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Tollroad Control Centre Building
O'Connell Terrace, Bowen Hills
Acoustic Assessment

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Tollroad Control Centre Building

O'Connell Terrace, Bowen Hills

Acoustic Assessment

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1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR Consulting) was engaged by the SKM-CW Joint Venture to conduct a noise assessment to support the development application for the proposed Tollroad Control Centre (TCC) building to be located at O'Connell Street, Bowen Hills.

The proposed TCC building will be a component of the Legacy Way Project (formerly Northern Link Project), which means that noise emissions associated with the building must be considered in accordance with the Queensland Department of Infrastructure and Planning (DIP) *Coordinator-General's Conditions of Approval* report.

In addition, the assessment has been carried out with regards to Section 3.9 Environment – General Noise Requirements of the *Bowen Hills Urban Development Area Development Scheme* (effective July 2009, amended April 2010) document issued by the Urban Land Development Authority (ULDA), and the referral document *Environmental Protection (Noise) Policy 2008*.

The purposes of this report are:

1. Assess operational noise emissions from the TCC building to nearby residences; and
2. Consider noise from construction activities to nearby residences.

Noise immission to the building from noise sources such as road or rail traffic or the adjacent ventilation station, does not require consideration as part of this assessment as the use of the building is not "noise sensitive" as defined in the ULDA development scheme document. It is expected that noise immission to the building would be considered as part of the detailed design process to ensure appropriate acoustic conditions for the use and occupancies of the building.

Appendix A provides descriptions and definitions of acoustic terminology used in this report.

2 PROPOSED DEVELOPMENT AND SURROUNDS

The location and surrounds of the proposed development has been shown on **Figure 1**.

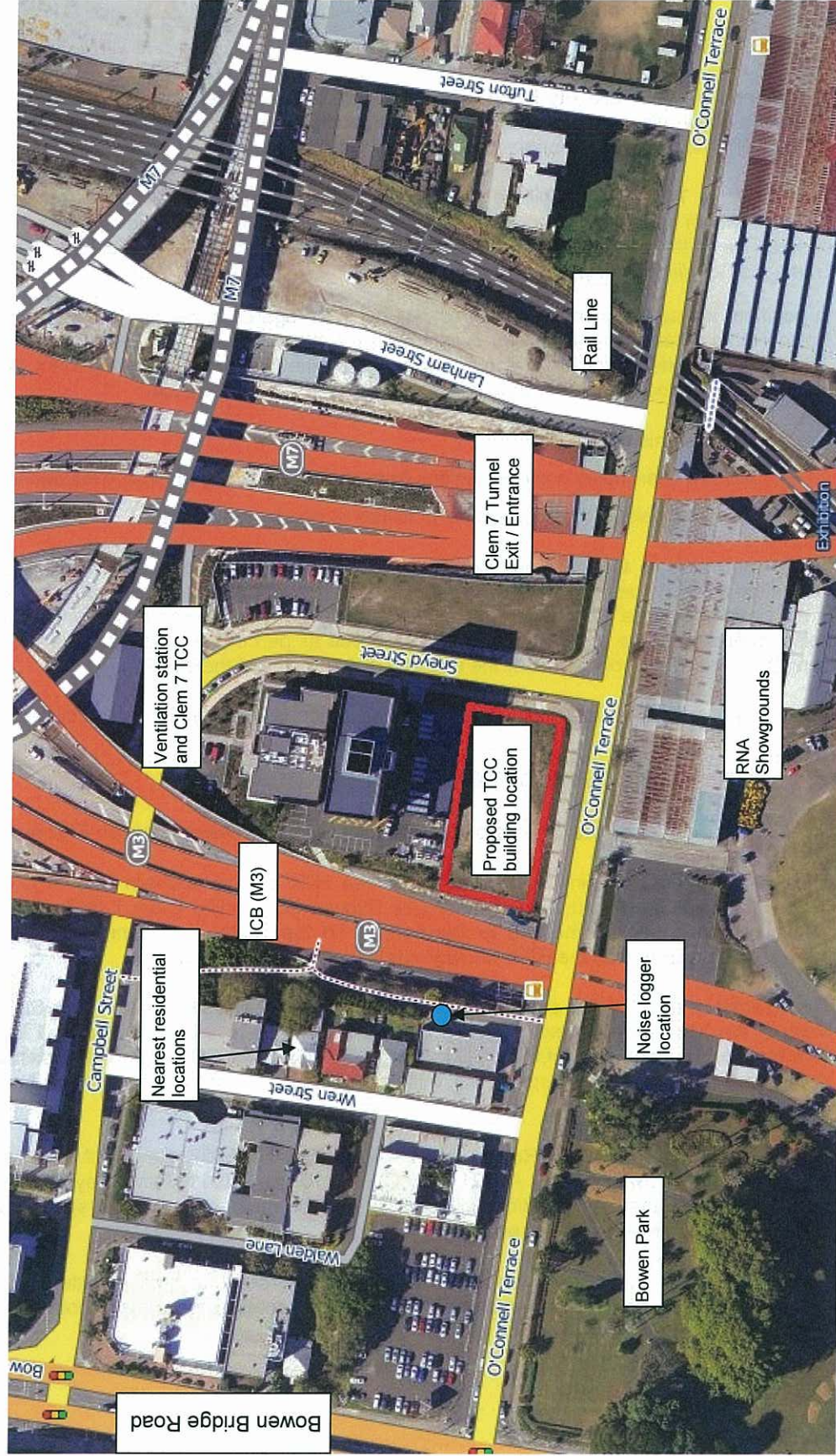
The proposed TCC building will be within Bowen Hills on the northern side of O'Connell Terrace between Sneyd Street and the M3 Inner City Bypass (ICB). The Clem 7 (M7) TCC building and a ventilation station adjoin the site to the north. To the south of O'Connell Terrace are industrial premises associated with the RNA Showgrounds, and open parkland.

The nearest relevant noise sensitive locations are residential buildings in Wren Street, immediately west of the ICB, and approximately 55 metres from the site. Bowen Park will be approximately 80 metres to the southwest of the TCC building. The Clem 7 TCC building, approximately 50 metres to the north, contains office space but will be significantly screened from noise by the intervening ventilation station.

Site development plans A000 (Rev B), A001 – A006 (Rev H), A007 (Rev C), A1600 – A1603 (Rev D), A1610 (Rev H), A1622, A1900, A1901 (Rev C), A1910 and A1911 (Rev A) by DC8 Studio (provided by SKM) shows that the building will consist of four main areas: retail space, workshop area, commercial office space and car parking.

The proposed TCC building will be 7 storeys high. The ground floor will include a TCC maintenance workshop, garage, switch room, substation and potential retail space. It is intended that the top three floors will contain commercial office space.

Figure 1 Proposed TCC Building Site and Surrounds



3 EXISTING NOISE ENVIRONMENT

Noise surveys were conducted to establish the existing noise environment at the residences near to the development site and to assist in determining noise criteria for the development.

The noise surveys were conducted in general accordance with the Department of Environment and Resource Management (DERM) *Noise Measurement Manual*.

Weather conditions were obtained from the Bureau of Meteorology weather station in Brisbane and were generally acceptable (ie dry and calm or light winds) for the purpose of conducting noise surveys. Wind speeds were predominantly below 10 m/s. A rainfall event of up to 14 mm occurred between 12.00 pm and 3.00 pm on Friday 9 September 2011. Noise data was excluded from the analysis of the survey results when wind speeds exceeded 10 m/s and rainfall exceeded 0.2 mm.

3.1 Attended Noise Measurements

Attended noise measurements were performed on Monday 5 September 2011 and Tuesday 13 September 2011 to measure existing significant sources of noise near to the development site.

Measurements were conducted with a RION NA-27 precision sound level meter configured to record a range of A-weighted noise levels, including the LA1, LA10, LAeq, and LA90 statistical parameters, over a 15-minute period. The calibration of the sound level meter was confirmed before and after the monitoring survey using a RION Type NC-73 Sound Level Calibrator.

Measurements of ambient noise were taken at various times at the noise logger location as shown in **Figure 1**. **Table 1** provides the results of the attended monitoring survey.

