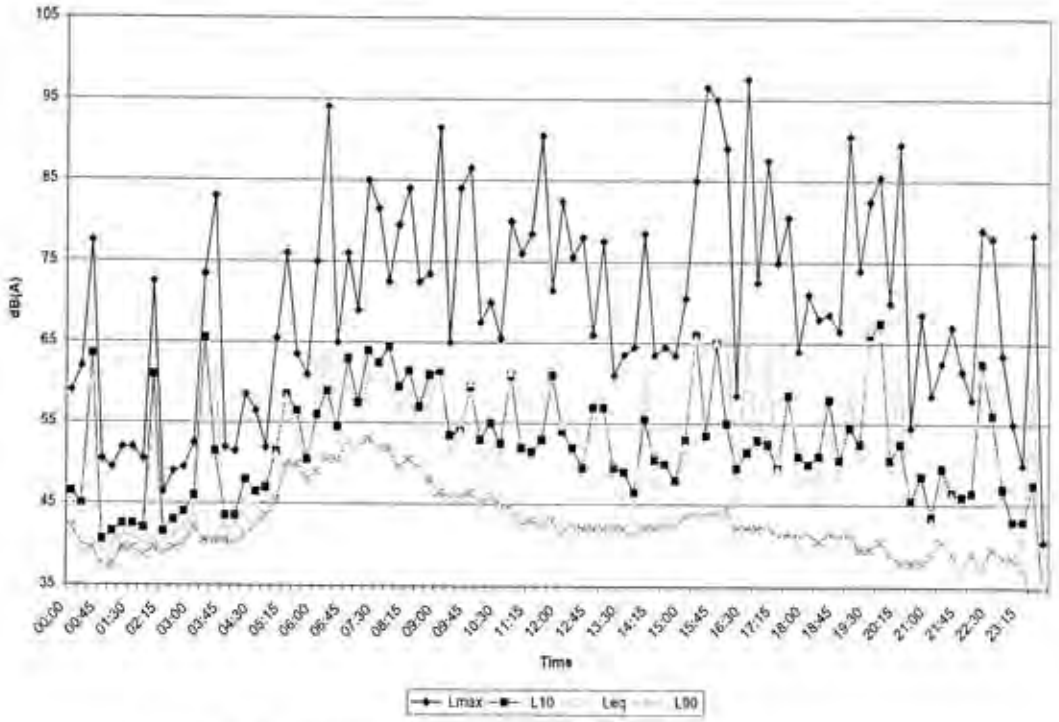
Banksia Street (north) - October 7, 2001



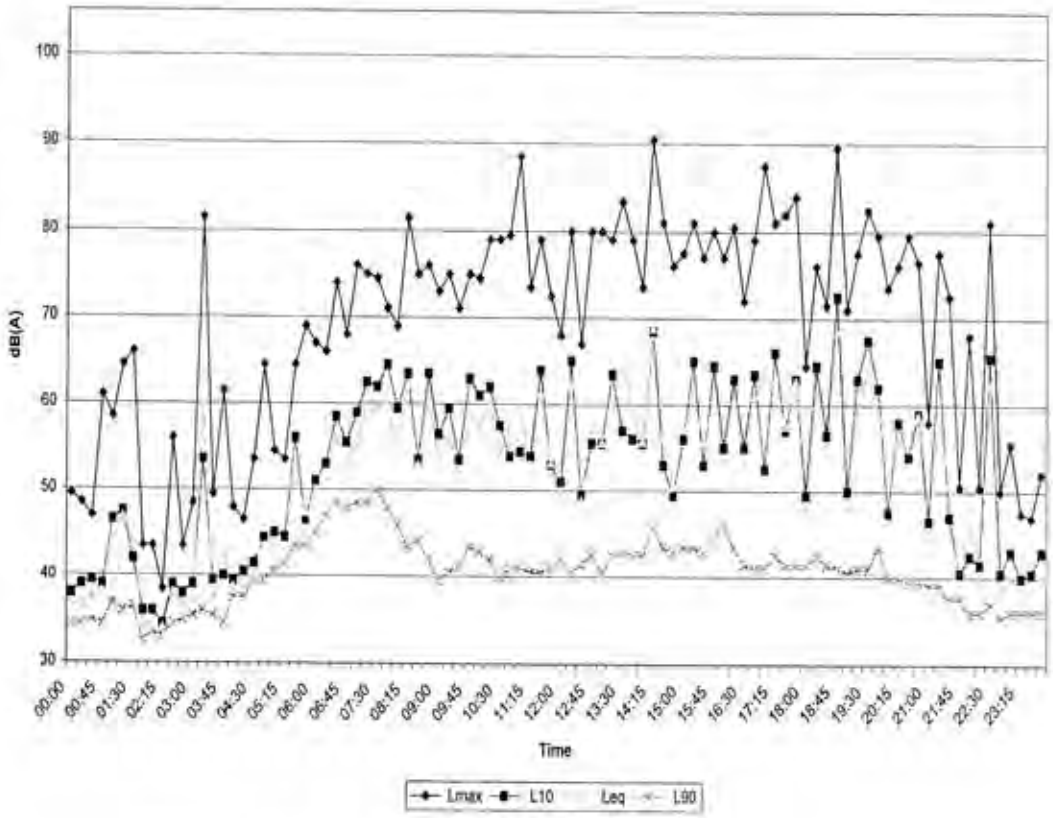
Banksia Street (north) - October 8, 2001



