

# APPENDIX 19

## Noise and Vibration Assessment

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## PROJECT 71723.00 – BARANGAROO HEADLAND PARK

### MAIN WORKS NOISE AND VIBRATION ASSESSMENT

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**Appendix 1 – Project Site Plan**

**Appendix 2 –Preliminary Noise and Vibration Management Plan**

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## 1. EXECUTIVE SUMMARY

A noise and vibration assessment has been carried out for the proposed main works activities associated with the development of Barangaroo Headland Park. The evaluation has assessed whether these activities would adversely impact sensitive receivers around the site. The results of the assessment have been used to develop a preliminary Noise and Vibration Management Plan (NVMP) that will be used to manage identified impacts from these activities.

This assessment will highlight those activities and receiver locations where there is the potential for noise or vibration from activities on (or associated with) the site to adversely impact either amenity or cause damage to structures, so that these can be appropriately addressed and managed.

The NVMP outlines the development of controls and safeguards that would be applied by the Barangaroo Delivery Authority, and provide guidance for the ongoing management of activities on the site. The objective of these controls is to ensure that all work is carried out in a highly controlled and predictable manner that will minimise emissions and protect the amenity of the sensitive receivers surrounding the site.

The NVMP requires that the implemented controls and safeguards be reviewed as work proceeds to ensure noise and vibration impacts are minimised in line with the objectives of the Plan. Further reviews would be undertaken through the extraction period, as required, in response to revised methods and equipment, as well as in response to the monitoring and evaluation of actual impacts. This NVMP outlines the procedures that would be adopted by the contractor.

The Management Plan also outlines the ongoing noise and vibration monitoring that would be carried out to record and verify the noise and vibration levels being achieved at sensitive receiver locations.

The processes adopted in the Management Plan will minimise noise and vibration emissions, to meet the overall objectives of Department of Environment, Climate Change and Water (DECCW) Interim Construction Noise Guideline, minimising and ameliorating any impacts caused by these activities to the extent that it is feasible and reasonable.

## 2. INTRODUCTION

This document presents a noise and vibration assessment and plan that will be used to manage noise and vibration of the various activities occurring during the main works stage for the Barangaroo Headland Park development.

## 3. PROJECT DESCRIPTION

Barangaroo is the site of the former Patricks Stevedore and P & O Passenger Ship Terminal.

The scope of works for the main works phase of the Headland Park development is continued from the activities associated with the early works phase. A noise and vibration assessment of the activities proposed under the early works phase has already been outlined in a previous report prepared by this office (Ref: 010539/1009/R2/VF)

The activities to be conducted at this stage are as follows:

- Continue extraction of sandstone / stockpiling
- Dewatering
- Continue receipt of fill from Stage 1
- Excavation, filling and land formation – creating naturalistic shoreline, northern cove and Headland Park
- Construction Activities – cultural space area within the headland for future use with a lower level carpark and public wharf facility.

The Headland Park site is bounded by The Hungry Mile to the east, Shelley Street to the south and Sydney Harbour to the west and north. The site is located north of Transit Shed no. 5, stretching to Moores Wharf. Refer Figure 1 and Appendix 1.

#### 4. ACTIVITIES TO BE CONDUCTED AND ASSOCIATED NOISE SOURCES

The proposed main works activities are based on Preliminary Environmental & Construction Management Plan provided by Barangaroo Development Authority (Draft – August 9 2010). A description of each of the identified noise producing processes and the associated equipment is presented below:

- **Continuing Sandstone Excavation and Stockpiling**

The proposed area of sandstone extraction is located on the seaward side of the cut rock face at the back of the former Patricks Wharf 4, Millers Point. Merriman Street lies at the top of the rock face and the Sydney Ports Harbour Control Tower is tucked into the base of the rock face. Clyne Reserve lies to the north of both Merriman Street and the Control Tower.

The extraction process is expected to proceed until the following requirements for the landscaping of the Headland Park area are achieved,

- 32 000 m<sup>3</sup> of rough cut sandstone for use along headland's water edge, in tidal pools
- 10 000 m<sup>3</sup> of dimensioned stone for use in seawalls and paving
- 20 000 m<sup>3</sup> of dimensioned stone for building cladding

Sandstone extraction will be undertaken using three methods:

- Ripping using excavator mounted claws or attachments fitted to bulldozers
- Rock sawing
- Hammering of rock to broach and free the blocks.
- Front end loader with lifting forks or large cranes to manoeuvre the blocks from site

Smaller blocks will be temporarily stockpiled to 3 blocks high in a specially designated section of the site. For sandstone needing secondary processing for cutting into pavers, cladding and stone columns, individual sandstone blocks will be taken off site to a masonry yard.

The main noise sources may include:

- Rock Saw (or similar) on 30t Excavator
- 2 x Hammer (or similar) on 30t Excavator
- Alternating Rock Saw and Bucket on 30t Excavator
- 2 x Site Cranes
- 2 x Flatbed Trucks
- Front end Loader

- **Dewatering of Groundwater Inflow into Extraction Area**

The proposed extraction area has been located with its sandstone rim above high tide level, to prevent inflow to extraction area. Douglas Partners have indicated lower levels than the filling/bedrock profiles and also very low permeability conditions in the rock mass. Even with the assumption of a very permeable open jointed zone, inflows were reported to likely be less than 10litres/minute. Such water quantities can be handled by directing flow to temporary sumps and pumping them into holding stations for flocculation and discharge to stormwater drain.

The main noise sources may include:

- Water Pump (petrol 1kW)

- **Continuing receipt of fill from Stage 1**

The following measures have been necessitated to prepare for the receipt of fill from Stage 1:

- Construction of footings for retaining walls at the northern site entry route to sandstone extraction area, western side of extraction area and around SPS0014 site boundary.
- Construction of Retaining Walls
- Earthwork operations including fill placement and compaction using material from stage 1

The main noise sources may include:

- CAT 825 Compactor
- 2 x D6-D9 bulldozers
- 4 x 10 tonne tipper trucks
- Vibration roller
- Flat drum roller

- **Excavation, Filling and Land Formation – Creating Naturalistic Shoreline, Northern Cove and Headland Park**

This package involves the creating of a naturalistic shoreline and the Northern Cove. Excavation is proposed to occur to a level of two metres below sea level. Excavation is proposed behind the caisson walls and portions of the caisson structure facing the sea will be cut down. The proposed fill for the Headland Park is in addition to the receipt and placement of fill from Stage 1. Excavated material from behind the caisson walls will be used as fill to create final landform. Any additional fill would likely come from Stage 1 basement excavations.

The main noise sources for the excavation, filling and land formation works may include:

- Hydraulic Jaw Cutter
- Concrete Saw on excavator
- Rock Saw (or similar) on 30t Excavator
- Hydraulic Hammer (or similar) on 30t Excavator
- 150 – 200 tonne Cranes (2)

- Concrete truck
- Concrete Pump
- Trucks (2)
- Excavator

- **Construction Activities – Cultural space Area for Future Use with Lower Level Carpark and Public Wharf Facility**

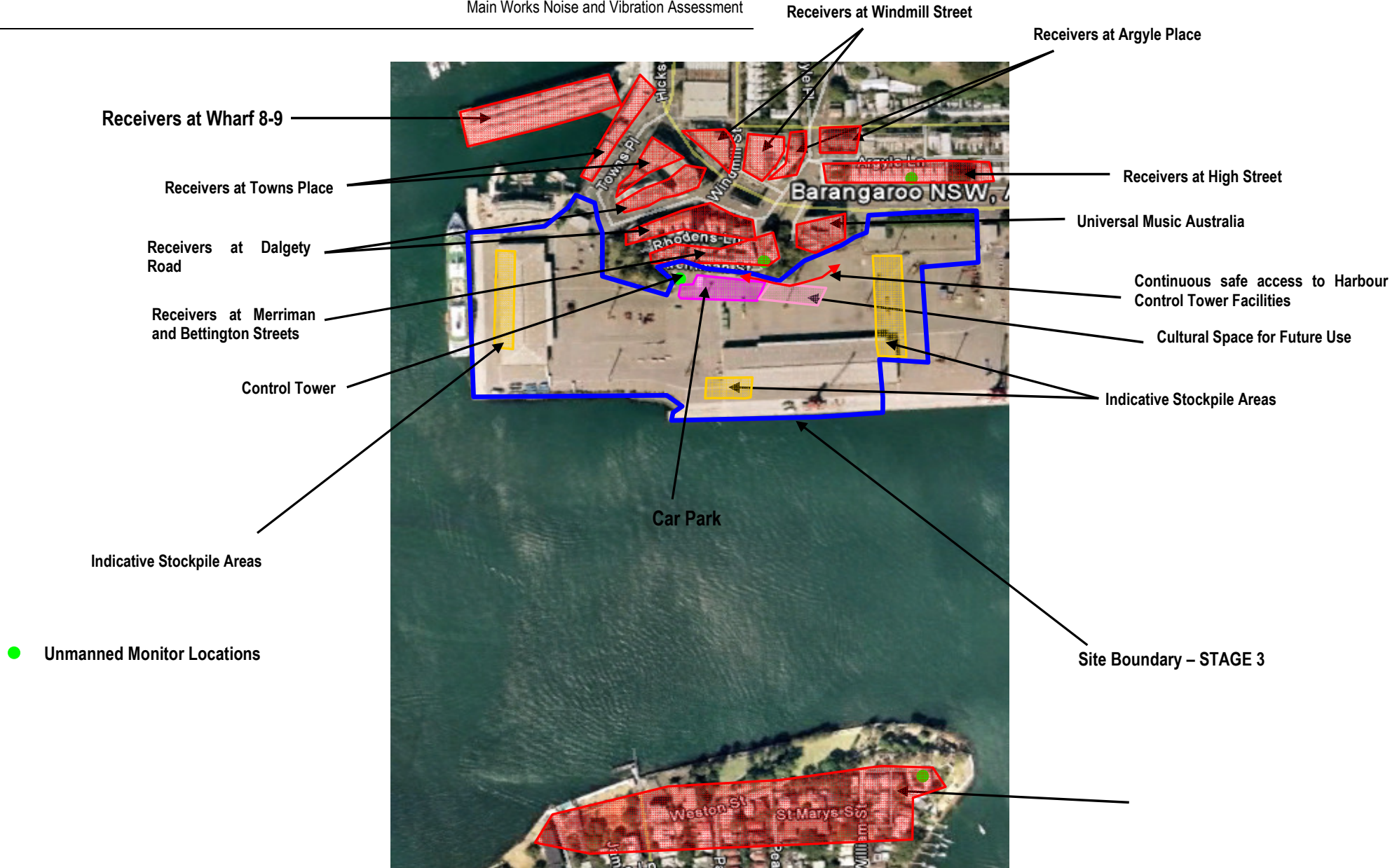
The main works activities include the construction of a car park with approximately 300 spaces and a cultural space area for future use. Use of the area as a cultural facility will be subject to a separate project application. Both the carpark structure and cultural space for future use will be built from a mixture of off-site manufactured pre-cast beams and elements and on site in-situ concrete structures.

The concept development is in two stages with the first stage comprising the allocation of a 75,000m<sup>3</sup> space associated with a lower level carpark in an efficient foot-print of approximately 6,000m<sup>2</sup>. A second stage will mature the landform contour design and may allow the space to increase to up to 100,000 m<sup>3</sup>.

The public wharf facility at the northern cove will likely be delivered from the landside with off – site pre-fabricated elements and modules. The piles may either be incorporated into the cove during excavation phase or driven from barge following completion of the cove.

The main noise sources for the construction activities may include:

- Site cranes (Electric and Diesel, and Mobile)
- Pilling Rig
- Bobcats/excavators/pallet moving equipment
- Steel cutting using angle grinders
- Drilling, cutting and hammering formwork
- Concrete pumps
- Concrete trucks
- Concrete floating equipment
- Concrete vibrators
- Excavator mounted hydraulic crusher for waste masonry ,etc
- Trucks and general materials handling equipment



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Figure 1 – Project Site Boundary and Sensitive Receivers

#### 4.1 NOISE SOURCE LEVELS

The A-weighted sound power levels for typical equipment/processes anticipated to be used are outlined in Table 1 below.

**Table 1 – Sound Power levels**

| EQUIPMENT /PROCESS                    | SOUND POWER LEVEL dB(A) |
|---------------------------------------|-------------------------|
| Excavator/ Bulldozer                  | 114                     |
| Bobcat                                | 105                     |
| Concrete crusher                      | 114                     |
| Concrete Trucks (2)                   | 107 each                |
| Mobile Cranes (2)                     | 105 each                |
| Flatbed Trucks (2)                    | 105 each                |
| 100 – 120 tonne Excavators (4)        | 114 each                |
| Concrete Pump                         | 112                     |
| Low Loaders (2)                       | 105                     |
| Electric Saw                          | 116                     |
| Drilling                              | 94                      |
| Hammering                             | 125                     |
| Impact drill                          | 105                     |
| Rock Saw on 30t Excavator (2)         | 110* each               |
| Concrete Saw on Excavator             | 115                     |
| Hammer on 30t Excavator (3)           | 130* each               |
| Hydraulic Jaw Cutter on 30t Excavator | 110                     |
| Site Cranes (4)                       | 105 each                |
| Loader                                | 115                     |
| Pump                                  | 90                      |
| D6-D9 Bulldozers (2)                  | 115 each                |
| 10 tonne tipper trucks (4)            | 102 each                |
| Vibration Roller                      | 104                     |
| Flat Drum Roller                      | 111                     |
| Pneumatic Hammer                      | 115*                    |
| Electric Hammer                       | 105*                    |

| EQUIPMENT /PROCESS       | SOUND POWER LEVEL dB(A) |
|--------------------------|-------------------------|
| Angle grinders           | 118*                    |
| Electric Saw             | 116*                    |
| Drilling                 | 94                      |
| Hammering                | 125*                    |
| Impact drill             | 105                     |
| Piling Rig               | 115                     |
| Concrete Float/Vibrators | 105                     |
| Compactor(2)             | 117 each                |

The noise levels presented in the above table are derived from the following sources:

1. On-site measurements
2. Table D2 of Australian Standard 2436-1981
3. Data held by this office from other similar studies.

## 4.2 EXTRACTION TRAFFIC

Construction traffic shall utilise the existing Gates entries from Hungry Mile (Hickson Road), Towns Place and from within the overall site opposite Gate 5.

Earth moving equipment, cranes and other large construction machinery would be delivered at the start of the project and would remain on site for significant periods (i.e. they would not be removed overnight).

Heavy vehicle traffic will include large rigid and articulated trucks. It is anticipated that the largest vehicle to be used will be a large semi-trailer as described in the RTA Guidelines (16.9m by 2.5m). The peak number of truck movements per day varies between stages and will not occur on the same days. Detailed analysis and number of truck movements during the various stages

There will also be heavy vehicle movements due to spoil being transported to the Headland Park from the southern end of the Barangaroo site. Generally, these movements will mostly occur within the Barangaroo site, boundary.