The dominant source of noise was traffic using the ICB. Noise from traffic on O'Connell Terrace and Clem 7 was also significant. Noise from the ventilation station and associated mechanical plant was not audible when observed at the measurement location near to the Wren Street residences. No other significant noise sources were identified during the noise surveys.

Table 1 Attended Noise Survey Results

Date/Time	Measured Noise Level, dBA			
	LA1	LA10	LAeq	LA90
Monday 5 Sep 2011 4.20 pm	78	75	73	72
Tuesday 13 Sep 2011 9.45 pm ¹	75	69	65	58

1. Construction work on the Inner City Bypass reduced traffic speeds to approximately 40 km/h.

3.2 Unattended Noise Monitoring

A continuous unattended noise monitoring survey was undertaken between Monday 6 September 2011 to Tuesday 12 September 2011.

The monitoring survey was carried out using an Acoustic Research Laboratories Type EL-316 Environmental Noise Logger. The noise logger was configured to record a range of A-weighted noise levels, including the LA1, LA10, LA90, and LAeq statistical parameters, over consecutive 15-minute periods. The calibration of the logger was confirmed before and after the monitoring survey using a RION Type NC-73 Sound Level Calibrator.

The location used for the noise logger measurements is indicated in **Figure 1**. SLR Consulting used that location as it was considered to be representative of the Wren Street residences with regards to the acoustic ambient environment.

The noise logger microphone was 2.5 metres above the existing ground level and was not influenced by reflective surfaces other than the ground.

The measured statistical noise levels are displayed graphically in **Appendix B**. The measurement results have been analysed with regard to the Department of Environment and Resource Management (DERM) Ecoaccess Guideline: *Planning for Noise Control* document. A summary of the average measured noise levels has been presented in **Table 2**.

Table 2 Summary of Measured Ambient Noise Levels

Statistical Parameter	Period	Average Measured Noise Levels, dBA
LA1	Daytime ¹	80
	Evening ²	78
	Night ³	76
LA10	Daytime	78
	Evening	75
	Night	71
	18 hour ⁴	77
LA90	Daytime	73
	Evening	68
	Night	52
LAeq	Daytime	76
	Evening	74
	Night	72
	24 hour ⁵	75
	Maximum 1 hour (day)	77
	Maximum 1 hour (night)	76

1. 7.00 am to 6.00 pm on a day
2. 6.00 pm to 10.00 pm on a day
3. 10.00 pm on a day to 7.00 am the next day
4. The LA10(18hour) is the arithmetic average of the hourly LA10 noise levels over the 18-hour period between 6.00am and 12.00 midnight.
5. The LAeq(24 hour) is the logarithmic average of the hourly LAeq noise levels measured over a 24-hour period.

It can be seen that the unattended and attended survey results were comparable and consistent with an area dominated by road traffic noise.

It is expected that ambient noise levels in Bowen Park would be similar to those measured adjacent to the Wren Street residences due to the contributions from road traffic on the ICB, O'Connell Terrace and Bowen Bridge Road.

4 NOISE CRITERIA

4.1 Construction Noise

4.1.1 Legacy Way: Coordinator General's Conditions of Approval

In Queensland it is usual, where construction noise may affect sensitive receptors, to limit the hours of construction to 6.30 am to 6.30 pm from Monday to Saturday, in accordance with the *Environmental Protection Act (1994)* (EP Act).

For construction work occurring during those hours, specific noise limits are generally not applicable.

However, the Coordinator General's report, which contains noise objectives for construction of infrastructure associated with the Legacy Way Project, is relevant as the TCC building forms a component of the Legacy Way Project.

Noise objectives for noise from construction activity, which have been based on the long-term EPP Noise objectives, can be seen in **Table 3**. Note that the noise objectives for dwellings are applicable during "standard construction hours".

The report stipulates "standard construction hours" of 6.30 am to 6.30 pm Monday to Saturday (no construction activity of Sunday and Public Holidays), which is in line with the EP Act.

Table 3 Acoustic Quality Objectives as per Table 9 of Coordinator General's Report

Sensitive receptor	Time of day	Acoustic quality objectives, dB(A) (measured at the receptor)		
		LAeq,adj,1hr	LA10,adj,1hr	LA1,adj,1hr
Dwelling (for outdoors)	Standard Construction Hours ¹	50	55	65
Dwelling (for indoors)	Standard Construction Hours ¹	35	40	45
Commercial and retail activity (for indoors)	When the activity is open for business	45	---	---
Park or garden that is open to the public (whether or not on payment of an amount) for use other than for sport or organised entertainment	Anytime	The level of noise that preserves the amenity of the existing park or garden ⁵		

1. 6.30 am to 6.30 pm Monday to Saturday, and at no time on Sundays or public holidays

The parameter/s chosen for assessment must be justified based on the character of the noise source.

At the time of this report, it is understood that construction will occur only during the standard construction hours.

The Coordinator General's report does however also contain noise criteria for construction activity occurring outside standard construction hours. Furthermore, the potential for sleep disturbance would exist if construction occurs between 6.30 pm and 6.30 am.

Therefore, it would also be appropriate to consider construction noise emissions, particularly short-term impact noise, with regard to World Health Organisation (WHO) sleep disturbance criteria, in addition to the Coordinator General's criteria, should construction activity occur outside standard construction hours.

4.2 Operational Noise

The Coordinator General's report does not specify operational noise criteria for sources of noise other than road traffic relating to the Legacy Way Project.

It will be appropriate to assess noise emissions from the TCC building in accordance with the ULDA *Bowen Hills Urban Development Area Development Scheme* document (the "Development Scheme").

4.2.1 Urban Land Development Authority

The proposed development site lies within the boundaries of the Bowen Hills Urban Development Area and is subject to the requirements of the Development Scheme.

Section 3.9 (Environment – General Noise Requirements) of the Development Scheme states the following:

The design, siting and layout of development must address noise impacts and where necessary incorporate appropriate noise mitigation measures.

Development is to achieve acceptable noise levels for noise sensitive uses in affected areas.⁸

Where determined necessary by the ULDA, an acoustic report will be required to evaluate and address potential noise impacts and recommend appropriate noise mitigation measures.

⁸ Refer to the *Environmental Protection (Noise) Policy 2008*

Schedule 2 of the Development Scheme defines "noise sensitive use" to mean any of the following:

- *house, multiple residential, other residential*
- *childcare centre, community facility, hospital or place of assembly*
- *park.*

Therefore the Environmental Protection (Noise) Policy 2008 (EPP Noise) will be used to establish "acceptable" noise levels, or noise criteria, for noise emissions from the proposed development.

4.2.2 Environmental Protection (Noise) Policy 2008

Schedule 1 of the EPP Noise provides acoustic quality objectives for enhancing or protecting the environmental values at noise sensitive receptors. The acoustic quality objectives relevant to the development, and the corresponding environmental values, have been summarised in **Table 4**.

The EPP Noise objectives are intended for use as long-term acoustic quality objectives to be progressively achieved as part of achieving the purpose of the EPP Noise. The objectives are not intended to assess impacts from temporary noise sources, and transportation noise or noise sources associated with safety (eg reverse alarms, pedestrian crossings) are specifically excluded.

As such, the values in **Table 4** would be applicable to operational noise from any mechanical plant (eg air conditioning, extraction fans, etc) and/or workshop activities.

Table 4 EPP Noise Acoustic Quality Objectives

Column 1	Column 2	Column 3			Column 4
Sensitive receptor	Time of day	Acoustic quality objectives, dB(A) (measured at the receptor)			Environmental value
		LAeq,adj,1hr	LA10,adj,1hr	LA1,adj,1hr	
Dwelling (for outdoors)	Daytime ¹ and evening ²	50	55	65	health and wellbeing
Dwelling (for indoors)	Daytime and evening	35	40	45	health and wellbeing
	Night-time ³	30	35	40	health and wellbeing, in relation to the ability to sleep
Commercial and retail activity (for indoors)	When the activity is open for business	45	---	---	health and wellbeing, in relation to the ability to converse
Park or garden that is open to the public for use ⁴ , other than for sport or organised entertainment	Anytime	The level of noise that preserves the amenity of the existing park or garden ⁵			Community amenity

1. 7.00 am to 6.00 pm on a day

2. 6.00 pm to 10.00 pm on a day

3. 10.00 pm on a day to 7.00 am the next day, not applicable for construction noise assessment

4. Whether or not on payment of an amount

5. Criteria will be based on existing acoustic environment ("control of background creep" criteria)

The parameter/s chosen for assessment must be justified based on the character of the noise source.