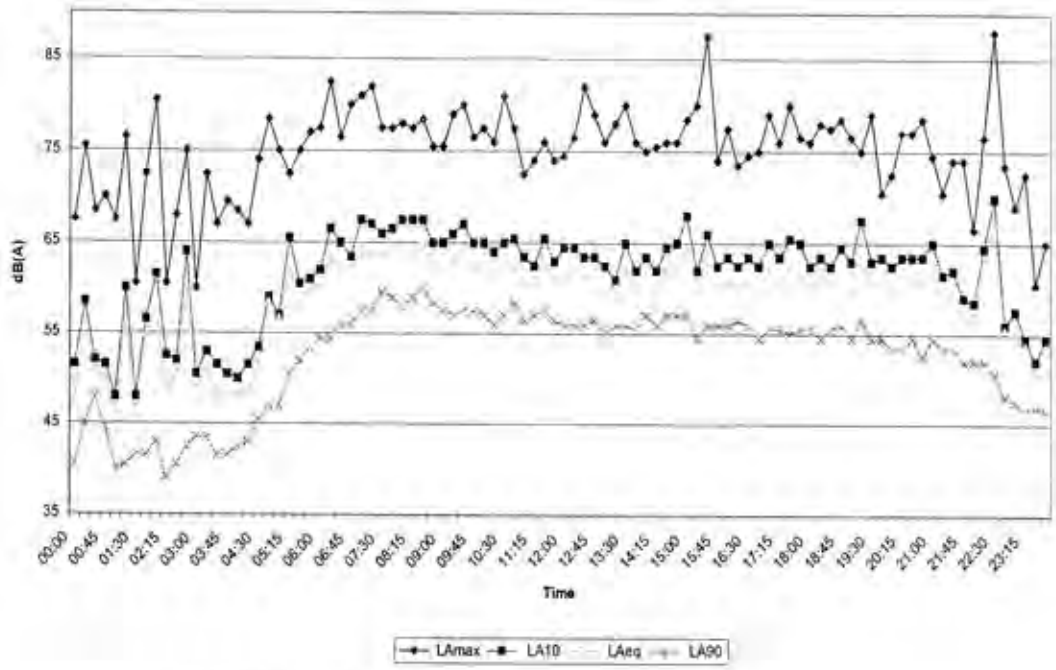
Banksia Street (north) - October 9, 2001



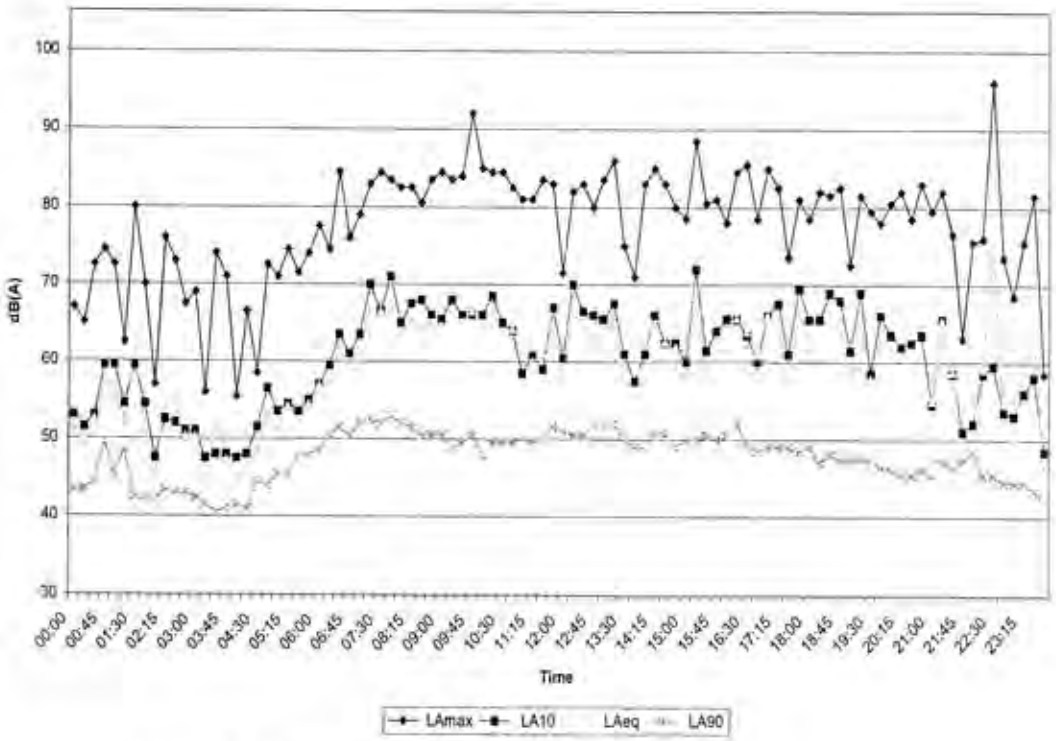
Banksia Street (north) - October 10, 2001



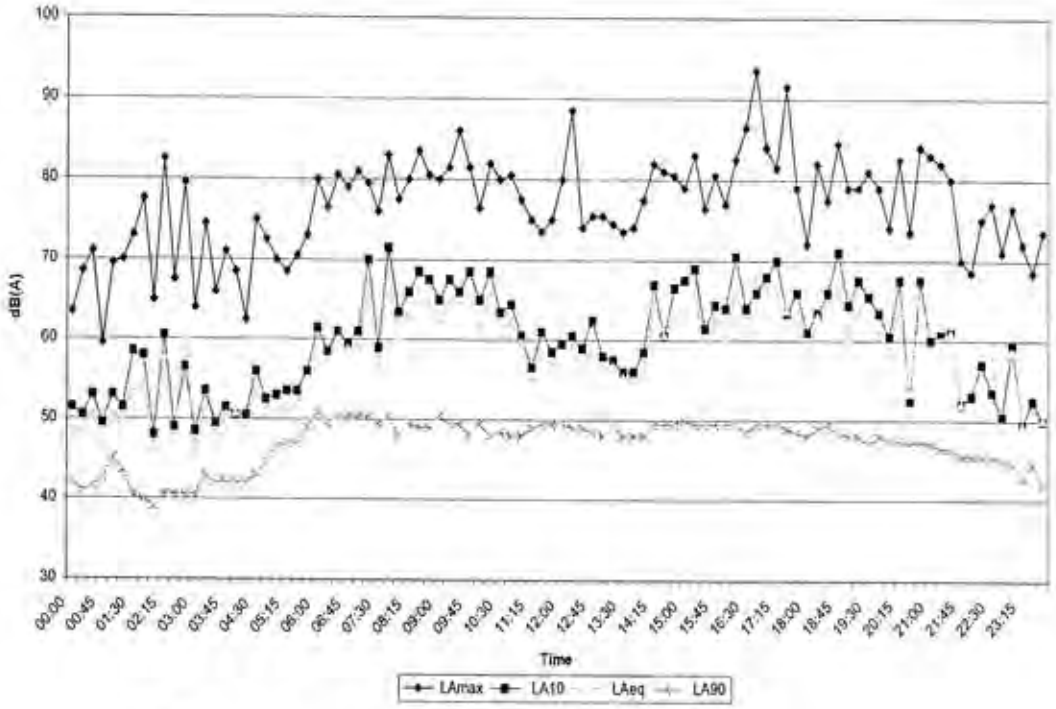
Banksia Street (north) - October 11, 2001