Detailed arrival / departure routes and number of truck movements occurring during various stages have been outlined in Barangaroo Headland Park Main Works – Traffic Impact Assessment and Construction Management Plan, CTLRKL002r01.3 revision 1.3 dated 16 October 2010 prepared by Halcrow.

## 5. HOURS OF WORK

Work is proposed to be undertaken during the following hours:

- 7am to 6pm Monday to Fridays. These hours are within the DECCW recommended construction times (Section 2.2 of Interim Construction Noise Guideline).
- 8am to 3pm Saturdays. Since most of the work carried out prior to the excavation of sandstone involves earthworks activities, moving fill and stockpiling; noise levels from these activities are less intensive. Loud activities such as saw cutting or excavator mounted hammers would not be permitted within the 1pm to 3pm work window.
- Exceptions to these hours apply for the delivery of oversize loads or certain materials as required for safety reasons and for emergency response. Furthermore, certain construction activities may be allowed to occur outside the hours above on a planned basis with the prior written approval of the Director-General or as provided for under separate legislation.
- Dewatering plant would need to operate on a 24 hours per day basis to clear groundwater inflow into excavations.
- No works or deliveries would take place on Sundays and public holidays.

It is noted that the period 1pm to 3pm Saturday exceeds the DECCW standard construction hours promulgated in the Interim Construction Noise Guideline. The justification for this is:

- The loudest activities such as percussive hammering will not be undertaken.
- The “normal” hours of construction adopted by the City of Sydney Construction Noise Code extends to 5pm on Saturdays. Therefore, the proposed time limits are still more restrictive than the time limits applying to other sites near the receivers close to the Headland Park site.
- The additional 2 hour period is needed to allow for an efficient work day, since some operations require set up times for example. Therefore, the additional Saturday construction hours will have a larger than proportional effect on reducing the total construction period.
- The standard hours in the ICNG are recommendations only and not mandatory.
- Background noise monitoring conducted at the most affected receivers indicates that background noise levels between 1pm and 3pm on Saturdays are similar to those occurring between 7am and 1pm on Saturdays, and only marginally less than that on weekdays.

## 6. NOISE AND VIBRATION GOALS

### 6.1 NOISE

The applicable guidelines and standards are:

- DECCW Interim Construction Noise Guideline. This guideline nominates a methodology for assessing and managing construction noise (and vibration) impacts.

A quantitative assessment is undertaken involving the prediction of likely noise levels from activities at sensitive receivers, and these noise levels are compared to noise “goals”. This process identifies the processes causing emissions that may exceed the goals, so that feasible and reasonable management of those processes can be assessed and implemented to these processes.

- Australian Standard 2436-1981 “Guide to Noise Control on Construction Maintenance and Demolition Site”. In particular, the requirements stipulated in Section 3 of the standard will be followed.

Section 3 of AS 2436 states that care shall be taken in applying criteria that normally would be used to regulate noise emitted from industrial, commercial and residential premises to construction, particularly for those activities which are transitory and of short duration.

For the control and regulation of noise from construction sites AS2436 nominates the following:

- That reasonable suitable noise criterion is established.
- That all practicable measures be taken on the building site to regulate noise emissions, including the siting of noisy static processes on parts of the site where they can be shielded, selecting less noisy processes, and if required regulating construction hours
- The undertaking of noise monitoring where non-compliance occurs to assist in the management and control of noise emission from the building site.
- The City of Sydney also has a comprehensive code for the regulation of noise emissions from construction sites “Construction Hours/Noise Within the Central Business District Code of Practice (1992)”. The Code divides the week into different categories corresponding to different times. Category 1 is regarded as standard hours, up to Category 4 hours which covers the most sensitive periods. Different noise assessment goals apply for the different categories:
  - Category 1 - Monday to Friday 7am to 7pm and Saturday 8am to 5pm – Background + 5 dB(A) + 5 dB(A) (10dB(A) total). The extra 5 dB(A) is applied on a case by case basis and is usually included unless there is a specific noise sensitive occupancy impacted.
  - Category 2 - Monday to Friday 7pm to 11pm and Saturday 5pm to 11pm – Background + 5 dB(A).
  - Category 3 – Sundays and Public Holidays 7am to 5pm – Background + 3 dB(A).
  - Category 4 – All other times– Background + 0 dB(A)
- The existing approval for the demolition of structures on the Barangaroo site adopted a noise management level of background + 10 dB(A) at all receiver locations. A large part of this demolition work was successfully undertaken prior to the World Youth Day in 2007/8, and is continuing, using these goals and the Management Plan developed. It is noted that the

management goals adopted in the DECCW ICNG are more stringent than the City of Sydney Code, and the goals previously used to regulate noise emissions from the Barangaroo site.

In assessing the methodologies in these documents, for “normal” construction hours:

- All the standards indicated above adopt a broadly similar approach – construction noise emissions should be managed to meet established management goals where feasible and reasonable.
- For residential receivers, DECCW, City of Sydney and the demolition approval all adopt a general noise management goal based on a 10 dB(A) exceedance of the background noise level.
- For commercial receivers, the DECCW guideline adopts an external or internal amenity goal (independent of background noise level), whereas the City of Sydney and the previous demolition approval use a background + 10 dB(A) approach as for residential receivers.

The DECCW guideline will be broadly used to set management goals for the project. However, the other guideline documents will be used where there are project specific situations/receiver types that are not specifically defined in the DECCW guideline.

Based on these the following procedure will be used to assess noise emissions:

- Assess noise levels produced by construction activities at the sensitive receivers.
- Define a “Noise Affected” Management level for each receiver type using the methodology outlined in the DECCW ICNG. Where there are not specific recommendations in the ICNG, or where these are not seen as appropriate, use other guideline documents to determine an appropriate management level.
- Where levels exceed “Noise Affected Management Level” (NAML), investigate and implement all reasonable and feasible techniques to limit noise emissions.
- For residential receivers, if noise levels exceed DECCW “Highly Noise Affected” Management Level (75dB(A)) after applying all practical engineering controls to limit noise emissions investigate time management and other techniques to further mitigate noise emissions.

## 6.2 VIBRATION

### 6.2.1 Structure Damage

It is proposed to adopt the following vibration guidelines, namely:

- German Standard DIN 4150-3 (1999-02): “*Structural Vibration – Effects of Vibration on Structures*” – which will be used to assess and limit building damage risk.
- DECCW Interim Construction Noise Guideline – which contains guidelines to assess and limit impacts on building occupant’s amenity based on the “Assessing Vibration: A Technical Guide”.

The criteria and the application of this standard are discussed in separate sections below.

German Standard DIN 4150-3 (1999-02) provides vibration velocity guideline levels for use in evaluating the effects of vibration on structures. The criteria presented in DIN 4150-3 (1999-02) are presented in Table 1.

It is noted that the peak velocity is the absolute value of the maximum of any of the three orthogonal component particle velocities as measured at the foundation, and the maximum levels measured in the x- and y-horizontal directions in the plane of the floor of the uppermost storey.

**Table 2 – DIN 4150-3 (1999-02) Safe Limits for Building Vibration**

| TYPE OF STRUCTURE |                                                                                                                                                                                                       | PEAK PARTICLE VELOCITY (mms <sup>-1</sup> ) |              |               |                                    |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|--------------|---------------|------------------------------------|
|                   |                                                                                                                                                                                                       | At Foundation at a Frequency of             |              |               | Plane of Floor of Uppermost Storey |
|                   |                                                                                                                                                                                                       | < 10Hz                                      | 10Hz to 50Hz | 50Hz to 100Hz | All Frequencies                    |
| 1                 | Buildings used in commercial purposes, industrial buildings and buildings of similar design                                                                                                           | 20                                          | 20 to 40     | 40 to 50      | 40                                 |
| 2                 | Dwellings and buildings of similar design and/or use                                                                                                                                                  | 5                                           | 5 to 15      | 15 to 20      | 15                                 |
| 3                 | Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order) | 3                                           | 3 to 8       | 8 to 10       | 8                                  |

### 6.2.2 Equipment Damage

The Sydney Ports Harbour Control Tower contains potentially vibration sensitive equipment in the control tower, and in huts in the base of the tower which is equipment associated with communications

equipment operated by third party telecommunications companies. Damage/operational limits for this equipment would be determined following consultation with these parties and equipment manufacturers. These limits are likely to be significantly less than the structural limits for the tower.

### 6.2.3 Project Specific Damage Limits

Project specific vibration limits have been developed based on:

- The recommendations in Table 2.
- The construction and type of building potentially impacted..

The following table summarises the recommended limits applied to sensitive structures around the site.

**Table 3 – Recommended Damage Vibration Limits**

| Building                                            | Recommended Damage Limits                                                      |
|-----------------------------------------------------|--------------------------------------------------------------------------------|
| Moores Wharf                                        | Category 3                                                                     |
| Terrace Houses and other sandstone buildings        | Category 3                                                                     |
| Harbour Control Tower Structure                     | Category 1                                                                     |
| Harbour Control Tower Equipment                     | To Be Determined in Consultation with Sydney Ports/Telecommunication Companies |
| Modern Residential Buildings Around Towns Place etc | Category 2                                                                     |
| Modern Commercial Buildings Around Towns Place etc  | Category 1                                                                     |

### 6.3 ASSESSING AMENITY

For the type of vibration producing activities proposed, vibration induced within the occupied levels of the adjacent buildings is likely to impact amenity well before the damage limits are reached.

The DECCW Interim Construction Noise Guideline provides procedures for assessing tactile vibration and regenerated noise within potentially affected buildings. The recommendations of this guideline should be adopted to assess and regulate vibration from proposed activities.

Where vibration levels would exceed the amenity goals, feasible and reasonable measures should be investigated to minimise vibration with a view to limiting vibration to the nominated goals.

**Table C1.1 Criteria for exposure to continuous and impulsive vibration**

| Place                                                                             | Time                 | Assessment criteria                                                                                                      |                  |                                                                                              |                  |                                      |         |
|-----------------------------------------------------------------------------------|----------------------|--------------------------------------------------------------------------------------------------------------------------|------------------|----------------------------------------------------------------------------------------------|------------------|--------------------------------------|---------|
|                                                                                   |                      | <sup>1</sup> rms acceleration (m/s <sup>2</sup> )<br>(& vib. accel. value)<br>(dB re 10 <sup>-6</sup> m/s <sup>2</sup> ) |                  | <sup>2</sup> rms velocity (mm/s)<br>(& vib. velocity value)<br>(dB re 10 <sup>-9</sup> mm/s) |                  | <sup>2</sup> Peak velocity<br>(mm/s) |         |
|                                                                                   |                      | Preferred                                                                                                                | Maximum          | Preferred                                                                                    | Maximum          | Preferred                            | Maximum |
| Continuous vibration                                                              |                      |                                                                                                                          |                  |                                                                                              |                  |                                      |         |
| Critical working areas (e.g. hospital operating theatres, precision laboratories) | Day- or night-time   | 0.0050<br>(74 dB)                                                                                                        | 0.010<br>(80 dB) | 0.10<br>(100 dB)                                                                             | 0.20<br>(106 dB) | 0.14                                 | 0.28    |
| Residences                                                                        | Daytime <sup>3</sup> | 0.010<br>(80 dB)                                                                                                         | 0.020<br>(86 dB) | 0.20<br>(106 dB)                                                                             | 0.40<br>(112 dB) | 0.28                                 | 0.56    |
|                                                                                   | Night-time           | 0.0070<br>(77 dB)                                                                                                        | 0.014<br>(83 dB) | 0.14<br>(103 dB)                                                                             | 0.28<br>(109 dB) | 0.20                                 | 0.40    |
| Offices                                                                           | Day- or night-time   | 0.020<br>(86 dB)                                                                                                         | 0.040<br>(92 dB) | 0.40<br>(112 dB)                                                                             | 0.80<br>(118 dB) | 0.56                                 | 1.1     |
| Workshops                                                                         | Day- or night-time   | 0.040<br>(92 dB)                                                                                                         | 0.080<br>(98 dB) | 0.80<br>(118 dB)                                                                             | 1.6<br>(124 dB)  | 1.1                                  | 2.2     |
| Impulsive vibration                                                               |                      |                                                                                                                          |                  |                                                                                              |                  |                                      |         |
| Critical working areas (e.g. hospital operating theatres, precision laboratories) | Day- or night-time   | 0.0050<br>(74 dB)                                                                                                        | 0.010<br>(80 dB) | 0.10<br>(100 dB)                                                                             | 0.20<br>(106 dB) | 0.14                                 | 0.28    |
| Residences                                                                        | Daytime <sup>3</sup> | 0.30<br>(110 dB)                                                                                                         | 0.60<br>(113 dB) | 6.0<br>(136 dB)                                                                              | 12.0<br>(142 dB) | 8.6                                  | 17.0    |
|                                                                                   | Night-time           | 0.10<br>(100 dB)                                                                                                         | 0.20<br>(106 dB) | 2.0<br>(126 dB)                                                                              | 4.0<br>(132 dB)  | 2.8                                  | 5.6     |
| Offices                                                                           | Day- or night-time   | 0.64<br>(116 dB)                                                                                                         | 1.28<br>(122 dB) | 13.0<br>(142 dB)                                                                             | 26.0<br>(148 dB) | 18.0                                 | 36.0    |
| Workshops                                                                         | Day- or night-time   | 0.64<br>(116 dB)                                                                                                         | 1.28<br>(122 dB) | 13.0<br>(142 dB)                                                                             | 26.0<br>(148 dB) | 18.0                                 | 36.0    |

1 Values derived from z-axis critical frequency range 4–8 Hz. Where required, a more detailed analysis can be conducted as per BS 6472–1992.

2 Values given for the most critical frequency range >8 Hz assuming sinusoidal motion. Where required, a more detailed analysis can be conducted as per AS 2670.2–1990. Sufficient justification should accompany the use of a peak velocity approach if used in an assessment.

3 Specific values depend on social and cultural factors, psychological attitudes and expected degree of intrusion.

## **7. ASSESSMENT OF POTENTIAL NOISE EMISSIONS**

### **7.1 POTENTIALLY AFFECTED RECEIVERS**

A survey of potentially affected sensitive commercial and residential receivers has been conducted and identified the following locations summarising the receivers potentially most impacted by the proposed activities:

- Hickson Road – Commercial premises including offices
- Merriman Street and Bettington Street – Residential premises
- Sydney Ports Harbour Control Tower, Moore's Wharf Building and surrounds, and Temporary Passenger Terminal
- Dalgety Road – Residential premises
- Windmill Street – Commercial premises including offices and cafés.
- Towns Place – Commercial premises including offices and cafés and residential premises.
- Pier 8-9 – Commercial premises including offices.
- Argyle Place – Commercial premises including offices and cafés and residential premises.
- High Street – Residential premises
- Balmain Peninsula – Residential premises

## 7.2 NOISE GOALS

### 7.2.1 Ambient Noise Monitoring

In order to establish noise goals, background noise levels were measured at locations representing the most sensitive receiver groups.