Additionally, one of the aims of the EPP Noise is to prevent "background creep", which is the progressive increase in ambient background noise as new noise-emitting activities are introduced into an area.

Section 10 of the EPP Noise stipulates:

- (2) *To the extent that it is reasonable to do so, noise from an activity must not be -*
- (a) *for noise that is continuous noise measured by LA90,T – more than nil dB(A) greater than the existing acoustic environment measured by LA90,T; or*
 - (b) *for noise that varies over time measured by LAeq,adj,T – more than 5dB(A) greater than the existing acoustic environment measured by LA90,T.*

Table 5 provides the noise criteria for the operational noise sources determined in accordance with the EPP Noise. The lower value of the acoustic quality objectives and "background creep" criterion will be applicable for the operational noise sources associated with the project.

Table 5 Operational Noise Criteria

Receiver	Time of Day	Acoustic Quality Objectives	"Background Creep"
Residential (for outdoors)	Daytime ¹ and evening ²	50 dBA LAeq,adj,1hr ³ 65 dBA LA1,adj,1hr ⁴	73 dBA LA90 ³ 78 dBA LAeq,adj,T ⁴
Residential (for indoors)	Daytime and evening	35 dBA LAeq,adj,1hr ³ 45 dBA LA1,adj,1hr ⁴	---
	Night-time ⁵	30 dBA LAeq,adj,1hr ³ 40 dBA LA1,adj,1hr ⁴	---
Commercial and retail activity (for indoors)	When the activity is open for business	45 dBA LAeq,adj,1hr	---
Park	Anytime	50 dBA LAeq,adj,1hr ³ 65 dBA LA1,adj,1hr ⁴	73 dBA LA90 ³ 78 dBA LAeq,adj,T ⁴

1. 7.00 am to 6.00 pm on a day
2. 6.00 pm to 10.00 pm on a day
3. Applicable for mechanical plant noise (continuous noise source)
4. Applicable for workshop activity (time-varying noise source)
5. 10.00 pm on a day to 7.00 am the next day, not applicable for construction noise assessment

It can be seen in **Table 5** that the existing noise environment is very high relative to the acoustic quality objectives.

The LAeq and LA1 acoustic parameters described in the acoustic quality objectives of the EPP Noise will be appropriate for considering the noise emissions associated with the mechanical plant (continuous noise source) and workshop activities (time-varying source) respectively. These sources would be measured with regard to the LA90 and LAeq parameters for comparison with the "background creep" criteria of EPP Noise.

4.3 Summary of Project Noise Criteria

Based on the above, and the noise survey measurement results, the lowest applicable objectives for the development has been summarised in **Table 6**.

Table 6 Limits for the TCC Development

Noise Source	EPA Period		
	Noise Criteria for Identified Noise Sources Relevant to the Development		
	Day (7am – 6pm)	Evening (6pm – 10pm)	Night (10pm – 7am)
Operational:			
Mechanical Plant	50 dBA LAeq,adj,1hr	50 dBA LAeq,adj,1hr	40 dBA LAeq,adj,1hr ¹
Workshop Activity	65 dBA LA1,adj,1hr	65 dBA LA1,adj,1hr	50 dBA LA1,adj,1hr ¹
Construction Activity	50 dBA LAeq,adj,1hr ² 55 dBA LA10,adj,1hr ² 65 dBA LA1,adj,1hr ²		

1. Assuming a 10 dB reduction from outside to inside a sleeping area via a partially open window.
2. Applicable between 6.30 am and 6.30 pm Monday to Saturday.
3. Applicable between 6.30 pm and 6.30 am Monday to Saturday, if required.
4. In accordance with WHO Sleep disturbance criteria, if required.

It is noted that all reasonable and practical measures must be undertaken in an endeavour to achieve the construction noise objectives in accordance with the Coordinator General's report. However, existing ambient noise levels in the area are already considerably higher than the noise objectives set by the Coordinator General and the EPP Noise. Compliance with the limits in **Table 6** would avoid further noise exposure at the Wren Street residences.

5 ASSESSMENT OF NOISE SOURCES AND NOISE-GENERATING ACTIVITIES

5.1 Identified Noise Issues

The activities/sources at the development expected to generate noise at the nearest residences will be as follows:

- Noise from rooftop mechanical plant;
- Noise from workshop activities; and
- Noise from construction activities.

Noise from vehicles in the car parking areas of the building, and entering/exiting from Sneyd Street, is expected be negligible when observed at the Wren Street residences given the influence of the existing road traffic noise, and has not been considered further.

Additionally, noise emissions associated with the retail and commercial operations at the building is also expected be negligible when observed at the Wren Street residences given the influence of the existing road traffic noise, and has not been considered further.

This assessment has considered noise from the project at the Wren Street residences. A design that achieves noise criteria at that location will also be compliant at other noise sensitive locations that are further away from the TCC building, eg Bowen Park.

5.2 Rooftop Mechanical Plant

Mechanical plant selection and location will be finalised during the detailed design phase.

Discussions with the project mechanical engineer indicated that a combination of packaged air handling units and reverse cycle condensers may be used to supply heat rejection and ventilation requirements. A central rooftop location, approximately 60 m from the Wren Street residences, covering approximately 160 m² has been anticipated.

The most critical time in terms of mechanical plant noise emissions will be the night-time. A design compliant with the night-time limit will be compliant at other times when the limits will be higher.

However, it is expected that heat rejection and ventilation requirements will be significantly lower for the night-time period and not all the plant items would be operational at that time.

Based on the night-time noise limit (40 dBA LAeq) and the separation distance between the Wren Street residences and the proposed rooftop plant location, the maximum **sound power level (SWL)** allowed for all rooftop plant items (combined) will be **88 dB**.

This means that compliance with the night-time noise objectives will be achieved if the maximum noise output for all rooftop plant items operating during the night period does not exceed 88 dB SWL.

The maximum SWLs for the day and evening periods, when the noise limit will be 50 dBA LAeq, will be **98 dB**.

Noise control by way of screening may also be considered if plant emissions exceed the nominated levels. Screening would provide noise reductions of the order of 10 dB – 15 dB, allowing plant with higher noise output to be considered.

A detailed investigation must be undertaken when mechanical plant selection, design and operating conditions have been finalised to determine if acoustic screening will be required or otherwise. However, it is expected that mechanical plant with appropriate noise output, combined with noise control screening if required, will be readily available to achieve the EPP Noise objectives at all times.

5.3 Workshop Activities

The workshop will be located on the ground floor of the proposed building. The walls to the ground floor areas will be precast concrete. There will be no openings in the façade which faces west towards the Wren Street residences. There will be a roller door facing O'Connell Terrace, and this will be the main emission point for workshop activity noise for the Wren Street residences.

Noise-generating activities in the workshop area are expected to be of a minor corrective and maintenance nature.

Such activities would generally involve hand-held equipment with sound power levels (SWL) of up to 105 dBA L_{Amax}. It is expected that the power tools would be used for short periods at a time, and that noise associated with power tools would have a prominent tonal and/or impulsive character.

Based on the above, the location of the workshop within the building, the proposed building design (including the roller door in a closed position), and the separation distance to the Wren Street residences, workshop noise levels of the order of 45 dBA L_{A1,adj,15 min} are predicted at the Wren Street residences.

Therefore, the workshop noise levels would be expected to comply with the EPP Noise objectives at all times.

5.4 Construction Activities

Construction of the TCC building is expected to last between 12 and 18 months. Construction activities will be limited to the standard construction hours of 6.30 am to 6.30 pm Monday – Saturday in accordance with the Coordinator General's report.

Table 7 shows the acoustically significant plant and equipment items to be used at various stages during construction as provided by the project team. The SWL and operating duration has also been shown in **Table 7**.