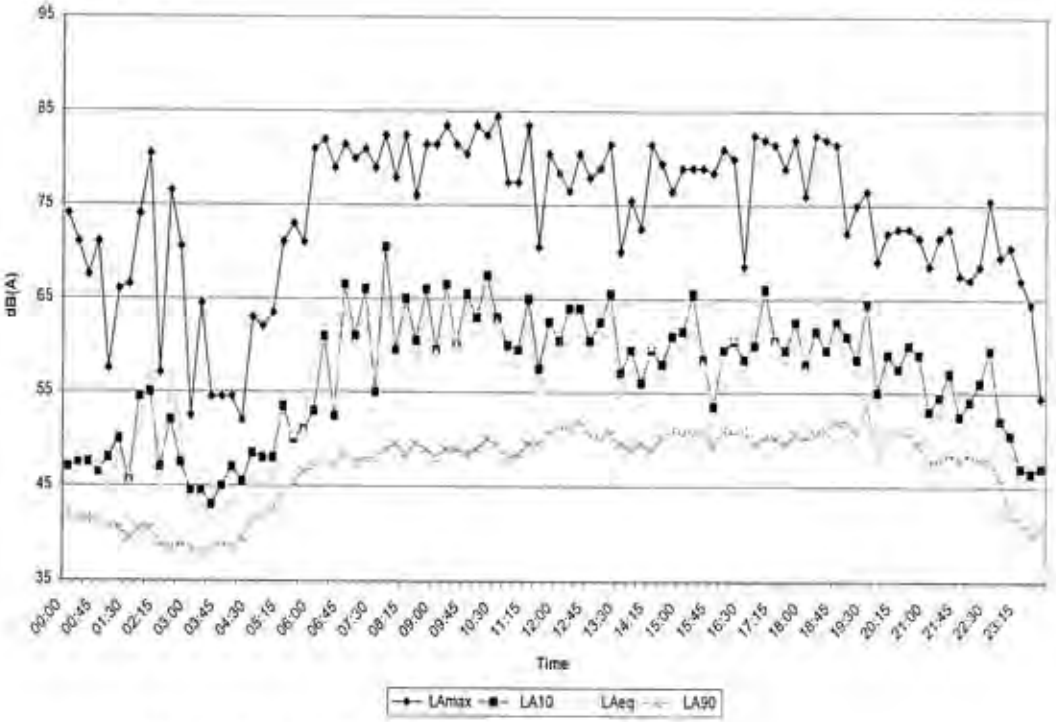
Baxter Road - October 5, 2001



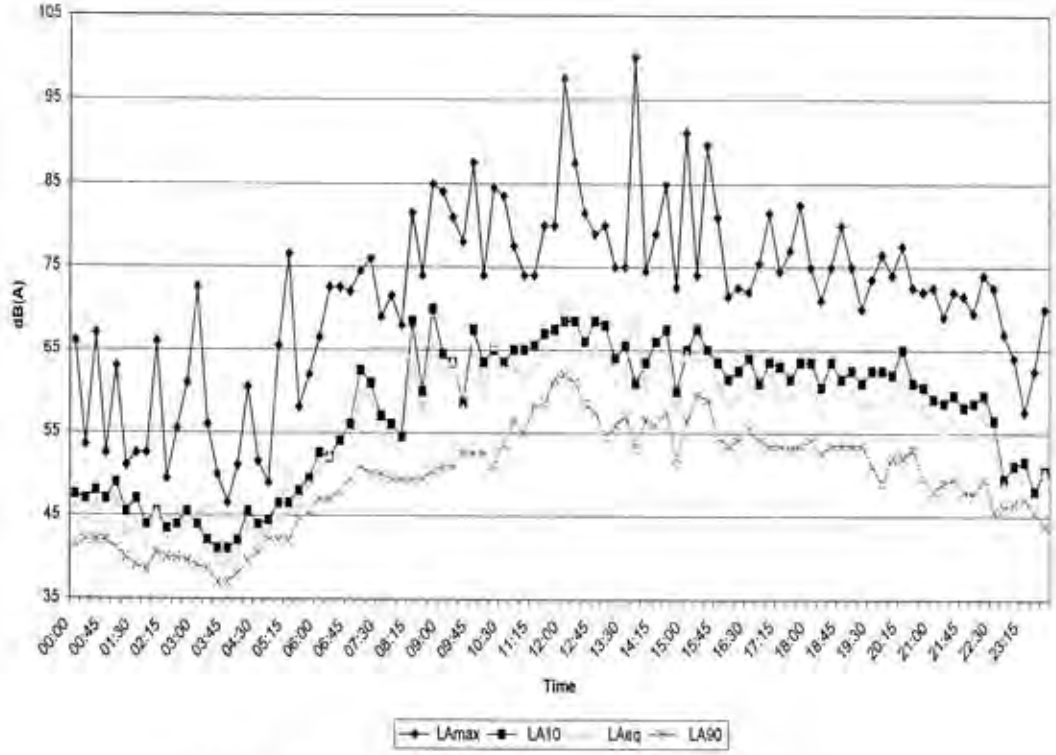
Baxter Road - October 6, 2001



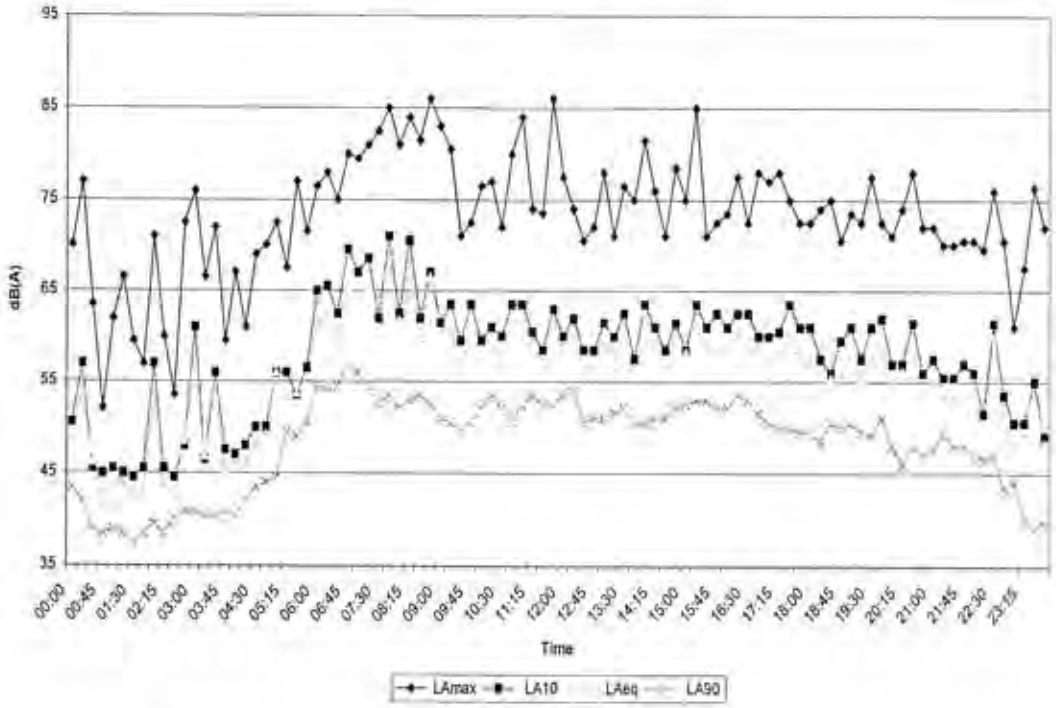
Baxter Road - October 7, 2001



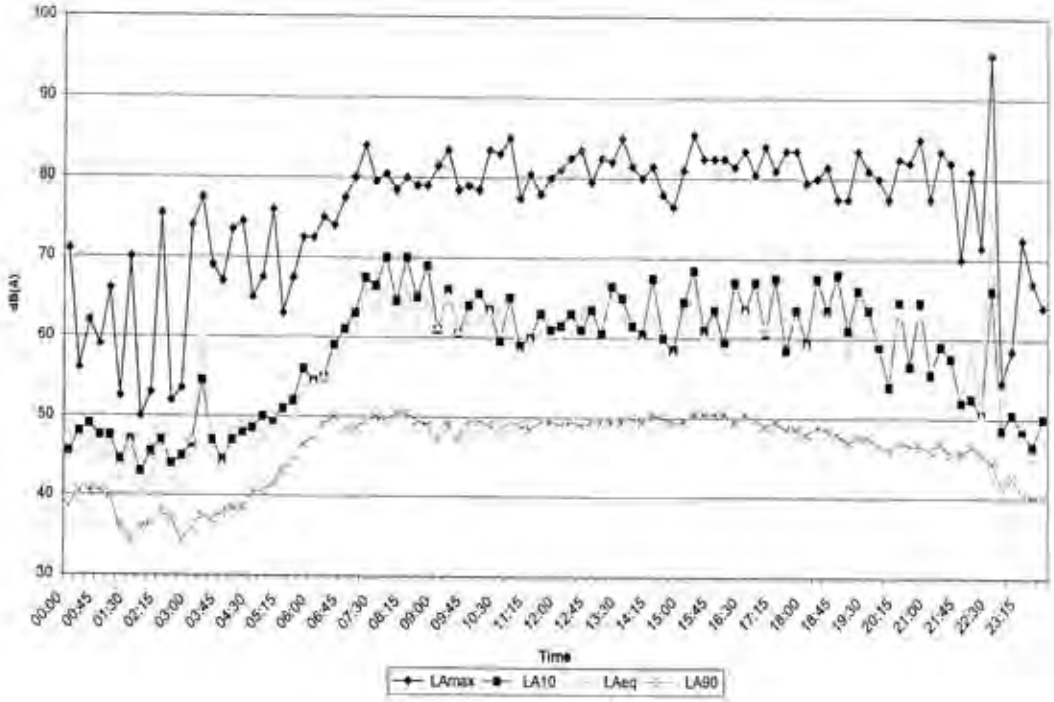
Baxter Road - October 8, 2001



Baxter Road - October 9, 2001



Baxter Road - October 10, 2001



Baxter Road - October 11, 2001

Appendix C

Attended Noise Monitoring

Attended Noise Monitoring Data

This appendix contains the data collected during the attended monitoring program. Included in the data collected during the passby of trains were:

- the site location
- start and finsihing time of the train passby
- Train destination (B Botany S Sydney)
- Locomotive markings
- Number of front and rear locomotives
- Train speed
- Noise events occuring during measurement
- LAmax and LAE

The following table includes the codes used to describe the noise events.

Key	
a	acceleration
ac	aircraft
b	bunching
b	brake noise
g	rail gap
h	horn
s	wheel squeal
ss	stop/start
t	traffic
w	wheel thump
wa	wagon