Attended measurements were obtained using a Norsonic SA140 Sound Level Analyser, set to A-weighted fast response. The analyser was calibrated before and after the measurements using a Norsonic Type 1443 Sound Level Calibrator. No significant drift was noted.

The daytime background noise level at these locations obtained from the measurements are summarised in the following table. A number of 15 minute noise recordings were made at each location between 7am to 5pm weekdays. Where there was a significant variation in measured background noise levels, the typical lowest levels are presented in the table and used to establish the noise goals.

Measurements were made on the following days:

- 21 May 2010
- 25 May 2010

**Table 4 – Measured Daytime Background Noise Levels**

| Location                                             | Day Background Noise Level<br>dB(A) L <sub>90</sub> |
|------------------------------------------------------|-----------------------------------------------------|
| Commercial Receivers on Hickson Street               | 53                                                  |
| Residences on Merriman and Bettington Streets        | 46                                                  |
| Commercial Receivers Dalgety Road                    | 51                                                  |
| Residential Receivers on Windmill Street             | 51                                                  |
| Commercial and Residential Receivers on Towns Place  | 53                                                  |
| Commercial Receivers Pier 8-9                        | 52                                                  |
| Commercial and Residential Receivers on Argyle Place | 52                                                  |
| Residences on High Street                            | 51                                                  |
| Residences Balmain Peninsula                         | 48                                                  |

Long term measurements were also carried out at the potentially most impacted residential receivers, and within the Harbour Control Tower. The residential receiver locations monitored were (refer Figure 1):

- Courtyard area of residential property at 48 Merriman Street, Millers Point;
- First floor balcony of residential property at 28a High Street, Milers Point;
- Front yard of residential property at 25 Edward Street, Balmain

These measurements were made using Acoustic Research Laboratories noise monitors that measure noise levels continuously and every 15 minutes calculate and store the statistic noise levels determined for the measurement interval. The monitors were calibrated using a Rion NC-73 calibrator with no significant drift occurring.

Appendix 3 provides the results of the ambient monitoring and periods of adverse weather data obtained for the corresponding period.

The following table summarises the RBL noise levels determined using the method described in the DECCW Industrial Noise Policy (INP), and excluding measurements potentially obtained during periods of adverse weather conditions in accordance with the method described in the INP.

**Table 5 – RBL's Determined From Long Term Monitoring**

| Location                    | Representative Background Noise Level dB(A) L <sub>90</sub> |         |       |
|-----------------------------|-------------------------------------------------------------|---------|-------|
|                             | Day                                                         | Evening | Night |
| Merriman Street             | 44                                                          | 42      | 37    |
| High Street                 | 51                                                          | 47      | 45    |
| 25 Edward Street<br>Balmain | 48                                                          | 44      | 39    |

The background noise level within the Harbour Control Tower was generally 50 dB(A), and dropped to as low as 48 dB(A).

### 7.2.2 Residential Receiver Noise Goals

At residential receivers, noise generated by plant and equipment operating during normal hours throughout the duration of the project will be managed to generally comply with the background + 10dB(A) goal, and where that is exceeded noise will be managed in strict compliance with AS2436 and the DECCW ICNG.

It is noted that the most impacted residential receivers are those represented by the long term monitoring locations in Table 5. The long term background noise levels determined from the monitoring will be used for these receivers.

For the remaining receivers the background noise levels obtained from the attended measurements will be used to indicate the potential extent of impacts at other less, impacted receivers. It is noted that any management controls applied to manage noise levels at Merriman Street, High Street and Balmain would also manage noise levels at the other receiver locations.

**Table 6 – Noise Affected Management Level**

| Location                                             | Noise Affected Management Level dB(A) $L_{eq}$ | Highly Noise Affected Management Level dB(A) $L_{eq}$ |
|------------------------------------------------------|------------------------------------------------|-------------------------------------------------------|
| Residences on Merriman and Bettington Streets        | 54                                             | 75                                                    |
| Residential Receivers on Windmill Street             | 61                                             | 75                                                    |
| Residential Receivers on Towns Place                 | 63                                             | 75                                                    |
| Commercial and Residential Receivers on Argyle Place | 62                                             | 75                                                    |
| Residences on High Street                            | 61                                             | 75                                                    |
| Residences Balmain Peninsula                         | 58                                             | 75                                                    |

For plant that operates 24 hours per day (e.g. dewatering pump), the noise criterion will be set at 5 dB(A) above the night time background noise level as determined from the long term monitoring locations, in accordance with the DECCW ICNG.

**Table 7 – Noise Criteria for Plant Operating 24 hours Per Day/7 Days Per Week**

| Location                                      | Noise Level dB(A) $L_{eq}$ |
|-----------------------------------------------|----------------------------|
| Residences on Merriman and Bettington Streets | 42                         |
| Residences on High Street                     | 45*                        |
| Residences Balmain Peninsula                  | 44                         |

\* Due to the long term nature and continuous nature of the pump operation noise level will be limited to 45 dB(A), equal to the urban night time amenity level in the DECCW INP.

### 7.2.3 Commercial and Other Receivers

The ICNG adopts the following external management levels for commercial and industrial receivers:

- Commercial (offices, retail outlets) – 70 dB(A)  $L_{eq}$
- Industrial 75 dB(A)  $L_{eq}$
- Other occupancies – Project specific based on type of occupancy, perhaps using “maximum” recommended level in AS 2107 to assist in determining relevant internal levels.

For the commercial receivers around the site the “standard” 70 dB(A) external noise goal may not be appropriate. For example:

- Some commercial receivers around the site are not located outside buildings, or are in buildings that provide almost no attenuation (such as the Temporary Passenger Terminal). For these receivers, the standard noise goal proposed in the ICNG may need to be made more stringent in order to appropriately manage impacts at these receivers.

- Some of the receivers are commercial properties (primarily office buildings) that have fixed, high performance glazing (or glazing that is normally closed) and are air conditioned. For these buildings the application of external noise goals may be excessively stringent. Internal noise goals will be adopted for these receivers rather than the external noise level.

In these instances the ICNG recommended external noise level will be used as an initial screening test, and these will be modified, or internal noise goals used, where appropriate.

#### 7.2.4 Internal Noise Goals – General Commercial

As indicated above, some of the commercial receivers potentially impacted have modern, sealed facades that achieve a high level of external noise reduction. In these cases simply using the external noise goal would result in unnecessarily restrictive goals.

It is noted that the standard ICNG external noise goal of 70 dB(A)  $L_{eq}$  would typically result in internal noise levels of:

- 60 dB(A)  $L_{eq}$  in buildings that are not air conditioned and have openable windows.
- 50 dB(A)  $L_{eq}$  in buildings with a closed facade but with standard, unsealed windows.

The ICNG refers to setting internal noise goals using the AS 2107 “maximum” recommended level for guidance. AS 2107 nominates a noise level of 45 dB(A)  $L_{eq}$  for general office areas.

The levels that would occur in typical commercial buildings based on the ICNG 70 dB(A) external level would exceed the 45 dB(A)  $L_{eq}$ .

In our experience of managing demolition/construction noise from the Barangaroo site and within the Sydney CBD indicates that:

- A significant level of complaints of excessive construction noise in office situations are unlikely when the level of construction noise is less than 55 dB(A) within commercial spaces.
- This is the level typically adopted when assessing noise to the City of Sydney Construction Noise Code.
- A 55 dB(A) goal was successfully adopted for the management of noise from the Demolition of Structures on the Barangaroo site.

Notwithstanding DECCW has requested that the lower 45 dB(A) level be adopted as an internal management goal. At this level, construction noise will be clearly acceptable within commercial tenancies and there would be minimal impact.

#### 7.2.5 Noise Goals – Ports Harbour Control Tower

The existing background noise level in the Harbour Control Tower (HCT) has been measured at 50 dB(A), and dropping to as low as 48 dB(A).

The noise management level for the HCT will be set at 48 dB(A), which would result in minimal impact.

Because satisfactory speech communication within the HCT should be maintained at all times, an upper limit on internal noise levels should be maintained at all times, unless specifically arranged otherwise for works that cannot comply with this level. A maximum level of 55 dB(A) within the HCT is recommended, based on a typical speech level of 65 dB(A). Notwithstanding this recommendation, conditions within the HCT should be monitored and the limit modified as appropriate.

The applicable management level for the communications huts at the base of the tower is 75 dB(A), which would only need to be considered when maintenance staff are within these huts.

### 7.2.6 Noise Goals – Ports Harbour Control Tower

It is understood that the Moores Wharf building is used as an office building, and that boat maintenance is undertaken at the berths on the eastern side of the building and other maintenance related activities around the building.

The Moores Wharf building is a historic sandstone building that is unlikely to have a high performance façade acoustically. For the Moores Wharf building a Noise Affected Management Level (NAML) of 70 dB(A)  $L_{eq}$  outside the building is applicable in accordance with DECCW guidelines.

The DECCW Management Level applying for the external maintenance activities is 75 dB(A).

Given the moorings are largely screened from the construction activities by the Moores Wharf building or the headland, and the higher management level for the maintenance activities, the 70 dB(A) external management level for the Moores Wharf building will be the governing requirement.

### 7.2.7 Noise Goals – Temporary Passenger Terminal (CPT)

The CPT facility will be used intermittently when passenger ships are berthed and passengers and/or luggage are required to be processed, etc.

The CPT is a lightweight “tent” building that inherently provides minimal attenuation of external noise sources. Therefore, while this building provides physical shelter, acoustically it effectively can be considered to be an outdoor space.

Construction of a new passenger terminal is proposed to begin in 2011 and be completed in 2012. Hence the temporary passenger terminal is expected to be required for approximately 2 years with the last ships forecast to arrive at the TCPT in June 2012.

The CPT has baggage handling areas (at the northern end of the building) and passenger processing areas (at the southern end of the building)

For the baggage handling areas (when in use) a 75 dB(A) external management level is appropriate.

For the passenger processing areas a more stringent management level is appropriate when in use. In setting an appropriate management level for the passenger processing areas, the following have been considered:

- AS 2107 recommends a “maximum” noise level of 50 dB(A)  $L_{eq}$  in check in areas of airports, or ticketing areas of railway or bus terminals.
- The ambient background noise level is likely to exceed this: the nearest long term monitoring location in High Street indicates an RBL of 51 dB(A).

Given the location of the CPT between two major construction sites, a 50 dB(A) goal would be unrealistic. It is proposed to adopt a noise management level of 5 dB(A) above the background noise level, combined from the Headland Park Site and the construction site to the south of the CPT.

This gives a management level of 54 dB(A) for noise from the Headland Park Site to the passenger processing areas when the CPT is in use which allows for 2 dB(A) cumulative build-up of noise due to the two construction sites.

It is noted that the maximum possible cumulative build up from the two sites is 3 dB(A), which will only occur when the noise levels emitted from the two construction sites is the same. The management level for the Headland Park site is assessed at the northern end of the CPT and noise from the site south of the CPT would be assessed at the southern most point of the CPT. Consequently, at the corresponding assessment points for the two sites, the level from the other site will be lower, meaning the maximum cumulative effect would be 2 dB(A).

#### **7.2.8 Noise Goals – External Cafes**

The proposed works may affect cafes with external seating.

For these receivers, a 70 dB(A)  $L_{eq}$  external level may be unacceptable especially during peak use periods around lunch time. For these occupancies it is proposed to set the management level during these periods at 10 dB(A) above the prevailing background noise level, and in any case not exceeding 70 dB(A).

**7.2.9 Summary of Noise Goals**

Following table provides a summary of the noise management levels for operations not occurring 24 hours per day.

**Table 8 – Noise Management Level\***

| Location/Receiver                                        | Noise Affected Management Level<br>dB(A) $L_{eq}$    | Highly Noise Affected Management Level Limit | Comment                                                               |
|----------------------------------------------------------|------------------------------------------------------|----------------------------------------------|-----------------------------------------------------------------------|
| Residences on Merriman and Bettington Streets            | 54                                                   | 75                                           |                                                                       |
| Residential Receivers on Windmill Street                 | 61                                                   | 75                                           |                                                                       |
| Residential Receivers on Towns Place                     | 63                                                   | 75                                           |                                                                       |
| Residential Receivers on Argyle Place                    | 62                                                   | 75                                           |                                                                       |
| Residences on High Street                                | 61                                                   | 75                                           |                                                                       |
| Residences Balmain Peninsula                             | 58                                                   | 75                                           |                                                                       |
| External Cafes around Argyle Place                       | 62/70                                                | -                                            | Lower goal applies during peak use periods                            |
| Commercial Buildings Generally                           | 70 externally<br>45 internally if 70 level exceeded. | -                                            |                                                                       |
| Harbour Control Tower Industrial/Maintenance Activities  | 75                                                   |                                              | When occurring for spasmodically occurring maintenance activities.    |
| Harbour Control Tower                                    | 48                                                   | See Comment                                  | 55 dB(A) $L_{eq}$ limit not to be exceeded without specific approval. |
| Temporary Passenger Terminal Cargo Area                  | 75                                                   |                                              | When in use                                                           |
| Temporary Passenger Terminal Customs and processing Area | 54                                                   |                                              | When in use                                                           |
| Moore's Wharf                                            | 70 externally<br>45 internally if 70 level exceeded. | -                                            |                                                                       |

\* Assessed at the most affected part of the occupancy

Following provide a summary of the noise management levels for operations occurring 24 hours per day at the most impacted receivers.

**Table 9 – Noise Criteria – 24 Hour Operations**

| Location/Receiver                             | Noise Criterion dB(A) $L_{eq}$ |
|-----------------------------------------------|--------------------------------|
| Residences on Merriman and Bettington Streets | 42                             |
| Residences on High Street                     | 45                             |
| Residences Balmain Peninsula                  | 45                             |

### 7.3 PREDICTED NOISE LEVELS

Noise levels at various locations representing the range of potentially affected receivers around the site. For each phase and for each plant item a range of worst case noise levels corresponding to the minimum and maximum distances between the source and receiver that is likely to occur. The cumulative worst case noise level was calculated by adding the individual noise sources together.

This form of presentation is used to identify those items of plant/activities that may be significant contributors to noise levels or may cause exceedences of the noise goals. The ICNG requires that conceptual treatment of those noise sources be considered, which is included in the attached Preliminary NVMP. The ICNG requires a final evaluation of noise levels and mitigation to be developed post-development approval once there is sufficient detail for evaluation and planning.

Particularly in the case of the cumulative noise levels, **the highest noise level in the range is a theoretical maximum, unlikely to be achieved in practice because:**

- All the plant is unlikely to be all simultaneously operating under worst case conditions at one time.
- It assumes no management measures would be put into place.
- It is assumed that the activities will be occurring continuously, whereas some activities occur intermittently.
- Particularly when undertaking excavation, noise levels generally decrease due to barrier effects from the perimeter of the excavations.