Table 7 Construction Plant and Equipment Sound Power Levels and Operating Duration

Plant/Equipment Item	Sound Power Level (dBA L _{Amax})	Operating Duration (minutes per hour)
Mobile/Tower crane	105	30
Fork lift	102	30
Truck/Semi-trailer ¹	114	30
Concrete truck ²	112	60
Concrete pump	107	60
Excavator	114	60
Power tools	105	30
Roller	118	60
Compressors	100	60

1. 5-10 concrete trucks on one day per week, fewer following structure completion.

2. 2-6 trucks on alternate days, fewer following structure completion.

Table 8 provides the predicted construction noise levels at the Wren Street residences. The predicted levels have been shown including the effects of solid screens of three different heights (2 m, 3.5 m, and 5 m). The screens would run the length of the west site boundary and would return along the north and south site boundaries for approximately 50 metres.

Predicted construction noise values that exceed the Coordinator General's objectives have been bolded.

The predicted construction noise levels have been based on L_{Amax} sound power levels adjusted for expected variations in noise output of the plant/equipment item. The predicted levels also include adjustments for tonal and/or impulsive noise character where applicable, and also have been adjusted for estimated audible duration in a one hour period.

Table 8 Predicted Construction Noise at External Areas of Wren Street Residences

Plant / Equipment Item	Predicted Noise Level, dBA $L_{Aadj,1\text{ hr}}$ including effect of solid screen ¹								
	2 metre screen			3.5 metre screen			5 metre screen		
	L_{Aeq}	L_{A10}	L_{A1}	L_{Aeq}	L_{A10}	L_{A1}	L_{Aeq}	L_{A10}	L_{A1}
Mobile/Tower crane	51	54	57	47	50	53	43	46	49
Fork lift	45	48	51	41	44	47	37	40	43
Truck/Semi-trailer	57	60	63	53	56	59	49	52	55
Concrete truck	55	58	61	51	54	57	47	50	53
Concrete pump ²	58	60	61	54	56	57	50	52	53
Excavator	60	63	66	56	59	62	52	55	58
Power tools ³	54	57	59	50	53	55	46	49	51
Roller	61	64	67	58	61	64	56	59	62
Compressors	52	54	55	48	50	51	44	46	47
Noise objective⁴ (dBA)	50	55	65	50	55	65	50	55	65

1. The screen must be constructed from a solid material with a minimum surface density of 12 kg/m³ (eg 20 mm timber, 15 mm plywood, 9 mm cement sheet, or colourbond sheet etc).
2. Includes a +2 dB adjustment for tonal character.
3. Includes a +5 dB adjustment for tonal and/or impulsive character.
4. As per Coordinator General's report.

It is noted that the predicted construction noise levels are less than the existing background noise levels during the daytime (6:30 am – 6:30 pm) at the Wren Street residences. Therefore, none of the construction activities would be considered "high impact" as defined in the Coordinator General's report.

The predicted construction noise levels in **Table 8** suggest that construction noise would generally achieve the noise objectives in the Coordinator General's report when a 5-metre high screen is in place. Noise associated with the roller and excavator may be expected to exceed the objectives by up to 6 dB on occasions. Excesses of that magnitude would be considered minor for construction noise, and insignificant in the context of the relatively high existing ambient noise environment.

The excesses rise to 8 dB and 11 dB for screen heights of 3.5 m and 2 m respectively, in addition to a greater number of the construction noise sources exceeding the objectives. Similarly, construction noise excesses of those magnitudes would be considered moderate. However, given the existing high noise ambient environment, it would be expected that the predicted construction noise levels would still be considered acceptable.

It is understood that construction activity at the RNA showground development may occur around the same time as the proposed TCC building. It is expected that the construction noise from the TCC building would be acoustically dominant when observed at the Wren Street residences, owing to the greater separation distance to the RNA development. Additionally, construction noise maxima from both projects would be unlikely to occur at the same time. Therefore, any cumulative impact of construction noise would be acoustically negligible or minimal.

5.4.1 Construction Noise Minimisation and Management

In accordance with the Coordinator General's report, it will be appropriate to identify reasonable and practical measures designed to minimise construction noise emissions as part of a Noise and Vibration Environmental Management Plan Sub-Plan (N&V EMP Sub-Plan).

There will be several techniques available that would be considered reasonable and practical, which could be incorporated into a N&V EMP Sub Plan, including:

- Installing noise reduction screens. The screens should be as high as practicable (and consider safety constraints etc to be determined in the detail design phase) in order to obtain maximum noise reduction (see **Table 8**). The screens would run the length of the west site boundary and would return along the north and south site boundaries for approximately 50 metres, and would be constructed as per Note 1 in **Table 8**.
- Selecting plant/equipment with lower noise output (ie with silencers, mufflers or other noise control devices fitted), than listed in **Table 7** will also reduce noise construction noise emissions.
- The delivery area of material to the site should be arranged to eliminate the need for vehicles to reverse, thereby eliminating reverse alarms. Plant items on site full-time should be fitted with reverse alarms of the broadband type (ie bland, "quacking" type).
- Adhere to the standard construction hours as far as practicable.
- Position compressors behind structures that act as barriers or on the east of the site
- Orientate concrete pumps/trucks so that noise emissions are directed to the east.
- Encourage contractors and construction workers to practice "quiet" work methods, including:
 - avoid creating "impact" noises, particularly during loading/unloading activities; and
 - maintain plant/equipment in good working order, eg engine tuning, sharp cutting blades, etc.

6 CONCLUSION

SLR Consulting has considered noise issues associated with the proposed TCC building at O'Connell Street, Bowen Hills.

Operational noise emissions from the development include noise from workshop activity and rooftop mechanical plant. Construction noise has also been assessed.

Attended and unattended noise monitoring surveys were conducted at the site to establish the existing ambient environment and to assist in determining limits for noise from the development site.

Noise associated with the project must be considered in accordance with the Queensland Department of Infrastructure and Planning *Coordinator-General's Conditions of Approval* report. Additionally, noise limits (see **Table 6**) were determined in accordance with the *Bowen Hills Urban Development Area Development Scheme* document issued by the Urban Land Development Authority, and the referral document *Environmental Protection (Noise) Policy 2008*.

Predictions of operational noise from the TCC building indicate that all applicable noise limits can be achieved. Further consideration of rooftop mechanical plant will be required during the detailed design stage to establish the need for noise control, or otherwise.

Construction noise would exceed the noise objectives specified in the Coordinator General's report (see **Table 6**) on occasion for some activities. However, construction noise would still be expected to be acceptable at the Wren Street residences provided noise screening and mitigation measures are employed at the site. This statement is made in the context of the relatively high existing ambient noise environment. Measures to minimise construction noise as far as reasonable and practical have been discussed in Section 5.4.1 of this report.

7 CLOSURE

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.

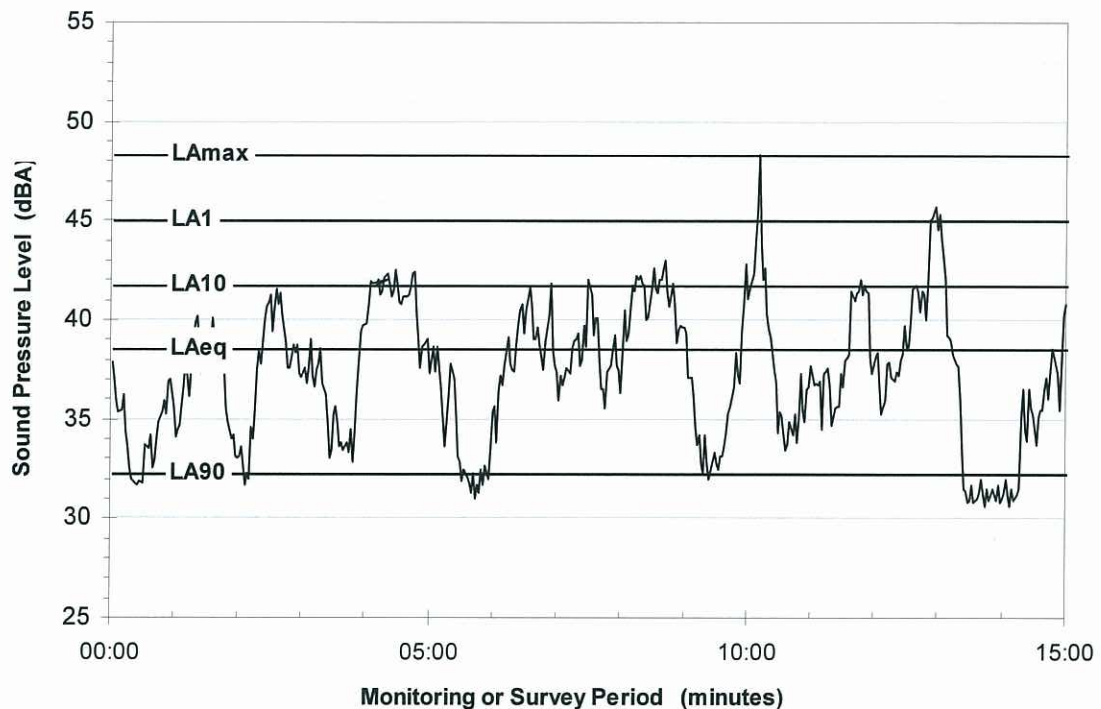
SLR Consulting disclaims any responsibility to the client and others in respect of any matters outside the agreed scope of the work.