Site	Location	Distance (m)	Date	Start Time	Destinaton Sydney Botany	Loco Front Marking	# Front Loco	Loco Rear Marking	# Rear Loco	Wagon #	% Wagons w containers	km/h	Events (see key)					End Time	LAmax	LAE
3	Baxter Rd (west)	15	22/Oct	6:47:40	S	2	2		0	30	100	45	g					6:48:42	81.5	92.5
3	Baxter Rd (west)	15	22/Oct	7:15:03	B	PL4	1	PL1	1	18	0	35	g					7:15:41	79.2	88.9
3	Baxter Rd (west)	15	22/Oct	7:36:50	B	8239	1		0	27	100	40	s	br	b	h	a	7:39:15	99.8	102.6
3	Baxter Rd (west)	15	22/Oct	8:06:51	S	8040	1		0	20	0	35	s	br	b	h	ac	8:07:35	85.6	93.7
3	Baxter Rd (west)	15	22/Oct	8:38:01	S	PL5	1	PL6	1	17	0	20	g					8:38:51	79	89
4	Baxter Rd (east)	15	12/Oct	13:01:06	S	PL4	1	PL7	1	16	70	20	t	a				13:02:45	81.3	91.1
4	Baxter Rd (east)	15	12/Oct	13:27:57	B	8130	1		0	24	50	15	t	ac	s		g	13:29:56	83.5	92.9
4	Baxter Rd (east)	15	12/Oct	13:43:35	S	EL63	1		0	23	10	40	t				h	13:44:51	85	94.1
4	Baxter Rd (east)	15	12/Oct	14:16:19	S	8316/8201	2		0	7	100	30	ac	h			s	14:16:58	84.7	90.3
4	Baxter Rd (east)	15	12/Oct	14:48:00	B	PL2	1	PL1	1	17	90	15	t				ss	14:49:59	85.5	93.9
4	Baxter Rd (east)	15	12/Oct	15:22:11	B	8163	1		0	34	60	15	a	s	ac	t	t	15:25:25	82.4	94.4
4	Baxter Rd (east)	15	12/Oct	15:52:17	B	42209/4703/EL580	3		0	31	50	25	t	b	ac		w	15:54:43	83.3	94.6
4	Baxter Rd (east)	15	12/Oct	16:30:52	S	8130	1		0	0	0	15	ac	t				16:31:25	74.7	82.7
4	Baxter Rd (east)	15	12/Oct	16:53:25	S	8159	1		0	32	0	40	ac	t				16:54:36	87.9	96
4	Baxter Rd (east)	15	12/Oct	17:56:28	S	8163	1		0	0	0	20	t	ac				17:57:02	80	86.4
4	Baxter Rd (east)	15	12/Oct	18:19:21	S	PL1	1	PL2	1	17	0	25	t	ac				18:20:40	78.5	90.1
4	Baxter Rd (east)	15	12/Oct	19:10:32	S	GR	1		0	9	100	30	t	h				19:11:12	82.3	90.9
4	Baxter Rd (east)	15	12/Oct	19:30:38	B	EL63	1		0	28	95	30	ac	s	t			19:33:07	81.1	91.5
4	Baxter Rd (east)	15	12/Oct	21:10:08	B	44255	1		0	23	100	40	b	ac	t			21:12:50	81.4	91.7
4	Baxter Rd (east)	15	12/Oct	21:42:00	S	42209	1		0	45	60	40	h	t				21:43:43	89.2	100.1
4	Baxter Rd (east)	15	12/Oct	22:38:54	S	8168	1		0	48	10	30	t	h				22:41:17	88.8	97
4	Baxter Rd (east)	15	13/Oct	0:08:09	B	8017	1		0	27	100	40	h					0:10:28	85.5	90.4
4	Baxter Rd (east)	15	13/Oct	0:33:59	S		2		0	24	10	40	h					0:35:30	90	97.6
4	Baxter Rd (east)	15	13/Oct	0:57:18	S	8039	1		0	27	15	40	s					0:59:02	93.6	94.2
4	Baxter Rd (east)	15	13/Oct	1:48:12	B		2		0	18	95	40	h					1:50:37	82.8	91.5
4	Baxter Rd (east)	15	13/Oct	2:11:23	B	8039	1		0	0	0	35	h					2:11:40	78.1	81.1
4	Baxter Rd (east)	15	13/Oct	3:51:36	S	Silverton	2		0	21	80	30	s					3:53:34	80.9	90.9
4	Baxter Rd (east)	15	13/Oct	5:16:19	S	NR16/NR7	2		0	19	60	30	h	s				5:17:43	90	93.8
4	Baxter Rd (east)	15	13/Oct	5:50:22	S	8017	1		0	16	0	30	t					5:51:26	81.6	92.4
4	Baxter Rd (east)	15	13/Oct	7:22:49	B	8211	1		0	38	95	20	b	h				7:27:00	75.2	88.8
4	Baxter Rd (east)	15	13/Oct	7:57:03	B	8007	1		0	13	75	15	t	b	h	br		7:59:26	78.9	86.8
4	Baxter Rd (east)	15	13/Oct	8:48:44	B	8149/4239/48115	3		0	28	95	25	h	ac	t			8:51:08	78.2	89.8
4	Baxter Rd (east)	15	13/Oct	9:15:24	S	8007	1		0	0	0	20						9:16:00	82.2	87.4