For these reasons a cumulative noise level towards the middle of the range would be more typical.

Where noise emissions to all receivers located in a group would be attenuated by existing built or natural barriers this attenuation has been included. Otherwise, the noise predictions represent worst case noise levels (without screening). Using this methodology, the worst case noise levels are presented: those receivers benefiting from additional screening would receive correspondingly lower noise levels.

### 7.3.1 Commercial Premises at Hickson Street

The following table presents a summary of noise levels which will occur at the Commercial receiver – “Universal Music Australia” on Hickson Road. These commercial receivers are situated in a building with closed windows and air conditioning, and a likely façade noise reduction of 20 dB(A) has been assumed. Noise levels would be assessed using the external commercial management level of 70 dB(A).

**Table 10 – Predicted Worst Case Noise Levels – Commercial Receivers at Hickson Road – External**

| EQUIPMENT /PROCESS                               | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) L <sub>eq</sub> | RECEIVER GOAL NOISE LEVEL dB(A) L <sub>eq</sub> |
|--------------------------------------------------|----------------------------|-------------------------------------------------------|-------------------------------------------------|
| Sandstone Excavation & Dewatering                |                            |                                                       |                                                 |
| Trencore Rock Saw on 30t Excavator               | 57 to 66                   | 80 to 89                                              | 70                                              |
| Krupp 950 Hammer on 30t Excavator (2)            | 80 to 89                   |                                                       |                                                 |
| Alternating Rock Saw and Bucket on 30t Excavator | 57 to 66                   |                                                       |                                                 |
| Site Cranes (2)                                  | 55 to 64                   |                                                       |                                                 |
| Flatbed Trucks (2)                               | 50 to 70                   |                                                       |                                                 |
| Loader                                           | 57 to 77                   |                                                       |                                                 |
| Pump                                             | 37 to 46                   |                                                       |                                                 |
| Receipt of fill from Stage 1                     |                            |                                                       |                                                 |
| CAT 825 Compactor(2)                             | 65 to 78                   | 68 to 80                                              | 70                                              |
| D6-D9 Bulldozers (2)                             | 64 to 73                   |                                                       |                                                 |
| 10t Tipper Trucks (4)                            | 54 to 63                   |                                                       |                                                 |
| Vibration Roller                                 | 50 to 59                   |                                                       |                                                 |
| Flat Drum Roller                                 | 57 to 66                   |                                                       |                                                 |

| EQUIPMENT /PROCESS                     | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) Leq | RECEIVER GOAL NOISE LEVEL dB(A) Leq |
|----------------------------------------|----------------------------|-------------------------------------------|-------------------------------------|
| Excavation, Filling and Land Formation |                            |                                           |                                     |
| Hydraulic Jaw Cutter                   | 50 to 62                   | 71 to 84                                  | 70                                  |
| Concrete Saw on Excavator              | 55 to 67                   |                                           |                                     |
| Rock Saw on Excavator                  | 50 to 62                   |                                           |                                     |
| Hydraulic hammer on Excavator          | 70 to 82                   |                                           |                                     |
| 150-200 tonne cranes (2)               | 49 to 62                   |                                           |                                     |
| Concrete Trucks (2)                    | 56 to 69                   |                                           |                                     |
| Concrete Pump                          | 51 to 64                   |                                           |                                     |
| Trucks (2)                             | 49 to 70                   |                                           |                                     |
| Excavator                              | 55 to 68                   |                                           |                                     |
| Bulldozer                              | 55 to 76                   |                                           |                                     |
| Construction Activities                |                            |                                           |                                     |
| Site Cranes (2)                        | 55 to 68                   | 70 to 83                                  | 70                                  |
| Pilling Rig                            | 60 to 63                   |                                           |                                     |
| Bobcat                                 | 52 to 65                   |                                           |                                     |
| Angle grinders                         | 60 to 73                   |                                           |                                     |
| Electric Saw                           | 58 to 71                   |                                           |                                     |
| Drilling                               | 36 to 49                   |                                           |                                     |
| Hammering                              | 67 to 80                   |                                           |                                     |
| Impact drill                           | 47 to 60                   |                                           |                                     |
| Concrete Pump                          | 59 to 72                   |                                           |                                     |
| Concrete Trucks (2)                    | 60 to 73                   |                                           |                                     |
| Concrete Float/Vibrators               | 52 to 65                   |                                           |                                     |
| Truck                                  | 55 to 68                   |                                           |                                     |
| Forklifts                              | 47 to 60                   |                                           |                                     |

The predictions indicate that in worst case situations, excavator mounted hydraulic hammers would significantly exceed the noise affected management level at the most affected receivers. Noise emissions from this activity should be minimised by adopting the process indicated in NVMP to ensure that noise emissions are managed.

Some other processes would also generate noise levels exceeding the noise affected management goal. However, these exceedences are relatively small, or would occur for limited periods, and would sometimes be caused by equipment which would be used to minimise operation of louder plant (e.g. saws). Notwithstanding this, noise emissions from these activities should be reviewed in accordance with the noise and vibration management plan to minimise any exceedences of the management levels.

### 7.3.2 Residents on Merriman and Bettington Street

The following table presents a summary of noise levels which will occur at the residences located on Merriman Street, Millers Point. The residence located at Bettington Street has no windows to habitable rooms facing the proposed quarry, and hence the noise exposure will be similar to the Merriman Street residents.

**Table 11 – Predicted Worst Case Noise Levels – Residential Receivers at Merriman and Bettington Streets - External**

| EQUIPMENT /PROCESS                               | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) L <sub>eq</sub> | RECEIVER GOAL NOISE LEVEL dB(A) L <sub>eq</sub> |
|--------------------------------------------------|----------------------------|-------------------------------------------------------|-------------------------------------------------|
| Sandstone Excavation & Dewatering                |                            |                                                       |                                                 |
| Trencore Rock Saw on 30t Excavator               | 62 to 69                   | 85 to 92                                              | 54                                              |
| Krupp 950 Hammer on 30t Excavator (2)            | 85 to 92                   |                                                       |                                                 |
| Alternating Rock Saw and Bucket on 30t Excavator | 62 to 69                   |                                                       |                                                 |
| Site Cranes (2)                                  | 52 to 67                   |                                                       |                                                 |
| Flatbed Trucks (2)                               | 52 to 67                   |                                                       |                                                 |
| Loader                                           | 59 to 74                   |                                                       |                                                 |
| Pump                                             | 42 to 49*                  |                                                       |                                                 |
| Receipt of fill from Stage 1                     |                            |                                                       |                                                 |
| CAT 825 Compactor(2)                             | 64 to 70                   | 67 to 79                                              | 54                                              |
| D6-D9 Bulldozers (2)                             | 62 to 77                   |                                                       |                                                 |
| 10t Tipper Trucks (4)                            | 52 to 67                   |                                                       |                                                 |
| Vibration Roller                                 | 48 to 63                   |                                                       |                                                 |
| Flat Drum Roller                                 | 55 to 70                   |                                                       |                                                 |

\* - 24 hour noise limit of 42 dB(A) applies. This indicates that the pump would need to be relocated further from the receivers, screened or enclosed to meet the 24 hour noise limit.

| EQUIPMENT /PROCESS                     | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) Leq | RECEIVER GOAL NOISE LEVEL dB(A) Leq |
|----------------------------------------|----------------------------|-------------------------------------------|-------------------------------------|
| Excavation, Filling and Land Formation |                            |                                           |                                     |
| Hydraulic Jaw Cutter                   | 53 to 58                   | 74 to 79                                  | 54                                  |
| Concrete Saw on Excavator              | 58 to 63                   |                                           |                                     |
| Rock Saw on Excavator                  | 53 to 58                   |                                           |                                     |
| Hydraulic hammer on Excavator          | 73 to 78                   |                                           |                                     |
| 150-200 tonne cranes (2)               | 51 to 56                   |                                           |                                     |
| Concrete Trucks (2)                    | 58 to 63                   |                                           |                                     |
| Concrete Pump                          | 53 to 58                   |                                           |                                     |
| Trucks (2)                             | 51 to 70                   |                                           |                                     |
| Excavator                              | 57 to 62                   |                                           |                                     |
| Bulldozer                              | 57 to 62                   |                                           |                                     |
| Construction Activities                |                            |                                           |                                     |
| Site Cranes (2)                        | 58 to 70                   | 73 to 85                                  | 54                                  |
| Pilling Rig                            | 59 to 61                   |                                           |                                     |
| Bobcat                                 | 55 to 67                   |                                           |                                     |
| Angle grinders                         | 63 to 75                   |                                           |                                     |
| Electric Saw                           | 61 to 73                   |                                           |                                     |
| Drilling                               | 39 to 51                   |                                           |                                     |
| Hammering                              | 70 to 82                   |                                           |                                     |
| Impact drill                           | 50 to 62                   |                                           |                                     |
| Concrete Pump                          | 62 to 74                   |                                           |                                     |
| Concrete Trucks (2)                    | 63 to 75                   |                                           |                                     |
| Concrete Float/Vibrators               | 55 to 67                   |                                           |                                     |
| Truck                                  | 58 to 70                   |                                           |                                     |
| Forklifts                              | 50 to 62                   |                                           |                                     |

The predictions indicate that in worst case situations, many of the activities associated with the main works significantly exceed the noise affected management level at the most affected receivers. Noise emissions from these activities should be minimised by adopting the process indicated in NVMP to ensure that noise emissions are managed.

The dewatering pump would need to be relocated further from the receivers, screened or enclosed to meet the 24 hour noise limit.

### 7.3.3 Sydney Ports Harbour Control Tower

The following table presents a summary of noise levels which will occur at the Control tower tucked into the base of the rock face. The control tower has sealed windows and air conditioning, hence an internal background noise level of 45 dB(A) and a typical façade noise reduction of 33 dB(A) has been used to predict internal noise levels.

**Table 12 – Predicted Worst Case Noise Levels – Sydney Ports Harbour Control Tower – Internal**

| EQUIPMENT /PROCESS                               | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) $L_{eq}$ | RECEIVER GOAL NOISE LEVEL dB(A) $L_{eq}$ |
|--------------------------------------------------|----------------------------|------------------------------------------------|------------------------------------------|
| Sandstone Excavation & Dewatering                |                            |                                                |                                          |
| Trencore Rock Saw on 30t Excavator               | 25 to 35                   | 48 to 58                                       | 48 ML<br>55 Limit                        |
| Krupp 950 Hammer on 30t Excavator (2)            | 48 to 58                   |                                                |                                          |
| Alternating Rock Saw and Bucket on 30t Excavator | 25 to 35                   |                                                |                                          |
| Site Cranes (2)                                  | 18 to 33                   |                                                |                                          |
| Flatbed Trucks (2)                               | 18 to 33                   |                                                |                                          |
| Loader                                           | 25 to 40                   |                                                |                                          |
| Pump                                             | 5 to 15                    |                                                |                                          |
| Receipt of fill from Stage 1                     |                            |                                                |                                          |
| CAT 825 Compactor(2)                             | 34 to 35                   | 35 to 38                                       | 48 ML<br>55 Limit                        |
| D6-D9 Bulldozers (2)                             | 27 to 33                   |                                                |                                          |
| 10t Tipper Trucks (4)                            | 17 to 23                   |                                                |                                          |
| Vibration Roller                                 | 13 to 19                   |                                                |                                          |
| Flat Drum Roller                                 | 20 to 26                   |                                                |                                          |

| EQUIPMENT /PROCESS                     | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) Leq | RECEIVER GOAL NOISE LEVEL dB(A) Leq |
|----------------------------------------|----------------------------|-------------------------------------------|-------------------------------------|
| Excavation, Filling and Land Formation |                            |                                           |                                     |
| Hydraulic Jaw Cutter                   | 19 to 25                   | 40 to 46                                  | 48 ML<br>55 Limit                   |
| Concrete Saw on Excavator              | 24 to 30                   |                                           |                                     |
| Rock Saw on Excavator                  | 19 to 25                   |                                           |                                     |
| Hydraulic hammer on Excavator          | 39 to 45                   |                                           |                                     |
| 150-200 tonne cranes (2)               | 18 to 25                   |                                           |                                     |
| Concrete Trucks (2)                    | 25 to 32                   |                                           |                                     |
| Concrete Pump                          | 20 to 27                   |                                           |                                     |
| Trucks (2)                             | 18 to 33                   |                                           |                                     |
| Excavator                              | 24 to 31                   |                                           |                                     |
| Bulldozer                              | 24 to 31                   |                                           |                                     |
| Construction Activities                |                            |                                           |                                     |
| Site Cranes (2)                        | 23 to 33                   | 38 to 48                                  | 48 ML<br>55 Limit                   |
| Pilling Rig                            | 24 to 24                   |                                           |                                     |
| Bobcat                                 | 20 to 30                   |                                           |                                     |
| Angle grinders                         | 28 to 38                   |                                           |                                     |
| Electric Saw                           | 26 to 36                   |                                           |                                     |
| Drilling                               | 4 to 14                    |                                           |                                     |
| Hammering                              | 35 to 45                   |                                           |                                     |
| Impact drill                           | 15 to 25                   |                                           |                                     |
| Concrete Pump                          | 27 to 37                   |                                           |                                     |
| Concrete Trucks (2)                    | 28 to 38                   |                                           |                                     |
| Concrete Float/Vibrators               | 20 to 30                   |                                           |                                     |
| Truck                                  | 23 to 33                   |                                           |                                     |
| Forklifts                              | 15 to 25                   |                                           |                                     |

The predictions indicate that in worst case situations, excavator mounted hydraulic hammers would exceed the noise limits. This could be prevented by allowing only one hammer to operate near the tower at any one time and using smaller equipment or sound attenuated equipment when operating close to the tower. The remaining plant would not exceed the management level.