ACOUSTIC TERMINOLOGY

This report makes repeated reference to certain noise level indices (also known as statistical parameters), in particular the LA1, LA10, LA90, LAeq and LMax noise levels. A graphical representation of these descriptors is shown below.

- The LAeq is a special type of average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound over the same measurement period.
- The LA90 noise level is the A-weighted sound pressure level exceeded 90% of a given measurement period (ie 13.5 minutes of a 15-minute period) and is representative of the average minimum background sound level (in the absence of the source under consideration). It is commonly referred to as the “background” noise level.
- The LA10 is the A-weighted sound pressure level exceeded 10% of a given measurement period (ie 1.5 minutes of a 15-minute period). It is representative of the average of a range of higher level noise events during the measurement period.
- The LA01 noise level is the A-weighted sound pressure level exceeded 1% of a given measurement period (ie 9 seconds of a 15-minute period) noise level is representative of the higher A-weighted noise levels associated with site activity.
- The LMax noise level is the maximum A-weighted noise level associated with site activity.
- The LMax,adj,T noise level is the average of the maximum noise levels during time period, T.

Graphical Display of Typical Noise Indices



Sensitivity of People to Noise Level Changes

A change of up to 3 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness.

Sound Pressure and Sound Power Levels

The sound pressure level is a measure of the fluctuations in sound pressure relative to atmospheric pressure. It is measured using a microphone that responds proportionally to the sound pressure. The sound pressure due to a noise source (eg, an item of mechanical plant) will depend upon the distance from the source and/or the acoustic conditions ("reverberant" or otherwise) of the space in which it is located, as well as the "directionality" of the noise source and the location of any reflecting surfaces near to the source and/or the measurement location.

The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W. It is not dependant on distance or acoustic conditions.

The relationship between Sound Power and Sound Pressure may be likened to an electric radiator, which is characterised by a power rating, but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

A-Weighting or dBA Noise Levels

Sound pressure is not sensed equally by the human ear at all frequencies. The overall level of a sound is usually expressed in terms of dBA which is measured using the "A-weighting" filter incorporated in sound level meters. The filter is modified to have a frequency response corresponding approximately to that of human hearing. People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and is less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of a human's perception of loudness of that sound.

Sound levels expressed as dB, or "linear" levels have not been weighted.

Different sources having the same dBA level generally sound about equally as loud, although the perceived loudness can also be affected by the character of the sound (eg the loudness of human speech and a distant motorbike may be perceived differently, although they are of the same dBA level). The overall level of a sound may be adjusted for particularly strong (or annoying) characteristics (see below).

Adjustment for Noise Character

The LA1 indices, and to a lesser extent the LA10 indices, is particularly influenced by short-term noise events, which typically feature impulsive and/or intermittent characteristics. These events, when attributable to the noise source in question, have the potential to increase the subjective loudness of the noise at the receptor.

This is also true of noise that contains a tonal character such as a distinctive hum, whine, whistle, and the like.

These "annoying" characteristics are considered during the assessment process in the form of an adjustment to the noise source in question when observed at the receiver. This is notated in the noise indices by the 'adj' term, eg LA10,adj,15mins.