Site	Location	Distance (m)	Date	Start Time	Destinaton Sydney Botany	Loco Front Marking	# Front Loco	Loco Rear Marking	# Rear Loco	Wagon #	% Wagons w containers	km/h	Events (see key)				End Time	LAmax	LAE
4	Baxter Rd (east)	15	13/Oct	9:38:19	S	4815/8329/8419	3		0	0	0	20	t				9:38:48	85	89.4
4	Baxter Rd (east)	15	13/Oct	12:28:00	S	8211	2		0	28	0	20					12:29:40	74.5	84.8
6	McBurney Ave	15	21/Feb	6:37:00	B		1		0	41	100	30	s	g			6:40:20	88.1	93.6
6	McBurney Ave	15	21/Feb	7:08:16	B		3		0	32	100	32	w				7:10:20	85.6	92.8
6	McBurney Ave	15	21/Feb	7:55:06	B		1		0	30	100	30	ac				7:57:02	84.4	95.2
6	McBurney Ave	15	21/Feb	8:19:41	B		2		0	0	0	30	ac				8:19:57	78.9	82.5
6	McBurney Ave	15	21/Feb	8:29:57	S		3		0	0	0	30					8:30:11	70.7	79.8
6	McBurney Ave	15	21/Feb	9:11:17	S		1		1	18	0	34	w				9:12:16	80.2	91.7
6	McBurney Ave	15	21/Feb	9:37:38	S		1		1	18	95	30	h				9:39:59	72.4	86.4
6	McBurney Ave	15	21/Feb	10:05:19	B		1		0	17	100	32					10:06:16	85.2	93.6
6	McBurney Ave	15	21/Feb	10:31:53	B		2		0	25	98	37	w				10:37:22	89.1	101.3
8	Bay St (north)	15	18/Oct	18:44:02	S	1	1		0	22	0	25	g				18:46:00	77.8	90
8	Bay St (north)	15	18/Oct	19:04:48	S	1	1		0	39	0	30	w	t			19:06:25	77.3	91.1
8	Bay St (north)	15	18/Oct	19:45:39	B	2265	2		0	27	100	20	t				19:47:22	81.8	89.1
8	Bay St (north)	15	18/Oct	20:54:11	S	EL58	1		0	17	0	25	t				20:55:00	81.3	89.8
8	Bay St (north)	15	18/Oct	21:15:00	S	4458/22/4471	3		0	15	90	35	t	w			21:16:10	76	87.6
8	Bay St (north)	15	18/Oct	21:51:25	B	2 x 4425	2		0	22	80	20	t	h			21:53:39	84.1	87.9
8	Bay St (north)	15	18/Oct	22:06:57	S	8015	1		0	13	40	20	t				22:07:44	76	86.6
8	Bay St (north)	15	18/Oct	22:48:53	S	2	2		0	15	50	35	t				22:50:12	79.8	89.6
8	Bay St (north)	15	19/Oct	1:31:30	B	NR22/NR12	2		0	31	70	20					1:34:26	75.8	88.8
8	Bay St (north)	15	19/Oct	1:55:40	B	8033	1		0	27	95	40	wa				1:57:19	77.9	90.7
8	Bay St (north)	15	19/Oct	2:18:36	B	8015	1		0	23	97	35	b				2:20:06	81.6	86.7
8	Bay St (north)	15	19/Oct	2:42:35	B	PL2	1	PL1	1	17	0	25					2:44:18	74	86.6
8	Bay St (north)	15	19/Oct	3:32:48	S	44255/44252	2		0	21	100	35					3:34:49	80.9	90.6
8	Bay St (north)	15	19/Oct	4:40:15	B	PL6	1	PL5	1	17	55	20	h				4:42:03	80.5	89.3
8	Bay St (north)	15	19/Oct	5:06:06	B	8218	1		0	40	95	30	s	h			5:08:09	80.7	88.9
8	Bay St (north)	15	19/Oct	5:50:20	B	PL3/PL4	2		0	17	20	20	s	h			5:51:54	79.6	91.4
8	Bay St (north)	15	19/Oct	7:44:36	B	8232/8209	2		0	46	90	20	t	h	ac		7:47:57	80	87.7
8	Bay St (north)	15	19/Oct	8:11:43	S	PL5	1	PL6	1	19	0	20	h	s			8:12:39	81.7	88.3
8	Bay St (north)	15	19/Oct	9:35:01	B	8152	1		0	35	80	20					9:37:04	88.5	92.8
8	Bay St (north)	15	19/Oct	10:11:36	B	1873/EL60	2		0	18	70	20	t	s	h	ss	10:16:18	85	90.4
8	Bay St (north)	15	19/Oct	10:21:07	S	NR22/NR12	2		0	33	60	40	t	h	w		10:22:32	95.4	94.3
8	Bay St (north)	15	19/Oct	10:43:01	S	8152/8209	2		0	21	0	40	t	h			10:44:19	93.2	94.1
8	Bay St (north)	15	19/Oct	11:14:01	S	PL4	1	PL3	1	19	40	40	t	h	s		11:14:51	87.8	93.9
8	Bay St (north)	15	4/Oct	12:13:23	B	PL2	1	PL3	1	19	100	15	h	ac			12:14:45	78.1	88
8	Bay St (north)	15	4/Oct	12:52:26	S	873/EL63	2		0	23	20	25	s	t			12:54:00	80.6	90.7
8	Bay St (north)	15	4/Oct	13:40:14	B	PL7	1	PL6	1	17	80	20	t				13:43:51	88.5	92.8
8	Bay St (north)	15	4/Oct	14:01:08	S	8216	1		0	30	95	25	h	b			14:02:15	81.6	88.2
8	Bay St (north)	15	4/Oct	15:10:41	B	4209/EL58D/4717/4210	4		0	33	80	20	h	b			15:17:19	80.1	93.5