**Table 13 – Predicted Worst Case Noise Levels –Sydney Ports Harbour Control Tower – External**

| EQUIPMENT /PROCESS                               | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) $L_{eq}$ | RECEIVER GOAL NOISE LEVEL dB(A) $L_{eq}$ |
|--------------------------------------------------|----------------------------|------------------------------------------------|------------------------------------------|
| Sandstone Excavation & Dewatering                |                            |                                                |                                          |
| Trencore Rock Saw on 30t Excavator               | 60 to 76                   | 83 to 99                                       | 75                                       |
| Krupp 950 Hammer on 30t Excavator (2)            | 83 to 99                   |                                                |                                          |
| Alternating Rock Saw and Bucket on 30t Excavator | 60 to 76                   |                                                |                                          |
| Site Cranes (2)                                  | 51 to 74                   |                                                |                                          |
| Flatbed Trucks (2)                               | 51 to 74                   |                                                |                                          |
| Loader                                           | 58 to 81                   |                                                |                                          |
| Pump                                             | 40 to 56                   |                                                |                                          |
| Receipt of fill from Stage 1                     |                            |                                                |                                          |
| CAT 825 Compactor(2)                             | 67 to 68                   | 68 to 71                                       | 75                                       |
| D6-D9 Bulldozers (2)                             | 60 to 66                   |                                                |                                          |
| 10t Tipper Trucks (4)                            | 50 to 56                   |                                                |                                          |
| Vibration Roller                                 | 46 to 52                   |                                                |                                          |
| Flat Drum Roller                                 | 53 to 59                   |                                                |                                          |

| EQUIPMENT /PROCESS                     | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) Leq | RECEIVER GOAL NOISE LEVEL dB(A) Leq |
|----------------------------------------|----------------------------|-------------------------------------------|-------------------------------------|
| Excavation, Filling and Land Formation |                            |                                           |                                     |
| Hydraulic Jaw Cutter                   | 52 to 60                   | 73 to 82                                  | 75                                  |
| Concrete Saw on Excavator              | 57 to 65                   |                                           |                                     |
| Rock Saw on Excavator                  | 52 to 60                   |                                           |                                     |
| Hydraulic hammer on Excavator          | 72 to 80                   |                                           |                                     |
| 150-200 tonne cranes (2)               | 51 to 60                   |                                           |                                     |
| Concrete Trucks (2)                    | 58 to 67                   |                                           |                                     |
| Concrete Pump                          | 53 to 62                   |                                           |                                     |
| Trucks (2)                             | 51 to 74                   |                                           |                                     |
| Excavator                              | 57 to 66                   |                                           |                                     |
| Bulldozer                              | 57 to 66                   |                                           |                                     |
| Construction Activities                |                            |                                           |                                     |
| Site Cranes (2)                        | 56 to 74                   | 71 to 89                                  | 75                                  |
| Pilling Rig                            | 57 to 63                   |                                           |                                     |
| Bobcat                                 | 53 to 71                   |                                           |                                     |
| Angle grinders                         | 61 to 79                   |                                           |                                     |
| Electric Saw                           | 59 to 77                   |                                           |                                     |
| Drilling                               | 37 to 55                   |                                           |                                     |
| Hammering                              | 68 to 86                   |                                           |                                     |
| Impact drill                           | 48 to 66                   |                                           |                                     |
| Concrete Pump                          | 60 to 78                   |                                           |                                     |
| Concrete Trucks (2)                    | 61 to 79                   |                                           |                                     |
| Concrete Float/Vibrators               | 53 to 71                   |                                           |                                     |
| Truck                                  | 56 to 74                   |                                           |                                     |
| Forklifts                              | 48 to 66                   |                                           |                                     |

The predictions indicate that hammering, electric saw, concrete trucks and concrete pump during the construction stage and excavator mounted hydraulic hammers, rock saws and loaders during the sandstone extraction stage would exceed the noise management level.

Noise emissions from these activities should be minimised by adopting the process indicated in NVMP to ensure that noise emissions are managed. The level of mitigation should consider that the external areas around the base of the tower are generally not occupied, but may be occupied by maintenance staff from time to time, and by control tower staff accessing the control tower. The mitigation should attempt, as a minimum, to minimise noise levels to 85 dB(A)  $L_{eq}$ , the 8 hour per day long term noise level recommended to minimise risk of long term hearing damage.

Furthermore, activities like hammering, electric saws, loaders etc. that generate noise levels exceeding the noise affected management goal, produce exceedences that are relatively small, only affect a part of the receivers, would occur for limited periods, and would sometimes be caused by equipment which would be used to minimise operation of louder plant (e.g. saws).

Those activities identified as exceeding the management level should be managed by adopting alternative processes, and investigating potential mitigation measures, etc as indicated in NVMP to the extent that it is feasible and reasonable. The final processes used and mitigation measures applied will be developed by the contractor, who will be required to meet the objectives of the NVMP.

### 7.3.4 Moore's Wharf Facilities

The predicted noise levels are summarised below for the Moores Wharf Building based on the most stringent management level.

**Table 14 – Predicted Worst Case Noise Levels – External Receivers at Sydney Ports  
Moore's Wharf Facility – External**

| EQUIPMENT /PROCESS                               | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) $L_{eq}$ | RECEIVER GOAL NOISE LEVEL dB(A) $L_{eq}$ |
|--------------------------------------------------|----------------------------|------------------------------------------------|------------------------------------------|
| Sandstone Excavation & Dewatering                |                            |                                                |                                          |
| Trencore Rock Saw on 30t Excavator               | 34 to 58                   | 58 to 81                                       | 70                                       |
| Krupp 950 Hammer on 30t Excavator (2)            | 57 to 81                   |                                                |                                          |
| Alternating Rock Saw and Bucket on 30t Excavator | 34 to 58                   |                                                |                                          |
| Site Cranes (2)                                  | 52 to 56                   |                                                |                                          |
| Flatbed Trucks (2)                               | 32 to 56                   |                                                |                                          |
| Loader                                           | 39 to 63                   |                                                |                                          |
| Pump                                             | 14 to 38                   |                                                |                                          |
| Receipt of fill from Stage 1                     |                            |                                                |                                          |
| CAT 825 Compactor(2)                             | 40 to 42                   | 43 to 45                                       | 70                                       |
| D6-D9 Bulldozers (2)                             | 38 to 40                   |                                                |                                          |
| 10t Tipper Trucks (4)                            | 28 to 30                   |                                                |                                          |
| Vibration Roller                                 | 24 to 26                   |                                                |                                          |
| Flat Drum Roller                                 | 31 to 33                   |                                                |                                          |

| EQUIPMENT /PROCESS                     | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) Leq | RECEIVER GOAL NOISE LEVEL dB(A) Leq |
|----------------------------------------|----------------------------|-------------------------------------------|-------------------------------------|
| Excavation, Filling and Land Formation |                            |                                           |                                     |
| Hydraulic Jaw Cutter                   | 32 to 68                   | 40 to 78                                  | 70                                  |
| Concrete Saw on Excavator              | 37 to 73                   |                                           |                                     |
| Rock Saw on Excavator                  | 32 to 68                   |                                           |                                     |
| Hydraulic hammer on Excavator          | 52 to 88                   |                                           |                                     |
| 150-200 tonne cranes (2)               | 30 to 66                   |                                           |                                     |
| Concrete Trucks (2)                    | 35 to 73                   |                                           |                                     |
| Concrete Pump                          | 30 to 68                   |                                           |                                     |
| Trucks (2)                             | 31 to 69                   |                                           |                                     |
| Excavator                              | 34 to 72                   |                                           |                                     |
| Bulldozer                              | 34 to 72                   |                                           |                                     |
| Construction Activities                |                            |                                           |                                     |
| Site Cranes (2)                        | 30 to 35                   | 39 to 44                                  | 70                                  |
| Pilling Rig                            | 37 to 42                   |                                           |                                     |
| Bobcat                                 | 27 to 32                   |                                           |                                     |
| Angle grinders                         | 40 to 45                   |                                           |                                     |
| Electric Saw                           | 38 to 43                   |                                           |                                     |
| Drilling                               | 16 to 21                   |                                           |                                     |
| Hammering                              | 47 to 52                   |                                           |                                     |
| Impact drill                           | 27 to 32                   |                                           |                                     |
| Concrete Pump                          | 34 to 39                   |                                           |                                     |
| Concrete Trucks (2)                    | 35 to 40                   |                                           |                                     |
| Concrete Float/Vibrators               | 27 to 32                   |                                           |                                     |
| Truck                                  | 30 to 35                   |                                           |                                     |
| Forklifts                              | 22 to 27                   |                                           |                                     |

The predictions indicate that in worst case situations, excavator mounted hydraulic hammers would significantly exceed the noise affected management level (NAML) at the most affected receivers. Excluding noise emissions from hammering operations, for most of the time noise levels would not exceed the management level. Some processes would generate noise levels exceeding the noise affected management goal during the excavation, filling and land formation stage of the works, however these exceedences are relatively small, would occur for limited periods, and would sometimes

be caused by equipment which has been employed to minimise operation of the louder, percussive extraction plant.

Those activities identified as exceeding the management level should be managed by adopting alternative processes, and investigating potential mitigation measures, etc as indicated in NVMP to the extent that it is feasible and reasonable. The final processes used and mitigation measures applied will be developed by the contractor, who will be required to meet the objectives of the NVMP.

### 7.3.5 Sydney Ports Cruise Passenger Terminal

The predicted noise levels are summarised below for the customs and passenger areas of the CPT. It is noted that the baggage handling area of the CPT is closer to the construction site, but has a significant less stringent noise goal so any noise management adopted for the customs and passenger areas would also be effective for the baggage area.

**Table 15 – Predicted Worst Case Noise Levels – Cruise Passenger Terminal – External\***

| EQUIPMENT /PROCESS                               | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) L <sub>eq</sub> | RECEIVER GOAL NOISE LEVEL dB(A) L <sub>eq</sub> |
|--------------------------------------------------|----------------------------|-------------------------------------------------------|-------------------------------------------------|
| Sandstone Excavation & Dewatering                |                            |                                                       |                                                 |
| Trencore Rock Saw on 30t Excavator               | 54 to 56                   | 77 to 79                                              | 54                                              |
| Krupp 950 Hammer on 30t Excavator (2)            | 77 to 79                   |                                                       |                                                 |
| Alternating Rock Saw and Bucket on 30t Excavator | 54 to 56                   |                                                       |                                                 |
| Site Cranes (2)                                  | 52 to 58                   |                                                       |                                                 |
| Flatbed Trucks (2)                               | 52 to 58                   |                                                       |                                                 |
| Loader                                           | 59 to 65                   |                                                       |                                                 |
| Pump                                             | 34 to 36                   |                                                       |                                                 |
| Receipt of fill from Stage 1                     |                            |                                                       |                                                 |
| CAT 825 Compactor(2)                             | 66 to 72                   | 69 to 75                                              | 54                                              |
| D6-D9 Bulldozers (2)                             | 64 to 70                   |                                                       |                                                 |
| 10t Tipper Trucks (4)                            | 54 to 60                   |                                                       |                                                 |
| Vibration Roller                                 | 50 to 56                   |                                                       |                                                 |
| Flat Drum Roller                                 | 57 to 63                   |                                                       |                                                 |

| EQUIPMENT /PROCESS                     | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) Leq | RECEIVER GOAL NOISE LEVEL dB(A) Leq |
|----------------------------------------|----------------------------|-------------------------------------------|-------------------------------------|
| Excavation, Filling and Land Formation |                            |                                           |                                     |
| Hydraulic Jaw Cutter                   | 48 to 62                   | 69 to 83                                  | 54                                  |
| Concrete Saw on Excavator              | 53 to 67                   |                                           |                                     |
| Rock Saw on Excavator                  | 48 to 62                   |                                           |                                     |
| Hydraulic hammer on Excavator          | 68 to 82                   |                                           |                                     |
| 150-200 tonne cranes (2)               | 50 to 63                   |                                           |                                     |
| Concrete Trucks (2)                    | 57 to 70                   |                                           |                                     |
| Concrete Pump                          | 52 to 65                   |                                           |                                     |
| Trucks (2)                             | 50 to 63                   |                                           |                                     |
| Excavator                              | 56 to 69                   |                                           |                                     |
| Bulldozer                              | 56 to 69                   |                                           |                                     |
| Construction Activities                |                            |                                           |                                     |
| Site Cranes (2)                        | 51 to 56                   | 66 to 71                                  | 54                                  |
| Pilling Rig                            | 58 to 63                   |                                           |                                     |
| Bobcat                                 | 48 to 53                   |                                           |                                     |
| Angle grinders                         | 56 to 61                   |                                           |                                     |
| Electric Saw                           | 54 to 59                   |                                           |                                     |
| Drilling                               | 32 to 37                   |                                           |                                     |
| Hammering                              | 63 to 68                   |                                           |                                     |
| Impact drill                           | 43 to 48                   |                                           |                                     |
| Concrete Pump                          | 55 to 60                   |                                           |                                     |
| Concrete Trucks (2)                    | 56 to 61                   |                                           |                                     |
| Concrete Float/Vibrators               | 48 to 53                   |                                           |                                     |
| Truck                                  | 51 to 56                   |                                           |                                     |
| Forklifts                              | 43 to 48                   |                                           |                                     |

Construction of a new passenger terminal is proposed to begin in 2011 and be completed in 2012. Hence the temporary passenger terminal is expected to be required for approximately 2 years with the last ships forecast to arrive at the TCPT in June 2012.

The predictions indicate a number of processes would exceed the management level at this location.

However, noise emissions from the excavation and construction activities will impact the temporary cruise passenger terminal for only a couple of months and noise emissions from the land filling and formation of Headland park will have no impact on the TCPT as these works are proposed to begin only after the TCPT has moved to its new location.

Furthermore there is an opportunity to lower the noise emissions from plant carrying stage 1 fill by using the stockpile at the southern end of the site, thereby assisting in attenuating noise to the CPT.

Management of all other noise sources identified as exceeding the noise goal should be undertaken in accordance with the NVMP.

### 7.3.6 Residences at Dalgety Road

The following table presents a summary of noise levels which will occur at residences located along Dalgety Road, Miller's Point. The rock face and Merriman Street residences will act as a barrier, shielding these receivers from the construction noise.