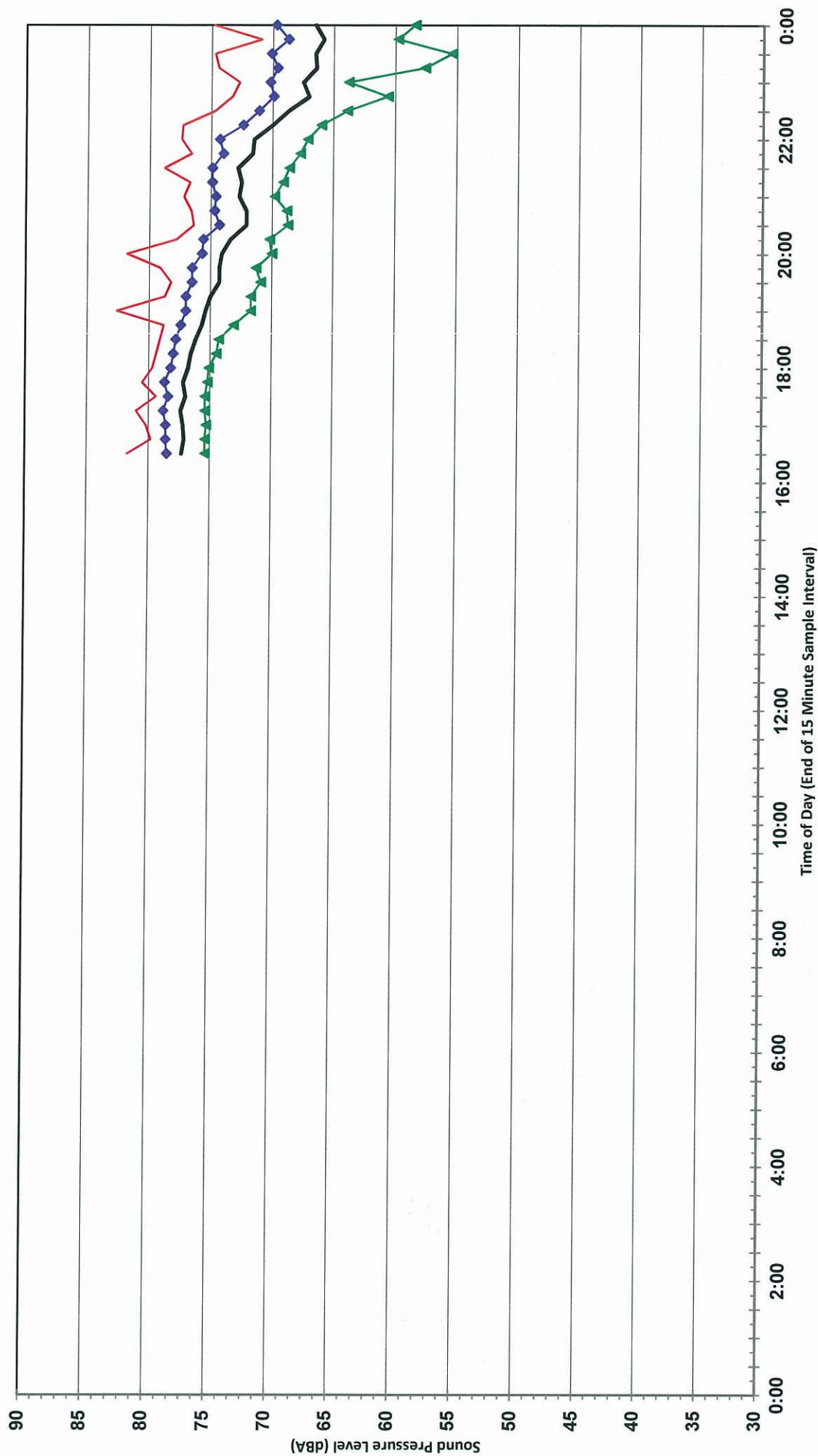
Appendix B

Report Number 620.01854.00300-R1

NOISE LOGGING MEASUREMENTS

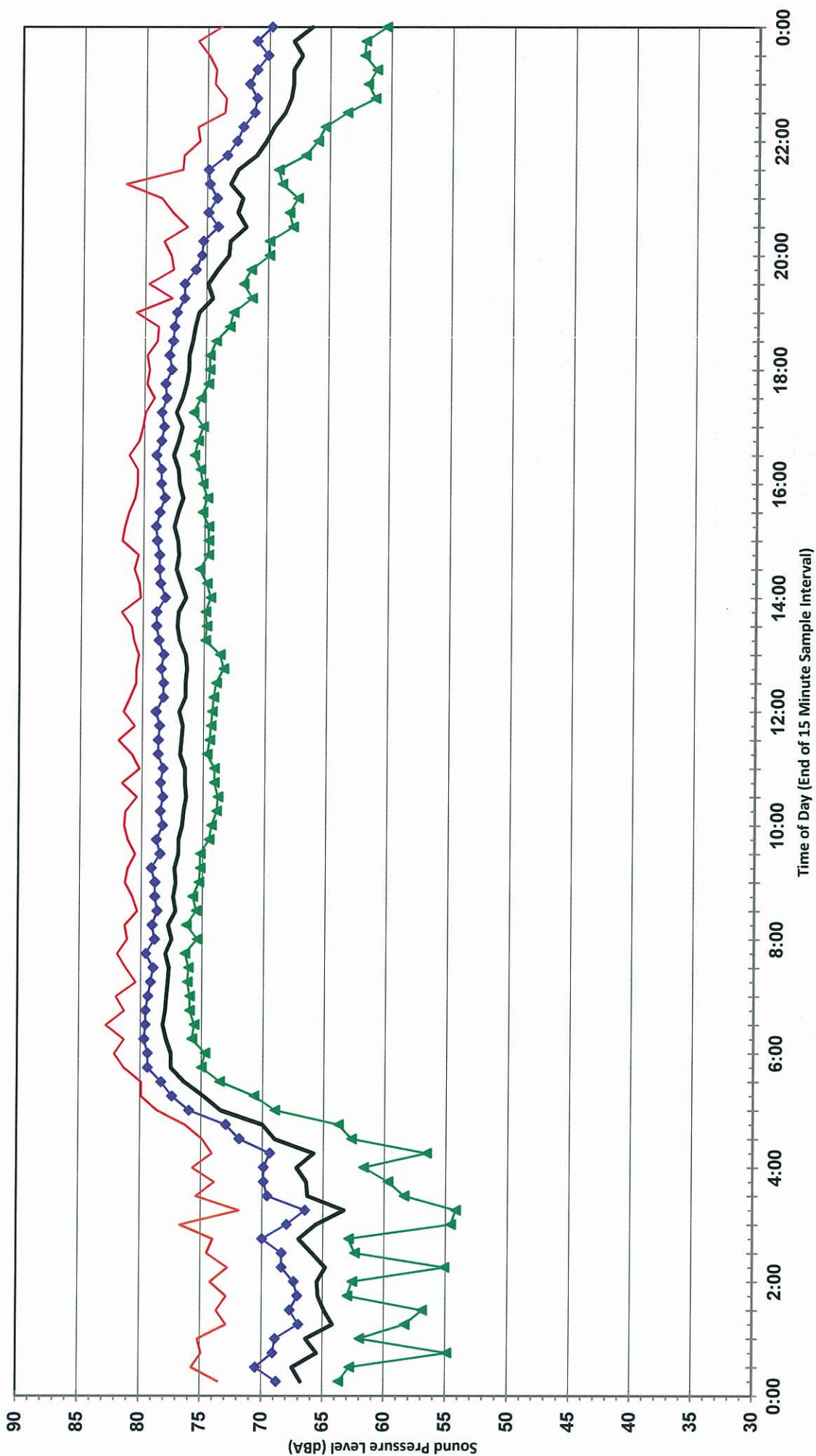
Statistical Ambient Noise Levels TCC Building Area - Monday 5 September 2011

— L1 — L10 — L90 — Leq



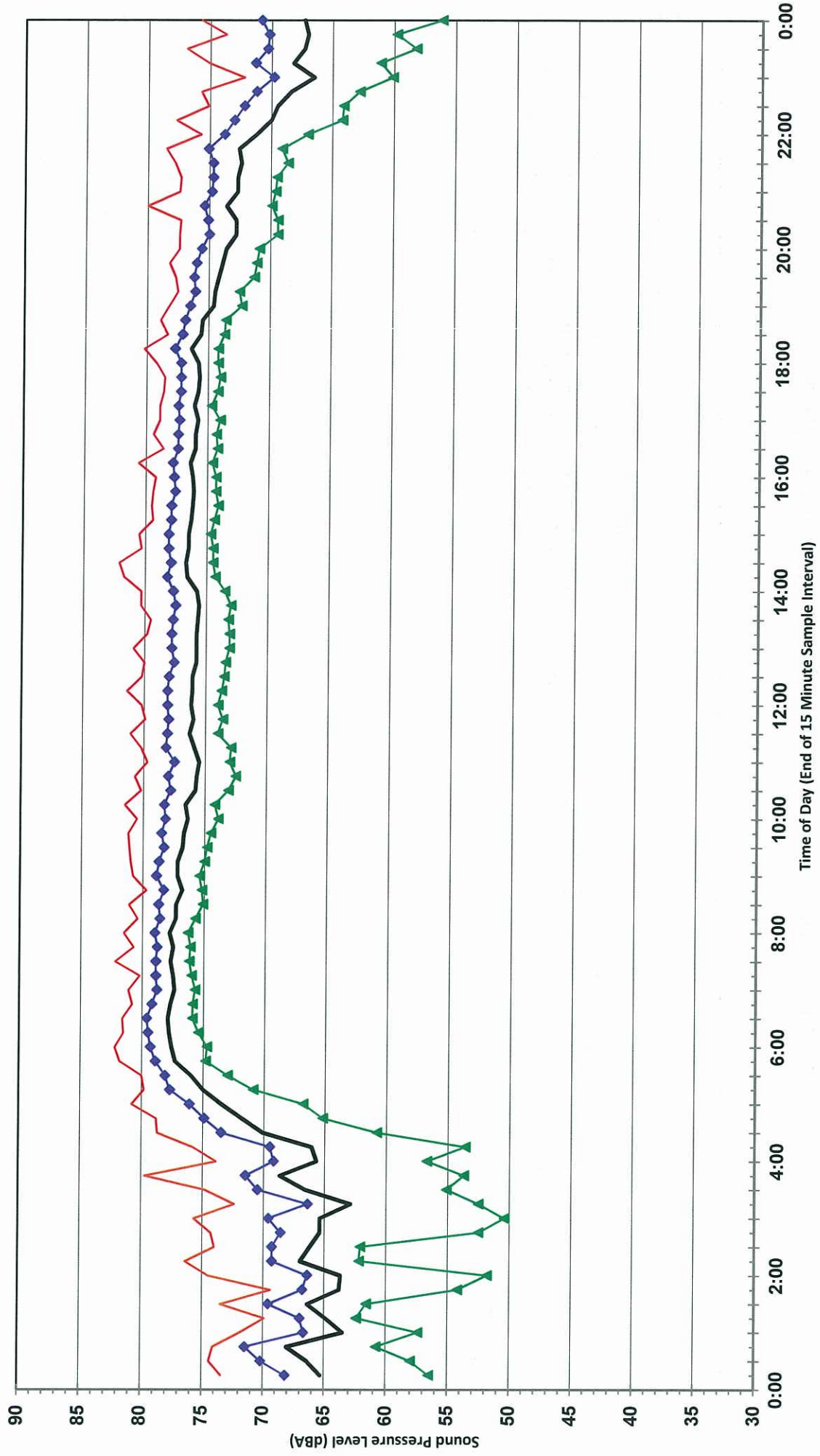
Statistical Ambient Noise Levels TCC Building Area - Tuesday 6 September 2011