Site	Location	Distance (m)	Date	Start Time	Destination Sydney Botany	Loco Front Marking	# Front Loco	Loco Rear Marking	# Rear Loco	Wagon #	% Wagons w containers	km/h	Events (see key)		End Time	LAmax	LAE
8	Bay St (north)	15	4/Oct	15:39:40	B	447	1		0	11	70	18	h	s	15:40:43	75.4	84.2
8	Bay St (north)	15	4/Oct	15:48:40	S	PL3/PL4	2	PL2	1	16	99	20	h	b	15:49:55	79.6	89.3
8	Bay St (north)	15	4/Oct	16:30:27	B	8213	1		0	13	80	20	h	s	16:31:16	99.8	95.5
8	Bay St (north)	15	4/Oct	16:54:06	S	8040	1		0	16	0	25	h	s	16:55:25	80.5	89.3
9	Banksia St (south)	15	8/Oct	12:02:29	S	EL58	1	PL1	1	17	100	25	t	s	12:03:45	92.3	92.5
9	Banksia St (south)	15	8/Oct	13:49:09	S	4716/4703	2		0	21	90	25	h		13:50:30	92.9	92.2
9	Banksia St (south)	15	8/Oct	14:15:49	S	8164	1		0	16	50	25	h		14:16:58	97.7	94.2
9	Banksia St (south)	15	8/Oct	15:07:38	B	4471/EL58/4220	3		0	30	60	25	h		15:10:05	82.8	93.5
9	Banksia St (south)	15	8/Oct	15:11:42	S	8175	1		0	24	60	25	ss	h	15:15:02	98.6	96.8
9	Banksia St (south)	15	8/Oct	15:24:55	S	EL58/4220/4471	3		0	0	0	15	sh		15:26:14	93.8	95.3
9	Banksia St (south)	15	8/Oct	15:47:05	B	22/4458	2		0	12	60	25	w	h	15:48:37	92.9	92.3
9	Banksia St (south)	15	8/Oct	16:10:37	B	8047	1		0	0	0	30	h	s	15:12:25	84.1	85.4
9	Banksia St (south)	15	8/Oct	17:24:59	S	8047	1		0	0	0	25	ss		17:25:51	71.4	78.8
9	Banksia St (south)	15	8/Oct	17:42:30	B	PL1	1	PL2	1	18	100	25	h		17:44:56	82.9	91.4
9	Banksia St (south)	15	8/Oct	17:45:50	S	8047	1		0	39	10	30	s		17:48:40	88.2	98.1
9	Banksia St (south)	15	8/Oct		B	EL63	2		0	25	90				20:08:40	87.9	95.2
9	Banksia St (south)	15	8/Oct	20:32:35	B	44251	1		0	21	80	25			20:35:45	89	93.1
9	Banksia St (south)	15	8/Oct	20:42:29	S	8021	1		0	28	0	30	ss		20:44:04	88.2	96.9
9	Banksia St (south)	15	8/Oct	21:34:42	S	42200	1		0	0	0	20	ss		21:34:50	61.9	71.6
9	Banksia St (south)	15	8/Oct	21:36:52	S	42200	1		0	6	50	20	h	ss	21:37:30	95.3	94.1
9	Banksia St (south)	15	8/Oct	22:00:21	S	4	4		0	35	0	40			22:01:59	91.7	98.9
9	Banksia St (south)	15	8/Oct	23:15:15	S	PL2	1	PL1	1	17	0	25			23:16:32	97	94
9	Banksia St (south)	15	8/Oct	23:42:17	S	8039	1		0	21	10	20			23:43:13	79.1	91.1
9	Banksia St (south)	15	9/Oct	0:02:44	S	1873	1		0	28	95	50			0:03:54	91.6	99.1
9	Banksia St (south)	15	9/Oct	1:46:25	B	NR18	1		0	31	60	25			1:49:08	83.1	90.1
9	Banksia St (south)	15	9/Oct	3:46:22	B	8039	1		0	20	70	40			3:48:20		
9	Banksia St (south)	15	9/Oct	4:00:53	S	44252	1		0	21	98	45	s		4:03:15	83.6	94.5
9	Banksia St (south)	15	9/Oct	4:48:45	B	PL1	1	PL2	1	17	90	30	a		4:50:55	87	94.5
9	Banksia St (south)	15	9/Oct	5:14:32	B	PL4	1	PL7	1	17	0	40	a		5:15:50	82.8	91.5
9	Banksia St (south)	15	9/Oct	5:58:11	B	8207	1		0	34	75	40			6:00:05	84.3	94.9
9	Banksia St (south)	15	9/Oct	6:19:16	S	NR18	1		0	32	40	20	h		6:22:01	78.4	88.2
9	Banksia St (south)	15	9/Oct	7:43:52	B	8211/48155	2		0	35	100	20	h		7:45:39	86.7	95.4
9	Banksia St (south)	15	9/Oct	8:18:08	B	8174	1		0	37	80	20	h		8:21:31	93	94.3
9	Banksia St (south)	15	9/Oct	8:28:21	S	PL2	1	PL1	1	18	0	20	h	s	8:29:46	73.7	87.5
9	Banksia St (south)	15	9/Oct	9:06:34	B	8175	1	8170	1	2	0	20	t	h	9:07:06	77.6	86.5
9	Banksia St (south)	15	9/Oct	9:40:56	S	PL7	1	PL4	1	19	100	30	h	s	9:42:42	77.9	87.4
9	Banksia St (south)	15	9/Oct	10:40:30	S	8039	1		0	1	0	30	sh		10:41:22	77.8	83
9	Banksia St (south)	15	9/Oct	10:51:49	B	4458/4816	2		0	23	100	40	t	h	10:53:21	82.5	91.6
9	Banksia St (south)	15	9/Oct	11:13:19	S	8170/8175	2		0	12	100	30	h	g	11:14:12	79.1	88.5