**Table 16 – Predicted Worst Case Noise Levels – Residential Receivers at Dalgety Road**

| EQUIPMENT /PROCESS                               | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) L <sub>eq</sub> | RECEIVER GOAL NOISE LEVEL dB(A) L <sub>eq</sub> |
|--------------------------------------------------|----------------------------|-------------------------------------------------------|-------------------------------------------------|
| Sandstone Excavation & Dewatering                |                            |                                                       |                                                 |
| Trencore Rock Saw on 30t Excavator               | 38 to 42                   | 61 to 65                                              | 61                                              |
| Krupp 950 Hammer on 30t Excavator (2)            | 61 to 65                   |                                                       |                                                 |
| Alternating Rock Saw and Bucket on 30t Excavator | 38 to 42                   |                                                       |                                                 |
| Site Cranes (2)                                  | 29 to 40                   |                                                       |                                                 |
| Flatbed Trucks (2)                               | 29 to 40                   |                                                       |                                                 |
| Loader                                           | 36 to 47                   |                                                       |                                                 |
| Pump                                             | 18 to 22                   |                                                       |                                                 |
| Receipt of fill from Stage 1                     |                            |                                                       |                                                 |
| CAT 825 Compactor(2)                             | 41 to 50                   | 44 to 53                                              | 61                                              |
| D6-D9 Bulldozers (2)                             | 39 to 48                   |                                                       |                                                 |
| 10t Tipper Trucks (4)                            | 29 to 38                   |                                                       |                                                 |
| Vibration Roller                                 | 25 to 34                   |                                                       |                                                 |
| Flat Drum Roller                                 | 32 to 41                   |                                                       |                                                 |

| EQUIPMENT /PROCESS                     | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) Leq | RECEIVER GOAL NOISE LEVEL dB(A) Leq |
|----------------------------------------|----------------------------|-------------------------------------------|-------------------------------------|
| Excavation, Filling and Land Formation |                            |                                           |                                     |
| Hydraulic Jaw Cutter                   | 44 to 47                   | 65 to 68                                  | 61                                  |
| Concrete Saw on Excavator              | 49 to 52                   |                                           |                                     |
| Rock Saw on Excavator                  | 44 to 47                   |                                           |                                     |
| Hydraulic hammer on Excavator          | 64 to 67                   |                                           |                                     |
| 150-200 tonne cranes (2)               | 43 to 46                   |                                           |                                     |
| Concrete Trucks (2)                    | 50 to 53                   |                                           |                                     |
| Concrete Pump                          | 45 to 48                   |                                           |                                     |
| Trucks (2)                             | 43 to 53                   |                                           |                                     |
| Excavator                              | 49 to 52                   |                                           |                                     |
| Bulldozer                              | 49 to 52                   |                                           |                                     |
| Construction Activities                |                            |                                           |                                     |
| Site Cranes (2)                        | 30 to 33                   | 45 to 48                                  | 61                                  |
| Pilling Rig                            | 32 to 33                   |                                           |                                     |
| Bobcat                                 | 27 to 30                   |                                           |                                     |
| Angle grinders                         | 35 to 38                   |                                           |                                     |
| Electric Saw                           | 33 to 36                   |                                           |                                     |
| Drilling                               | 11 to 14                   |                                           |                                     |
| Hammering                              | 42 to 45                   |                                           |                                     |
| Impact drill                           | 22 to 25                   |                                           |                                     |
| Concrete Pump                          | 34 to 37                   |                                           |                                     |
| Concrete Trucks (2)                    | 35 to 38                   |                                           |                                     |
| Concrete Float/Vibrators               | 27 to 30                   |                                           |                                     |
| Truck                                  | 30 to 33                   |                                           |                                     |
| Forklifts                              | 22 to 25                   |                                           |                                     |

The predictions indicate that in worst case situations, excavator mounted hydraulic hammers would exceed the noise affected management level (NAML) at the most affected receivers. Noise emissions from this activity should be minimised by adopting the process indicated in NVMP to ensure that noise emissions are managed.

**7.3.7 Commercial Receivers on Windmill Street**

The following tables present a summary of noise levels which will occur at commercial receivers at Windmill Street. Some of the commercial receivers are external (including cafes) and some are located within sealed and air conditioned buildings

**Table 17 – Predicted Worst Case Noise Levels – Commercial Receivers at Windmill Street – External**

| EQUIPMENT /PROCESS                               | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) $L_{eq}$ | RECEIVER GOAL NOISE LEVEL dB(A) $L_{eq}$ |
|--------------------------------------------------|----------------------------|------------------------------------------------|------------------------------------------|
| Sandstone Excavation & Dewatering                |                            |                                                |                                          |
| Trencore Rock Saw on 30t Excavator               | 32 to 35                   | 55 to 58                                       | 70<br>61 External Cafes                  |
| Krupp 950 Hammer on 30t Excavator (2)            | 55 to 58                   |                                                |                                          |
| Alternating Rock Saw and Bucket on 30t Excavator | 32 to 35                   |                                                |                                          |
| Site Cranes (2)                                  | 25 to 33                   |                                                |                                          |
| Flatbed Trucks (2)                               | 25 to 33                   |                                                |                                          |
| Loader                                           | 32 to 40                   |                                                |                                          |
| Pump                                             | 12 to 15                   |                                                |                                          |
| Receipt of fill from Stage 1                     |                            |                                                |                                          |
| CAT 825 Compactor(2)                             | 37 to 41                   | 40 to 44                                       | 70<br>61 External Cafes                  |
| D6-D9 Bulldozers (2)                             | 35 to 39                   |                                                |                                          |
| 10t Tipper Trucks (4)                            | 25 to 29                   |                                                |                                          |
| Vibration Roller                                 | 21 to 25                   |                                                |                                          |
| Flat Drum Roller                                 | 28 to 32                   |                                                |                                          |

| EQUIPMENT /PROCESS                     | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) L <sub>eq</sub> | RECEIVER GOAL NOISE LEVEL dB(A) L <sub>eq</sub> |
|----------------------------------------|----------------------------|-------------------------------------------------------|-------------------------------------------------|
| Excavation, Filling and Land Formation |                            |                                                       |                                                 |
| Hydraulic Jaw Cutter                   | 27 to 30                   | 48 to 51                                              | 70<br>61 External Cafes                         |
| Concrete Saw on Excavator              | 32 to 35                   |                                                       |                                                 |
| Rock Saw on Excavator                  | 27 to 30                   |                                                       |                                                 |
| Hydraulic hammer on Excavator          | 47 to 50                   |                                                       |                                                 |
| 150-200 tonne cranes (2)               | 26 to 29                   |                                                       |                                                 |
| Concrete Trucks (2)                    | 33 to 36                   |                                                       |                                                 |
| Concrete Pump                          | 28 to 31                   |                                                       |                                                 |
| Trucks (2)                             | 26 to 29                   |                                                       |                                                 |
| Excavator                              | 32 to 35                   |                                                       |                                                 |
| Bulldozer                              | 32 to 35                   |                                                       |                                                 |
| Construction Activities                |                            |                                                       |                                                 |
| Site Cranes (2)                        | 29 to 32                   | 44 to 47                                              | 70<br>61 External Cafes                         |
| Pilling Rig                            | 31 to 32                   |                                                       |                                                 |
| Bobcat                                 | 26 to 29                   |                                                       |                                                 |
| Angle grinders                         | 34 to 37                   |                                                       |                                                 |
| Electric Saw                           | 32 to 35                   |                                                       |                                                 |
| Drilling                               | 10 to 13                   |                                                       |                                                 |
| Hammering                              | 41 to 44                   |                                                       |                                                 |
| Impact drill                           | 21 to 24                   |                                                       |                                                 |
| Concrete Pump                          | 33 to 36                   |                                                       |                                                 |
| Concrete Trucks (2)                    | 34 to 37                   |                                                       |                                                 |
| Concrete Float/Vibrators               | 26 to 29                   |                                                       |                                                 |
| Truck                                  | 29 to 32                   |                                                       |                                                 |
| Forklifts                              | 21 to 24                   |                                                       |                                                 |

The predictions indicate that, even in worst case situations, noise emissions would not adversely impact commercial receivers at Windmill Street.

### 7.3.8 Receivers on Towns Place

The following tables present a summary of noise levels which will occur at residential and commercial receivers on Towns Place. As some of the receivers are external and some are located within sealed and air conditioned buildings, two assessments are presented - one for buildings with windows that are normally kept closed, and one set for external activities and occupancies that are likely to have windows normally open such as cafes, bars and restaurants; which also apply for residential receivers. Again for the closed windows scenario, a typical façade noise reduction of 33 dB(A) has been used to predict internal noise levels.

**Table 18 - Predicted Worst Case Noise Levels – External Commercial and Residential Receivers at Towns Place - External**

| EQUIPMENT /PROCESS                               | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) L <sub>eq</sub> | RECEIVER GOAL NOISE LEVEL dB(A) L <sub>eq</sub>                         |
|--------------------------------------------------|----------------------------|-------------------------------------------------------|-------------------------------------------------------------------------|
| Sandstone Excavation & Dewatering                |                            |                                                       |                                                                         |
| Trencore Rock Saw on 30t Excavator               | 31 to 34                   | 54 to 57                                              | 63 for residences and external cafes<br>70 dB(A) for general commercial |
| Krupp 950 Hammer on 30t Excavator (2)            | 54 to 57                   |                                                       |                                                                         |
| Alternating Rock Saw and Bucket on 30t Excavator | 31 to 34                   |                                                       |                                                                         |
| Site Cranes (2)                                  | 23 to 32                   |                                                       |                                                                         |
| Flatbed Trucks (2)                               | 23 to 32                   |                                                       |                                                                         |
| Loader                                           | 30 to 39                   |                                                       |                                                                         |
| Pump                                             | 11 to 14                   |                                                       |                                                                         |
| Receipt of fill from Stage 1                     |                            |                                                       |                                                                         |
| CAT 825 Compactor(2)                             | 35 to 38                   | 38 to 41                                              | 63 for residences and external cafes<br>70 dB(A) for general commercial |
| D6-D9 Bulldozers (2)                             | 33 to 36                   |                                                       |                                                                         |
| 10t Tipper Trucks (4)                            | 23 to 26                   |                                                       |                                                                         |
| Vibration Roller                                 | 19 to 22                   |                                                       |                                                                         |
| Flat Drum Roller                                 | 26 to 29                   |                                                       |                                                                         |

| EQUIPMENT /PROCESS                     | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) L <sub>eq</sub> | RECEIVER GOAL NOISE LEVEL dB(A) L <sub>eq</sub>                         |
|----------------------------------------|----------------------------|-------------------------------------------------------|-------------------------------------------------------------------------|
| Excavation, Filling and Land Formation |                            |                                                       |                                                                         |
| Hydraulic Jaw Cutter                   | 52 to 58                   | 73 to 79                                              | 63 for residences and external cafes<br>70 dB(A) for general commercial |
| Concrete Saw on Excavator              | 57 to 63                   |                                                       |                                                                         |
| Rock Saw on Excavator                  | 52 to 58                   |                                                       |                                                                         |
| Hydraulic hammer on Excavator          | 72 to 78                   |                                                       |                                                                         |
| 150-200 tonne cranes (2)               | 50 to 58                   |                                                       |                                                                         |
| Concrete Trucks (2)                    | 57 to 65                   |                                                       |                                                                         |
| Concrete Pump                          | 52 to 60                   |                                                       |                                                                         |
| Trucks (2)                             | 50 to 58                   |                                                       |                                                                         |
| Excavator                              | 56 to 64                   |                                                       |                                                                         |
| Bulldozer                              | 56 to 64                   |                                                       |                                                                         |
| Construction Activities                |                            |                                                       |                                                                         |
| Site Cranes (2)                        | 29 to 33                   | 44 to 48                                              | 63 for residences and external cafes<br>70 dB(A) for general commercial |
| Pilling Rig                            | 29 to 30                   |                                                       |                                                                         |
| Bobcat                                 | 26 to 30                   |                                                       |                                                                         |
| Angle grinders                         | 34 to 38                   |                                                       |                                                                         |
| Electric Saw                           | 32 to 36                   |                                                       |                                                                         |
| Drilling                               | 10 to 14                   |                                                       |                                                                         |
| Hammering                              | 41 to 45                   |                                                       |                                                                         |
| Impact drill                           | 21 to 25                   |                                                       |                                                                         |
| Concrete Pump                          | 33 to 37                   |                                                       |                                                                         |
| Concrete Trucks (2)                    | 34 to 38                   |                                                       |                                                                         |
| Concrete Float/Vibrators               | 26 to 30                   |                                                       |                                                                         |
| Truck                                  | 29 to 33                   |                                                       |                                                                         |
| Forklifts                              | 21 to 25                   |                                                       |                                                                         |

The predictions indicate that in worst case situations, excavator mounted hydraulic hammers and concrete trucks undertaking filling and land formation activities would exceed the noise affected management level (NAML) at the most affected receivers. Noise emissions from these activities should be minimised by adopting the process indicated in NVMP to ensure that noise emissions are managed.

The remaining processes and activities would not produce noise levels exceeding the management goals.

As some noise levels exceed the general commercial external noise goal, the likely internal noise levels will be calculated for the commercial buildings on the basis of these being air conditioned and modern facades offering a typical noise reduction of 33 dB(A).

**Table 19 – Predicted Worst Case Noise Levels – Commercial Receivers at Towns Place – Internal**

| EQUIPMENT /PROCESS                               | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) L <sub>eq</sub> | RECEIVER GOAL NOISE LEVEL dB(A) L <sub>eq</sub> |
|--------------------------------------------------|----------------------------|-------------------------------------------------------|-------------------------------------------------|
| Sandstone Excavation & Dewatering                |                            |                                                       |                                                 |
| Trencore Rock Saw on 30t Excavator               | -2 to 1                    | 21 to 24                                              | 45                                              |
| Krupp 950 Hammer on 30t Excavator (2)            | 21 to 24                   |                                                       |                                                 |
| Alternating Rock Saw and Bucket on 30t Excavator | -2 to 1                    |                                                       |                                                 |
| Site Cranes (2)                                  | -10 to -1                  |                                                       |                                                 |
| Flatbed Trucks (2)                               | -10 to -1                  |                                                       |                                                 |
| Loader                                           | -3 to 6                    |                                                       |                                                 |
| Pump                                             | -22 to -19                 |                                                       |                                                 |
| Receipt of fill from Stage 1                     |                            |                                                       |                                                 |
| CAT 825 Compactor(2)                             | 2 to 5                     | 5 to 8                                                | 45                                              |
| D6-D9 Bulldozers (2)                             | 0 to 3                     |                                                       |                                                 |
| 10t Tipper Trucks (4)                            | -10 to -7                  |                                                       |                                                 |
| Vibration Roller                                 | -14 to -11                 |                                                       |                                                 |
| Flat Drum Roller                                 | -7 to -4                   |                                                       |                                                 |

| EQUIPMENT /PROCESS                     | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) Leq | RECEIVER GOAL NOISE LEVEL dB(A) Leq |
|----------------------------------------|----------------------------|-------------------------------------------|-------------------------------------|
| Excavation, Filling and Land Formation |                            |                                           |                                     |
| Hydraulic Jaw Cutter                   | 19 to 25                   | 40 to 46                                  | 45                                  |
| Concrete Saw on Excavator              | 24 to 30                   |                                           |                                     |
| Rock Saw on Excavator                  | 19 to 25                   |                                           |                                     |
| Hydraulic hammer on Excavator          | 39 to 45                   |                                           |                                     |
| 150-200 tonne cranes (2)               | 17 to 25                   |                                           |                                     |
| Concrete Trucks (2)                    | 24 to 32                   |                                           |                                     |
| Concrete Pump                          | 19 to 27                   |                                           |                                     |
| Trucks (2)                             | 17 to 25                   |                                           |                                     |
| Excavator                              | 23 to 31                   |                                           |                                     |
| Bulldozer                              | 23 to 31                   |                                           |                                     |
| Construction Activities                |                            |                                           |                                     |
| Site Cranes (2)                        | -4 to 0                    | 11 to 15                                  | 45                                  |
| Pilling Rig                            | -4 to -3                   |                                           |                                     |
| Bobcat                                 | -7 to -3                   |                                           |                                     |
| Angle grinders                         | 1 to 5                     |                                           |                                     |
| Electric Saw                           | -1 to 3                    |                                           |                                     |
| Drilling                               | -23 to -19                 |                                           |                                     |
| Hammering                              | 8 to 12                    |                                           |                                     |
| Impact drill                           | -12 to -8                  |                                           |                                     |
| Concrete Pump                          | 0 to 4                     |                                           |                                     |
| Concrete Trucks (2)                    | 1 to 5                     |                                           |                                     |
| Concrete Float/Vibrators               | -7 to -3                   |                                           |                                     |
| Truck                                  | -4 to 0                    |                                           |                                     |
| Forklifts                              | -12 to -8                  |                                           |                                     |

The predictions indicate that in worst case situations, noise emissions from the cumulative impact of plant during the excavation, filling and land formation stage of the works would only marginally exceed the internal management level within commercial air conditioned buildings with closed windows.