— L1 — L10 — L90 — Leq

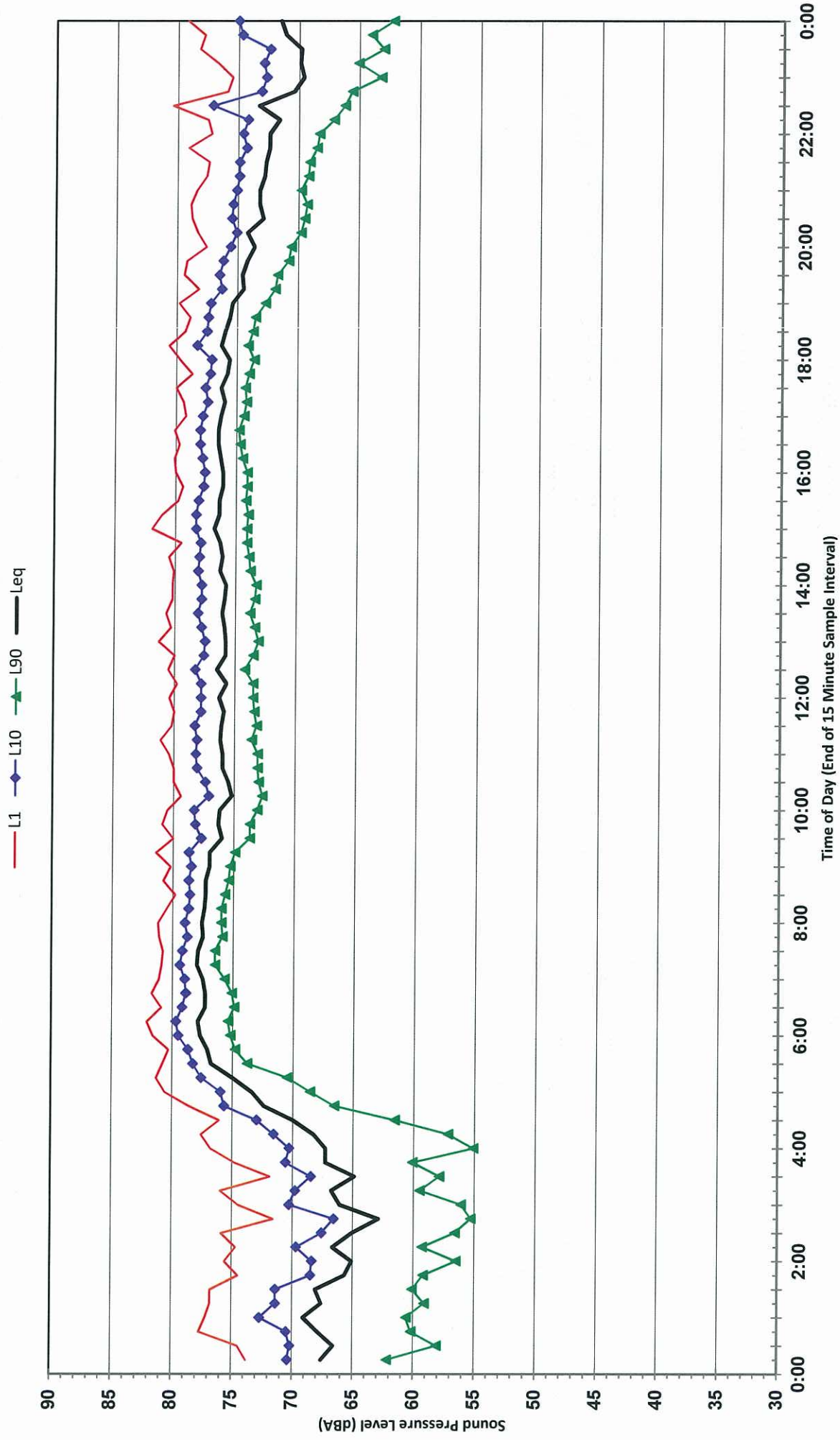


Statistical Ambient Noise Levels TCC Building Area - Wednesday 7 September 2011

— L1 — L10 — L90 — Leq



Statistical Ambient Noise Levels TCC Building Area - Thursday 8 September 2011

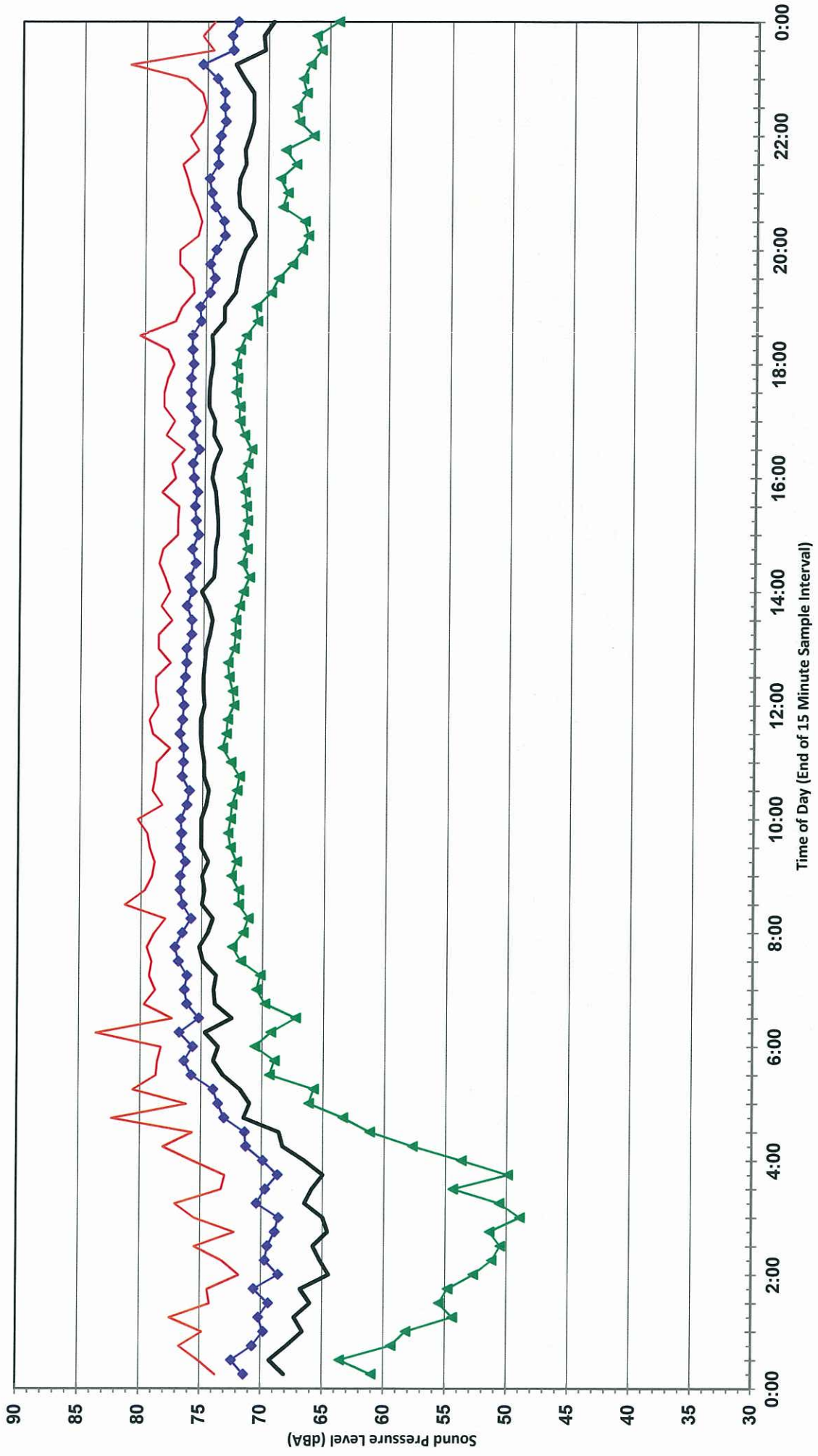


Statistical Ambient Noise Levels TCC Building Area - Friday 9 September 2011



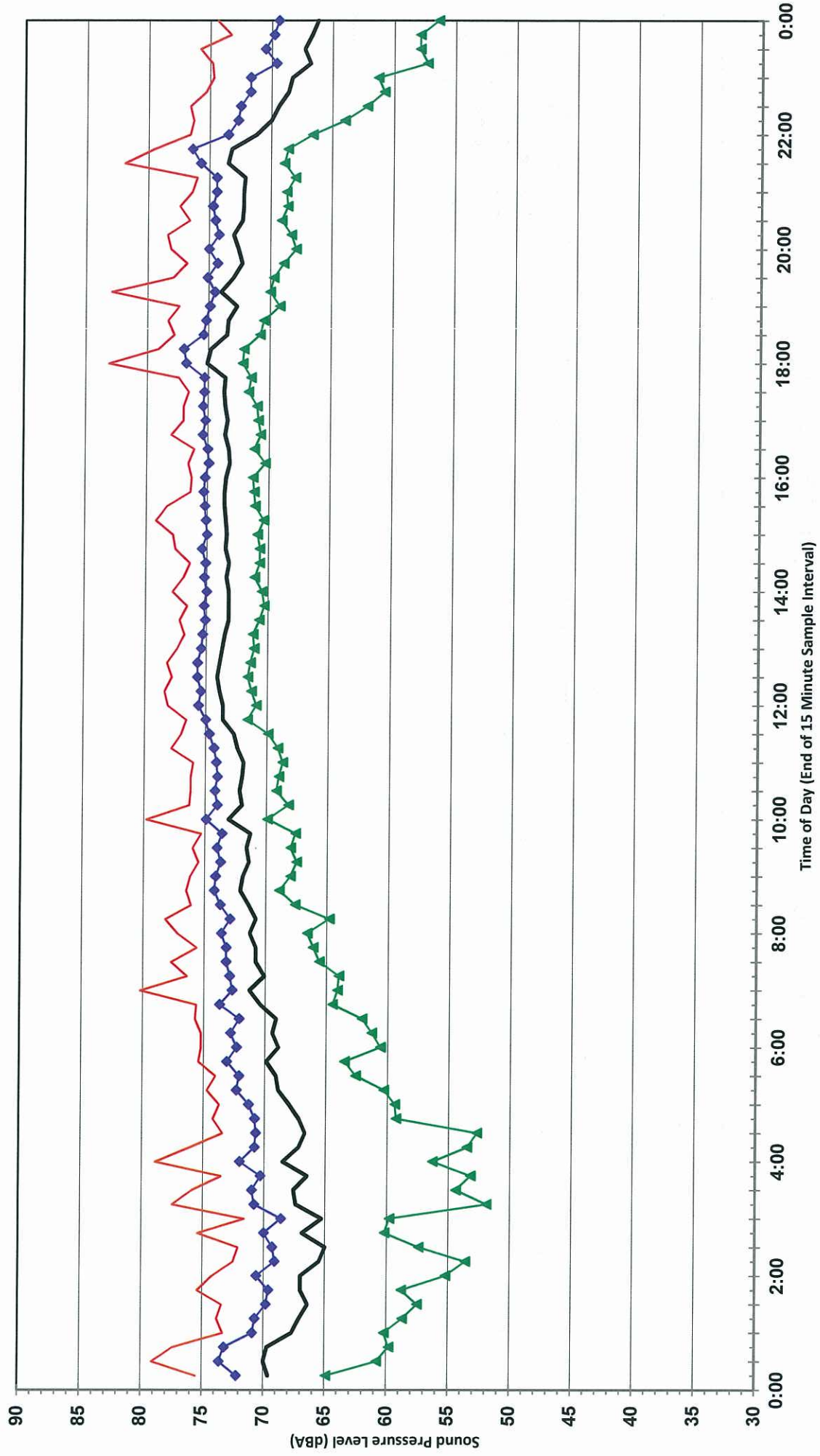