Site	Location	Distance (m)	Date	Start Time	Destinaton Sydney Botany	Loco Front Marking	# Front Loco	Loco Rear Marking	# Rear Loco	Wagon #	% Wagons w containers	km/h	Events (see key)				End Time	LAmax	LAE
9a	Banksia St (north)	15	25/Sep		S	8236/8256	2		0	28	0	40	ac				10:54:15	74.4	87.1
9a	Banksia St (north)	15	25/Sep		S	PL7/PL5	2		0	17	100	40	a				11:13:35	77.1	89.2
9a	Banksia St (north)	15	25/Sep		S	8017	1		0	28	90	40					12:20:00	80.2	91.2
9a	Banksia St (north)	15	25/Sep	13:00:16	S	PL3/PL2	2		0	0	0	20	b	h			13:01:22	77.5	88.5
9a	Banksia St (north)	15	25/Sep		S	1873/4814	2		0	0	0	25					13:05:10	81.5	91.5
9a	Banksia St (north)	15	25/Sep	14:29:42	B	8165	1		0	17	100	20	b					72.9	83.9
9a	Banksia St (north)	15	25/Sep	14:49:19	B	42209	1		0	19	100	20	ss				14:51:01	87.8	90.8
9a	Banksia St (north)	15	25/Sep	14:56:52	S	8101	1		0	0	0	25						73	80.5
10	Ocean St (north)	40	3/Oct	12:28:30	B	8230	1		0	10	90	40	h	g			12:29:30	72.5	85
10	Ocean St (north)	40	3/Oct	13:15:37	S	PL5/PL1	2		0	17	80	30	g				13:16:54	71.4	94.2
10	Ocean St (north)	40	3/Oct	13:40:30	S	8017	1		0	32	100	30	h	g			13:42:49	80.1	90
10	Ocean St (north)	40	3/Oct	15:10:55	B	EL56D	1		0	27	100	40	t				15:12:51	82.8	93.4
10	Ocean St (north)	40	3/Oct	15:38:39	B	8011	1		0	0	0	40	h				15:39:02	74.6	80.3
10	Ocean St (north)	40	3/Oct	15:43:20	S	8230	1		0	0	0	30					15:43:37	66.8	72.2
10	Ocean St (north)	40	3/Oct	16:20:41	B	4716	1		0	15	80	20	h	g			16:21:49	79.3	88.1
10	Ocean St (north)	40	3/Oct	16:51:30	B	PL1	1	PL5	1	19	70	20	g				16:52:56	81.5	90.6
10	Ocean St (north)	40	3/Oct	17:46:20	S	8171	1		0	22	70	25					17:48:29	72.1	84.4
10	Ocean St (north)	40	3/Oct	17:38:44	S	PL5	1	PL1	1	16	70	25	ac				17:39:50	69.6	82.1
10	Ocean St (north)	40	3/Oct	19:05:02	S	6011	1		0	43	70	30	h				19:07:46	81	92.6
10	Ocean St (north)	40	3/Oct	19:49:50	B	EL63	1		0	28	70	25	s				19:52:16	88	99.2
10	Ocean St (north)	40	3/Oct	20:08:06	S	2	2		0	5	0	20	h	w			20:08:26	89.1	93.7
10	Ocean St (north)	40	3/Oct	20:45:22	B	2	2		0	22	70	20	w				20:47:50	80.3	90.5
10	Ocean St (north)	40	3/Oct	21:05:51	S	3	3		0	31	100	20					21:07:40	81.2	90.1
10	Ocean St (north)	40	3/Oct	22:02:51	S	8047	1		0	0	0	25					22:03:10	65.1	74.4
10	Ocean St (north)	40	4/Oct	0:45:40	B	NR	1		0	14	70	20					0:48:14	73.8	83.5
10	Ocean St (north)	40	4/Oct	0:59:35	S	1873	2		0	27	40	25					1:02:06	88.6	97.3
10	Ocean St (north)	40	4/Oct	2:00:19	B	6047	1		0	27	75	20	w	g			2:02:40	82.4	93
10	Ocean St (north)	40	4/Oct	2:22:53	B	8011	1		0	27	100	20	b	g	w		2:25:35	81	93.3
10	Ocean St (north)	40	4/Oct	2:37:59	S	15	1		0	15	0	20	h				2:39:20	77.8	84
10	Ocean St (north)	40	4/Oct	4:22:00	S	44452	1		0	22	100	20	s				4:24:40	76.9	87.6
10	Ocean St (north)	40	4/Oct	5:33:12	B	8040	1		0	23	80	20	w	g			5:36:05	80.2	93.7
10	Ocean St (north)	40	4/Oct	5:56:28	B	PL7	1	PL6	1	17	0	20					5:58:10	79.2	89.5
10	Ocean St (north)	40	4/Oct	7:54:14	B	8216	1		0	23	100	20	t	g			7:55:58	77	85.6
10	Ocean St (north)	40	4/Oct	8:41:37	S	PL6	1	PL7	1	18	0	20	t	g			8:42:37	75.7	85.9
10	Ocean St (north)	40	4/Oct	9:58:08	B	EL63	1		0	28	100	20	h				10:00:08	90	95.6
10	Ocean St (north)	40	4/Oct	10:21:45	B	8167	1	8211	1	2	0	20	t	g	h		10:22:07	75.5	83
10	Ocean St (north)	40	4/Oct	11:04:06	S	8211/8167	2		0	22	80	20	h	t			11:06:06	80.1	87.6
11	Ocean Street(south)	15	10/Oct	2:30:19	B	8039	1		0	26	80	20					2:33:10	84.8	96.4
11	Ocean Street(south)	15	10/Oct	2:56:58	B	NR105	3		0	37	95	40	h				3:01:25	88.1	95.6

Site	Location	Distance (m)	Date	Start Time	Destinaton Sydney Botany	Loco Front Marking	# Front Loco	Loco Rear Marking	# Rear Loco	Wagon #	% Wagons w containers	km/h	Events (see key)					End Time	LAmax	LAE
11	Ocean Street (south)	15	10/Oct	3:47:38	B	6047	1		0	27	100	25	b	s				3:49:38	88	96.5
11	Ocean Street (south)	15	10/Oct	4:03:05	S	44252	2		0	21	98	25	s					4:06:03	88.9	99.3
11	Ocean Street (south)	15	10/Oct	4:36:59	S	6047	1		0	0	0	20						4:37:10	83.3	86.1
11	Ocean Street (south)	15	10/Oct	5:14:04	B	PL7	1	PL4	1	17	100	20	t					5:15:33	86.9	95.7
11	Ocean Street (south)	15	10/Oct	6:01:22	B	8230	1		0	33	93	35	t					6:03:46	88.8	94.9
11	Ocean Street (south)	15	10/Oct	18:16:58	S	8207	1		0	36	0	30						18:18:30	88.9	98.4
11	Ocean Street (south)	15	10/Oct	19:31:07	B	EL63	1	1873	1	28	100	30						19:23:38	86.4	97.4
11	Ocean Street (south)	15	10/Oct	20:17:58	B	4251	1		0	22	80	30	t					20:19:45	88.6	98.1
11	Ocean Street (south)	15	10/Oct	21:23:27	S	8039	1		0	18	0	30						21:25:01	86.6	98.1
11	Ocean Street (south)	15	10/Oct	21:44:52	S	4703	1		0	15	5	30	w					21:48:22	81.1	92.7
11	Ocean Street (south)	15	10/Oct	22:26:55	S	4471/EL58	2		0	44	0	35	w					22:29:42	86.6	100
11	Ocean Street (south)	15	10/Oct	23:50:30	S	1873	1		0	24	5	30	s					23:52:19	95	99.5
12	Morgan St	40	21/Oct	21:29:24	B	2	2		0	18	80	25	t					21:31:15	72.7	84.6
12	Morgan St	40	21/Oct	22:55:15	B	2	2		0	0	0	15						22:58:00	70.4	79.7
12	Morgan St	40	21/Oct	2:02:21	B	8040	1		0	0	98	20	h					2:04:40	76.9	88.8
12	Morgan St	40	21/Oct	2:56:02	S	Silverton	2		0	0	100	20	b	s				2:58:38	71.3	84.5
12	Morgan St	40	21/Oct	4:25:53	B	8168/8017	2		0		100	20	ss					4:30:00	71.6	84.3
12	Morgan St	40	21/Oct	5:42:59	S	NR111/NR2	2		0	0	0	15						5:46:10	64.4	81.1