### 7.3.9 Commercial Receivers at Pier 8-9

The following table presents a summary of noise levels which will occur at the Commercial receivers at Pier 8-9. As these commercial receivers are situated in a building with closed windows and air conditioning, an internal background noise level of 45 dB(A) and a typical façade noise reduction of 33 dB(A) has been used to predict internal noise levels. The residential receivers along Towns Place, Merriman Street and Dalgety Road will act as a barrier, shielding these receivers from the extraction and construction activities.

**Table 20 – Predicted Worst Case Noise Levels – Commercial Receivers located at Pier 8 – 9 – Internal**

| EQUIPMENT /PROCESS                               | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) $L_{eq}$ | RECEIVER GOAL NOISE LEVEL dB(A) $L_{eq}$ |
|--------------------------------------------------|----------------------------|------------------------------------------------|------------------------------------------|
| Sandstone Excavation & Dewatering                |                            |                                                |                                          |
| Trencore Rock Saw on 30t Excavator               | -6 to -2                   | 17 to 21                                       | 45                                       |
| Krupp 950 Hammer on 30t Excavator (2)            | 17 to 21                   |                                                |                                          |
| Alternating Rock Saw and Bucket on 30t Excavator | -6 to -2                   |                                                |                                          |
| Site Cranes (2)                                  | -8 to -4                   |                                                |                                          |
| Flatbed Trucks (2)                               | -8 to 2                    |                                                |                                          |
| Loader                                           | -1 to 9                    |                                                |                                          |
| Pump                                             | -26 to -22                 |                                                |                                          |
| Receipt of fill from Stage 1                     |                            |                                                |                                          |
| CAT 825 Compactor(2)                             | 27 to 39                   | 30 to 40                                       | 45                                       |
| D6-D9 Bulldozers (2)                             | 25 to 33                   |                                                |                                          |
| 10t Tipper Trucks (4)                            | 15 to 23                   |                                                |                                          |
| Vibration Roller                                 | 11 to 19                   |                                                |                                          |
| Flat Drum Roller                                 | 18 to 26                   |                                                |                                          |

| EQUIPMENT /PROCESS                     | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) Leq | RECEIVER GOAL NOISE LEVEL dB(A) Leq |
|----------------------------------------|----------------------------|-------------------------------------------|-------------------------------------|
| Excavation, Filling and Land Formation |                            |                                           |                                     |
| Hydraulic Jaw Cutter                   | 14 to 29                   | 35 to 50                                  | 45                                  |
| Concrete Saw on Excavator              | 19 to 34                   |                                           |                                     |
| Rock Saw on Excavator                  | 14 to 29                   |                                           |                                     |
| Hydraulic hammer on Excavator          | 34 to 49                   |                                           |                                     |
| 150-200 tonne cranes (2)               | 12 to 27                   |                                           |                                     |
| Concrete Trucks (2)                    | 19 to 34                   |                                           |                                     |
| Concrete Pump                          | 14 to 29                   |                                           |                                     |
| Trucks (2)                             | 12 to 27                   |                                           |                                     |
| Excavator                              | 18 to 33                   |                                           |                                     |
| Bulldozer                              | 18 to 33                   |                                           |                                     |
| Construction Activities                |                            |                                           |                                     |
| Site Cranes (2)                        | -8 to -5                   | 7 to 10                                   | 45                                  |
| Pilling Rig                            | -4 to -3                   |                                           |                                     |
| Bobcat                                 | -11 to -8                  |                                           |                                     |
| Angle grinders                         | -3 to 0                    |                                           |                                     |
| Electric Saw                           | -5 to -2                   |                                           |                                     |
| Drilling                               | -27 to -24                 |                                           |                                     |
| Hammering                              | 4 to 7                     |                                           |                                     |
| Impact drill                           | -16 to -13                 |                                           |                                     |
| Concrete Pump                          | -4 to -1                   |                                           |                                     |
| Concrete Trucks (2)                    | -3 to 0                    |                                           |                                     |
| Concrete Float/Vibrators               | -11 to -8                  |                                           |                                     |
| Truck                                  | -8 to -5                   |                                           |                                     |
| Forklifts                              | -16 to -13                 |                                           |                                     |

The predictions indicate that in worst case situations, excavator mounted hydraulic hammers would marginally exceed the noise affected management level (NAML) at the most affected receivers. Noise emissions from this activity should be minimised by adopting the process indicated in NVMP to ensure that noise emissions are managed.

**7.3.10 Receivers at Argyle Place**

The following tables present a summary of noise levels which will occur at residential and commercial receivers on Argyle Place. Some of the commercial receivers are external (including cafes) and some are located within sealed and air conditioned buildings

**Table 21 - Predicted Worst Case Noise Levels – Commercial and Residential Receivers at Argyle Place – External**

| EQUIPMENT /PROCESS                               | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) $L_{eq}$ | RECEIVER GOAL NOISE LEVEL dB(A) $L_{eq}$                                |
|--------------------------------------------------|----------------------------|------------------------------------------------|-------------------------------------------------------------------------|
| Sandstone Excavation & Dewatering                |                            |                                                |                                                                         |
| Trencore Rock Saw on 30t Excavator               | 31 to 35                   | 54 to 58                                       | 62 for residences and external cafes<br>70 dB(A) for general commercial |
| Krupp 950 Hammer on 30t Excavator (2)            | 54 to 58                   |                                                |                                                                         |
| Alternating Rock Saw and Bucket on 30t Excavator | 31 to 35                   |                                                |                                                                         |
| Site Cranes (2)                                  | 26 to 33                   |                                                |                                                                         |
| Flatbed Trucks (2)                               | 26 to 33                   |                                                |                                                                         |
| Loader                                           | 33 to 40                   |                                                |                                                                         |
| Pump                                             | 11 to 15                   |                                                |                                                                         |
| Receipt of fill from Stage 1                     |                            |                                                |                                                                         |
| CAT 825 Compactor(2)                             | 38 to 43                   | 41 to 46                                       | 62 for residences and external cafes<br>70 dB(A) for general commercial |
| D6-D9 Bulldozers (2)                             | 36 to 41                   |                                                |                                                                         |
| 10t Tipper Trucks (4)                            | 26 to 31                   |                                                |                                                                         |
| Vibration Roller                                 | 22 to 27                   |                                                |                                                                         |
| Flat Drum Roller                                 | 29 to 34                   |                                                |                                                                         |

| EQUIPMENT /PROCESS                     | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) L <sub>eq</sub> | RECEIVER GOAL NOISE LEVEL dB(A) L <sub>eq</sub>                         |
|----------------------------------------|----------------------------|-------------------------------------------------------|-------------------------------------------------------------------------|
| Excavation, Filling and Land Formation |                            |                                                       |                                                                         |
| Hydraulic Jaw Cutter                   | 26 to 32                   | 47 to 53                                              | 62 for residences and external cafes<br>70 dB(A) for general commercial |
| Concrete Saw on Excavator              | 31 to 37                   |                                                       |                                                                         |
| Rock Saw on Excavator                  | 26 to 32                   |                                                       |                                                                         |
| Hydraulic hammer on Excavator          | 46 to 52                   |                                                       |                                                                         |
| 150-200 tonne cranes (2)               | 25 to 31                   |                                                       |                                                                         |
| Concrete Trucks (2)                    | 32 to 38                   |                                                       |                                                                         |
| Concrete Pump                          | 27 to 33                   |                                                       |                                                                         |
| Trucks (2)                             | 25 to 31                   |                                                       |                                                                         |
| Excavator                              | 31 to 37                   |                                                       |                                                                         |
| Bulldozer                              | 31 to 37                   |                                                       |                                                                         |
| Construction Activities                |                            |                                                       |                                                                         |
| Site Cranes (2)                        | 25 to 33                   | 41 to 48                                              | 62 for residences and external cafes<br>70 dB(A) for general commercial |
| Pilling Rig                            | 34 to 36                   |                                                       |                                                                         |
| Bobcat                                 | 22 to 30                   |                                                       |                                                                         |
| Angle grinders                         | 30 to 38                   |                                                       |                                                                         |
| Electric Saw                           | 28 to 36                   |                                                       |                                                                         |
| Drilling                               | 6 to 14                    |                                                       |                                                                         |
| Hammering                              | 37 to 45                   |                                                       |                                                                         |
| Impact drill                           | 17 to 25                   |                                                       |                                                                         |
| Concrete Pump                          | 29 to 37                   |                                                       |                                                                         |
| Concrete Trucks (2)                    | 30 to 38                   |                                                       |                                                                         |
| Concrete Float/Vibrators               | 22 to 30                   |                                                       |                                                                         |
| Truck                                  | 25 to 33                   |                                                       |                                                                         |
| Forklifts                              | 17 to 25                   |                                                       |                                                                         |

The predictions indicate that, even in worst case situations, noise emissions would not adversely impact residential or external commercial receivers.

**7.3.11 Residents on High Street**

The following tables present a summary of noise levels which will occur at the most impacted residences located along High Street.

**Table 22 – Predicted Worst Case Noise Levels – Residential Receivers at High Street – External**

| EQUIPMENT /PROCESS                               | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) $L_{eq}$ | RECEIVER GOAL NOISE LEVEL dB(A) $L_{eq}$ |
|--------------------------------------------------|----------------------------|------------------------------------------------|------------------------------------------|
| Sandstone Excavation & Dewatering                |                            |                                                |                                          |
| Trencore Rock Saw on 30t Excavator               | 32 to 37                   | 55 to 60                                       | 61                                       |
| Krupp 950 Hammer on 30t Excavator (2)            | 55 to 60                   |                                                |                                          |
| Alternating Rock Saw and Bucket on 30t Excavator | 32 to 37                   |                                                |                                          |
| Site Cranes (2)                                  | 30 to 35                   |                                                |                                          |
| Flatbed Trucks (2)                               | 30 to 35                   |                                                |                                          |
| Loader                                           | 37 to 42                   |                                                |                                          |
| Pump                                             | 12 to 17                   |                                                |                                          |
| Receipt of fill from Stage 1                     |                            |                                                |                                          |
| CAT 825 Compactor(2)                             | 62 to 67                   | 65 to 71                                       | 61                                       |
| D6-D9 Bulldozers (2)                             | 59 to 68                   |                                                |                                          |
| 10t Tipper Trucks (4)                            | 52 to 58                   |                                                |                                          |
| Vibration Roller                                 | 48 to 54                   |                                                |                                          |
| Flat Drum Roller                                 | 55 to 58                   |                                                |                                          |

| EQUIPMENT /PROCESS                     | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) Leq | RECEIVER GOAL NOISE LEVEL dB(A) Leq |
|----------------------------------------|----------------------------|-------------------------------------------|-------------------------------------|
| Excavation, Filling and Land Formation |                            |                                           |                                     |
| Hydraulic Jaw Cutter                   | 34 to 57                   | 40 to 72                                  | 61                                  |
| Concrete Saw on Excavator              | 35 to 67                   |                                           |                                     |
| Rock Saw on Excavator                  | 30 to 62                   |                                           |                                     |
| Hydraulic hammer on Excavator          | 50 to 82                   |                                           |                                     |
| 150-200 tonne cranes (2)               | 28 to 60                   |                                           |                                     |
| Concrete Trucks (2)                    | 35 to 67                   |                                           |                                     |
| Concrete Pump                          | 30 to 62                   |                                           |                                     |
| Trucks (2)                             | 31 to 63                   |                                           |                                     |
| Excavator                              | 34 to 66                   |                                           |                                     |
| Bulldozer                              | 34 to 66                   |                                           |                                     |
| Construction Activities                |                            |                                           |                                     |
| Site Cranes (2)                        | 28 to 40                   | 41 to 45                                  | 61                                  |
| Pilling Rig                            | 39 to 43                   |                                           |                                     |
| Bobcat                                 | 33 to 37                   |                                           |                                     |
| Angle grinders                         | 42 to 46                   |                                           |                                     |
| Electric Saw                           | 40 to 44                   |                                           |                                     |
| Drilling                               | 18 to 22                   |                                           |                                     |
| Hammering                              | 49 to 53                   |                                           |                                     |
| Impact drill                           | 29 to 33                   |                                           |                                     |
| Concrete Pump                          | 36 to 40                   |                                           |                                     |
| Concrete Trucks (2)                    | 37 to 41                   |                                           |                                     |
| Concrete Float/Vibrators               | 29 to 33                   |                                           |                                     |
| Truck                                  | 32 to 36                   |                                           |                                     |
| Forklifts                              | 24 to 28                   |                                           |                                     |

The predictions indicate that in worst case situations, the compactor and bulldozers operating at the stage 1 fill stockpile at the southern end of the site and the excavators, bulldozers, concrete trucks, hydraulic hammers and rock saws operation during the excavation, filling and land formation stage would exceed the noise management level, with noise from excavators hammers significantly exceeding the management level.

Noise emissions from these activities should be minimised by adopting the process indicated in NVMP to ensure that noise emissions are managed.

Earth moving plant like bulldozers, excavators, trucks etc. that generate noise levels exceeding the noise affected management goal, produce exceedences that are relatively small, only affect some of the receivers whilst operating and would occur for limited periods. These activities should be managed by adopting alternative processes, and investigating potential mitigation measures, etc as indicated in NVMP to the extent that it is feasible and reasonable. The final processes used and mitigation measures applied will be developed by the contractor, who will be required to meet the objectives of the NVMP

### 7.3.12 Residences at Balmain Peninsula

The following table presents a summary of noise levels which will occur at residents on Balmain Peninsula.