Statistical Ambient Noise Levels TCC Building Area - Saturday 10 September 2011

— L1 — L10 — L90 — Leq

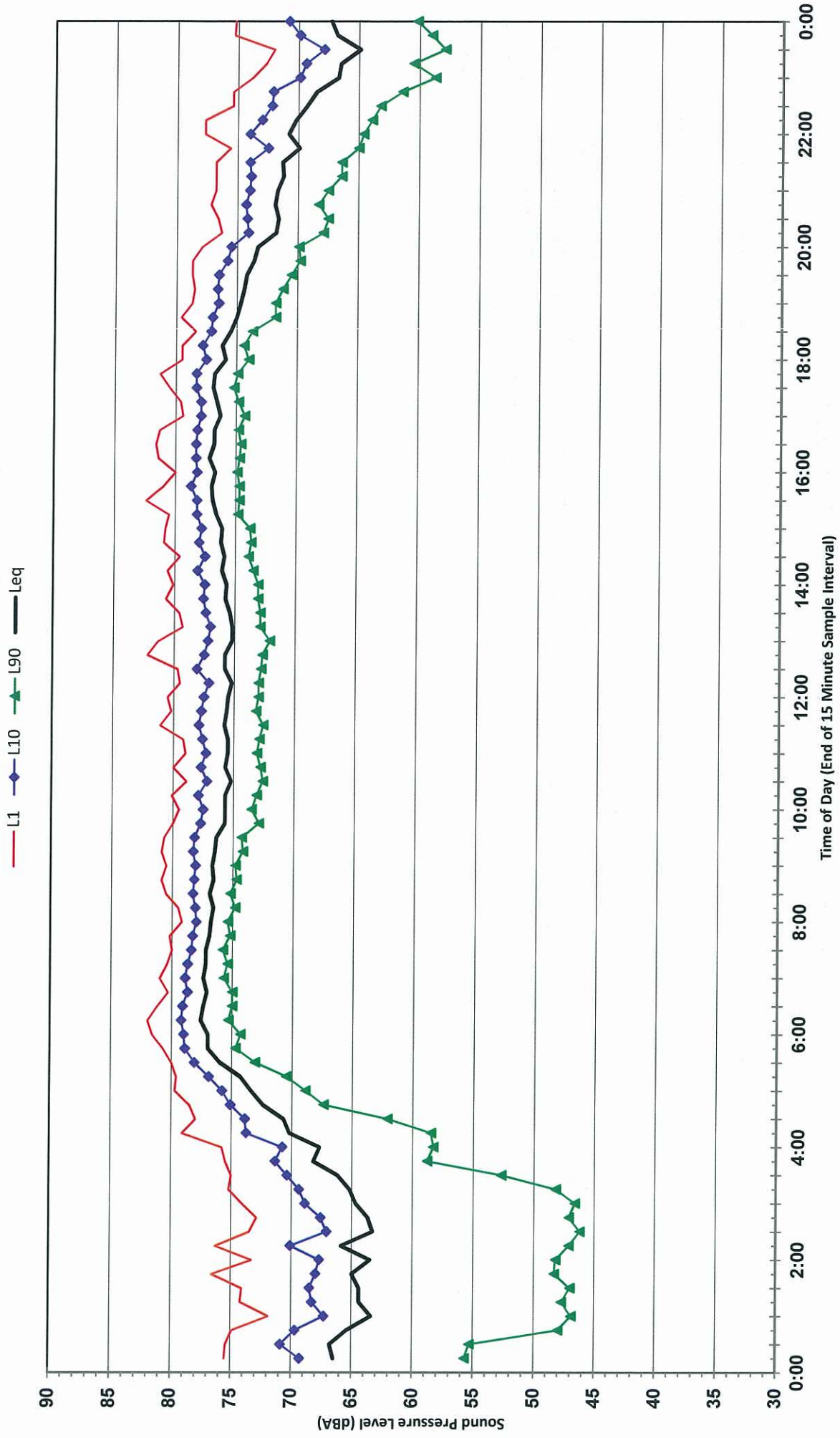


Statistical Ambient Noise Levels TCC Building Area - Sunday 11 September 2011

— L1 — L10 — L90 — Leq



Statistical Ambient Noise Levels TCC Building Area - Monday 12 September 2011



Statistical Ambient Noise Levels TCC Building Area - Tuesday 13 September 2011