**Table 23 – Predicted Worst Case Noise Levels – Residential Receivers at Balmain Peninsula – External**

| EQUIPMENT /PROCESS                               | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) L <sub>eq</sub> | RECEIVER GOAL NOISE LEVEL dB(A) L <sub>eq</sub> |
|--------------------------------------------------|----------------------------|-------------------------------------------------------|-------------------------------------------------|
| Sandstone Excavation & Dewatering                |                            |                                                       |                                                 |
| Trencore Rock Saw on 30t Excavator               | 47 to 47                   | 70 to 70                                              | 58                                              |
| Krupp 950 Hammer on 30t Excavator (2)            | 70 to 70                   |                                                       |                                                 |
| Alternating Rock Saw and Bucket on 30t Excavator | 47 to 47                   |                                                       |                                                 |
| Site Cranes (2)                                  | 44 to 46                   |                                                       |                                                 |
| Flatbed Trucks (2)                               | 44 to 46                   |                                                       |                                                 |
| Loader                                           | 51 to 53                   |                                                       |                                                 |
| Pump                                             | 27 to 27                   |                                                       |                                                 |
| Receipt of fill from Stage 1                     |                            |                                                       |                                                 |
| CAT 825 Compactor(2)                             | 58 to 60                   | 61 to 63                                              | 58                                              |
| D6-D9 Bulldozers (2)                             | 56 to 58                   |                                                       |                                                 |
| 10t Tipper Trucks (4)                            | 46 to 48                   |                                                       |                                                 |
| Vibration Roller                                 | 42 to 44                   |                                                       |                                                 |
| Flat Drum Roller                                 | 49 to 51                   |                                                       |                                                 |

| EQUIPMENT /PROCESS                     | RECEIVER SOUND LEVEL dB(A) | CUMULATIVE RECEIVER SOUND LEVEL dB(A) Leq | RECEIVER GOAL NOISE LEVEL dB(A) Leq |
|----------------------------------------|----------------------------|-------------------------------------------|-------------------------------------|
| Excavation, Filling and Land Formation |                            |                                           |                                     |
| Hydraulic Jaw Cutter                   | 44 to 50                   | 65 to 71                                  | 58                                  |
| Concrete Saw on Excavator              | 49 to 55                   |                                           |                                     |
| Rock Saw on Excavator                  | 44 to 50                   |                                           |                                     |
| Hydraulic hammer on Excavator          | 64 to 70                   |                                           |                                     |
| 150-200 tonne cranes (2)               | 43 to 47                   |                                           |                                     |
| Concrete Trucks (2)                    | 50 to 54                   |                                           |                                     |
| Concrete Pump                          | 45 to 49                   |                                           |                                     |
| Trucks (2)                             | 43 to 47                   |                                           |                                     |
| Excavator                              | 49 to 53                   |                                           |                                     |
| Bulldozer                              | 49 to 53                   |                                           |                                     |
| Construction Activities                |                            |                                           |                                     |
| Site Cranes (2)                        | 45 to 46                   | 60 to 61                                  | 58                                  |
| Pilling Rig                            | 51 to 52                   |                                           |                                     |
| Bobcat                                 | 42 to 43                   |                                           |                                     |
| Angle grinders                         | 50 to 51                   |                                           |                                     |
| Electric Saw                           | 48 to 49                   |                                           |                                     |
| Drilling                               | 26 to 27                   |                                           |                                     |
| Hammering                              | 57 to 58                   |                                           |                                     |
| Impact drill                           | 37 to 38                   |                                           |                                     |
| Concrete Pump                          | 49 to 50                   |                                           |                                     |
| Concrete Trucks (2)                    | 50 to 51                   |                                           |                                     |
| Concrete Float/Vibrators               | 42 to 43                   |                                           |                                     |
| Truck                                  | 45 to 46                   |                                           |                                     |
| Forklifts                              | 37 to 38                   |                                           |                                     |

The predictions indicate that in worst case situations, excavator mounted hydraulic hammers would significantly exceed the noise affected management level at the most affected residents on Balmain Peninsula. Noise emissions from this activity should be minimised by adopting the process indicated in NVMP to ensure that noise emissions are managed.

Some other processes would also generate noise levels exceeding the noise affected management goal. However, these exceedences are relatively small, would occur for limited periods, and would sometimes be caused by equipment which would be used to minimise operation of louder plant. Notwithstanding this, noise emissions from these activities should be reviewed in accordance with the noise and vibration management plan to minimise any exceedences of the management levels.

## 7.4 RAILWAY ASSETS

The nearest operational railway tunnels are located under the Bradfield Highway and under York Street, and are at least 600m from any activities. Given the distance separation, noise and vibration from the proposed activities would not impact upon this infrastructure.

## 7.5 DISCUSSION

Worst case noise levels from activities during normal working hours at the potentially most affected receivers have been predicted in order to identify those activities or plant that may cause noise levels exceeding the management levels.

These activities or processes would need to be managed so as to minimise noise impacts, either by using alternative processes, alternative equipment, time management, or using other mitigation such as noise barriers to the extent that it is feasible or reasonable using the process outlined in the Noise and Vibration Management Plan and the DECCW ICNG.

Without management or mitigation, the following commercial receivers would receive noise levels exceeding the management goals:

- Universal Music Australia located on Hickson Road, primarily due to excavator mounted hydraulic hammers.
- The Sydney Ports Harbour Control Tower, tucked into the base of the rock face, for internal and external operations, and potentially exceeding the noise limit imposed inside the control room. This is again as primarily a result of excavator mounted hydraulic hammers. External receivers operating at the base of the tower will also receive noise levels exceeding the management goals from rocks saws and earth moving plant, however these levels occur for limited periods and are not as high as the excavator mounted hydraulic hammers.
- The Moores Wharf Building, external commercial activities in Towns Place and internal commercial receivers at Pier 8 – 9, primarily due to excavator mounted hydraulic hammers.
- Temporary passenger terminal, due to noise emissions from a range of plant. It is however noted that the presence of a fill stockpile along the southern site boundary of the Headland Park Site provides an opportunity to put in place a barrier that would significantly reduce noise emissions to the terminal building. Moreover the TCPT will primarily only be affected by noise emissions from activities during the sandstone extraction and receipt of fill stages of the proposed works. The relocation of the TCPT to its new permanent facility will result in no noise exposure to any of the activities during the Formation of Headland Park (as this will commence after the relocation) and only a couple of months of exposure to the noise emissions from the construction and excavation stages.

For all other commercial receivers, even in worst case situations, the predicted noise levels would not generally exceed the Noise Affected Management Level and therefore not adversely affect the receivers.

For residential receivers, noise emissions from almost all processes during the main works stage along Merriman and Bettington Streets, would receive levels exceeding the noise affected management goal, and hammering would also exceed the highly noise affected management goal. The noise level predictions are representative of the first floor of the residences. At the ground floor level of the residences (which would be more likely to be occupied during the day when activities occur) noise levels would be 5 to 10 dB(A) lower, and the management level exceedences would be correspondingly smaller. Some of the processes exceeding the management levels would be used in place of (the much louder) hammering.

Receivers located along Towns Place, northern end of Dalgety Road and at Balmain Peninsula (with openable windows), would also receive noise levels exceeding the noise affected management goal. Again these exceedences are primarily as a result of excavator mounted hydraulic hammer operation.

Residents on High Street would receive noise levels exceeding the noise affected management goal, primarily from excavator mounted hydraulic hammers but also from plant arriving with fill from Stage 1 and to the proposed stockpiling area and earth moving plant during the filling and land formation stage.

As hydraulic hammering has been identified as being the primary noise source producing exceedences of the management goals, this activity should be specifically managed in accordance with the Noise and Vibration Management Plan.

The remaining processes process would generally comply with DECCW "Noise Affected" Management Level with the exception of the nearest residences in Merriman Street overlooking the site and the nearest residences in High Street.

A preliminary noise and vibration management plan has been developed which would be used post project approval to manage plant and equipment that may exceed the management levels and noise limits adopted for the various receivers.

## **7.6 ASSESSMENT OF CUMULATIVE IMPACT OF STAGE 1 AND MAIN WORKS**

The predicted worst case noise levels from the main works activities identify Universal Music Australia and the residents located at Merriman and Bettington Streets as the worst affected receivers. Both these receivers will have a number of activities during the main works significantly exceed the Noise Affected Management noise goals.

Due to the distance of these receivers from the proposed activities at the Stage 1 site, the noise levels generated by the main works activities will be considerably higher than equivalent activities associated with Stage 1 works. As a result the cumulative impact of the main works and Stage 1 works will not be significantly higher than the noise being generated by the main works activities.

The only receiver where there may be a small cumulative effect is the temporary passenger terminal, and an allowance has been made for this when setting management levels for this receiver.

## **7.7 ASSESSMENT OF POTENTIAL NOISE EMISSIONS – 24 HRS OPERATION**

It is proposed to undertake activities outside DECCW normal hours of construction. However, with the exception of 1pm to 3pm on Saturdays, this would be restricted to activities that are required to be undertaken outside normal construction hours, for example dewatering of the site and emergency maintenance activities.

It is noted that the subject site is located within a commercial precinct where there is significant other local activity during the construction periods, and also bearing in mind the site's previous use permitted 24 hour per day operation of the port facilities. It is also noted that fewer impacts on commercial receivers are expected during these times, as some of these buildings would have reduced occupation during these periods.

The main out of 24 hours activity is summarised below.

- Dewatering plant would need to operate on a 24 hours per day basis to clear groundwater from the site.

The dewatering pump would be sited, or treated to meet the established noise limits 24 hour operating plant at all residential receiver locations at all times.

## 8. ASSESSMENT OF VIBRATION

The hydraulic hammering of rock will be minimised by the extensive use of rock saws. Notwithstanding this, some rock hammering will be required. Hammering and compaction at the fill site are the only activities with the potential to produce ground vibration that may be perceptible at the receivers located around the site.

The potentially most impacted receivers are the Sydney Ports Harbour Control Tower, Moore's Wharf Facility, residential receivers on Merriman, Bettington and High Streets and the Universal Music commercial receiver, due to the proximity of these receivers to the activities. Safeguards are recommended for these receivers.

Due to the significant distance separation between the activities and other sensitive structures or occupancies and the nature of the works being undertaken, predicted vibration levels are relatively low and additional mitigation methods are unlikely to be required for modern structures. Safeguards are recommended for sandstone structures close to the site (e.g. on High Street), primarily because of their age, significance and form of construction, notwithstanding the expected induced ground vibration levels are not expected to be high at these locations.

The greatest level of vibration risk is likely to be the communications equipment located at the base of the Harbour Control Tower as the excavation activities are relatively close to the tower. Notwithstanding, the expected vibration levels from hammering would not be expected to adversely impact the amenity of the tower control room, or the structure. The limits applying to protect communications equipment at the base of the tower would be the governing requirement. Notwithstanding, the expected vibration level at the base of the tower is less than 5mm/s prior to the implementation of management if required. A detailed assessment of the impact of vibration on the equipment is recommended during the development of the noise and vibration management plan including selection of equipment and processes and monitoring.

Vibration levels from compaction activities would be expected to cause vibration levels in the range 0.5 to 2mm/s at the nearest structures (Moore's Wharf facility, residential receivers on High Street and the Universal Music commercial receiver). These are below structural damage limits, but may be perceptible. The DECCW amenity vibration goal for commercial spaces is 0.56 to 1.1 mm/s and 0.28 to 0.56 mm/s for residences. This indicates that mitigation of vibration from compaction activities should be investigated to determine reasonable and feasible measures that could be implemented to meet the amenity goals.

For the remaining structures around the site, vibration from the proposed activities is unlikely to be perceptible. This includes the temporary passenger terminal, given that the terminal will have ceased operating when compaction of the adjacent fill site is occurring.

In order to protect the sensitive structures and amenity, mitigation measures and safeguards would be implemented as described in the Noise and Vibration Management Plan. Adoption of this plan would ensure that these structures and amenity would be protected.

## 9. TRAFFIC NOISE GENERATION

The road most impacted by traffic generated by the proposed activities would be Hickson Road.

- Loading and unloading will take place within the site, except during concrete pours and driveway construction. Hence, this will not contribute to the noise levels already being generated by demolition and excavation plant on site.
- Most trucks will visit the site during the bulk filling and compacting stage. These will be travelling from the adjacent Stage 1 site and travel within the site.
- Excavated sandstone will also be transported to external quarries for saw-cutting. The main truck route would be through Gate 4B on Hickson Road (where it is not possible to use internal route).

Noise from truck movements outside the upper level of the residences along High Street facing the site have been predicted using the FHWA noise prediction model taking into account:

- Distance between roadway and the facades.
- 26 movements during worst hour.
- Speed of 50 km/hr and noise emission level of 83 dB(A) at 15m and flat gradient.
- 2.5 dB(A) façade reflection
- Barrier effect provided by the deep cutting along Hickson Road.

The predicted noise level at the most affected receivers is 58 dB(A) for the worst one hour. It is noted that this is the peak level of traffic noise generation, typical levels would be significantly lower.

Reference to the noise monitoring results from the location at High Street indicates the existing traffic noise levels generally vary between approximately 57 and 60 dB(A) through the day.

The combined noise level, based on worst case conditions, is 61-62 dB(A), or an increase of 1-2 dB(A) on existing peak noise levels.

The DECCW "Environmental Criteria for Road Traffic Noise" document provides guidance as to the likely level of noise impact.

Reference to this document indicates that:

- The most applicable functional category for Hickson Road is a collector road.
- The noise goal for residential receivers due to noise from new developments increasing noise on a collector road is 60 dB(A)  $L_{eq}$  (1 hr), and the noise increase should be limited to 2 dB(A).

Peak construction traffic generated by the proposal will result in marginal exceedences of the ECRTN base noise goals. However, typical traffic movements (being a peak of 26 trips per day) will cause an increase in noise within the 2 dB(A) recommended in the ECRTN.

Any additional noise from heavy vehicles on local roads is mitigated by the following factors:

- At most times there will be a relatively low number of excavation related movements on Hickson Street compared to other traffic using these streets, and even under worst case conditions there is only a marginal exceedence of the ECRTN goals.
- The amount of spoil to be trucked off site has already been minimised by reuse of materials on the site, and using the internal road to transport material between Stage 1 site and this site.
- The selected route minimises any impacts, any other alternative heavy vehicle route would produce greater noise impacts, or is unacceptable from a traffic management perspective.
- Historically, there were a significant number of heavy vehicle movements in the area generated by the previous port uses.

For these reasons, adverse noise impact from heavy vehicle movements that would require specific management measures is not expected. Notwithstanding this, the site exit for vehicles leaving the site in a southerly direction should be located as far as possible to the south of the site to minimise vehicle noise impacts.

## 10. CONCLUSION

A noise and vibration assessment has been undertaken of the proposed main works to identify whether these activities would impact sensitive receivers around the site.

The assessment of noise and vibration emissions indicates that:

- Some processes are likely to generate noise levels that will require additional management according to the procedures outlined in the management plan. Adoption of the elements of the Noise and Vibration Management Plan will ensure that noise and vibration impacts will be minimised.
- Ground vibration generated by the proposed activities would not impact nearby railway infrastructure.
- Recommendations are made to safeguard existing structures immediately adjacent to the site from ground vibration generated by the proposed rock extraction activities.

A Preliminary Noise and Vibration Management Plan has been developed that will be used by the contractor to manage impacts from these activities.

The management plan outlines the development of controls and safeguards that would be applied to all activity on the site. The objective of these controls is to ensure that all work is carried out in a highly controlled and predictable manner that will minimise emissions and protect the amenity of the sensitive receivers surrounding the site.

The controls and safeguards implemented as a result of the analysis recommended in the plan would be reviewed at a number of stages as required to respond to local conditions, revised methods and equipment, as well as in response to the monitoring and evaluation of actual impacts. This management plan outlines the procedures that would be adopted during the planning and execution phases by the contractor.

Prepared by



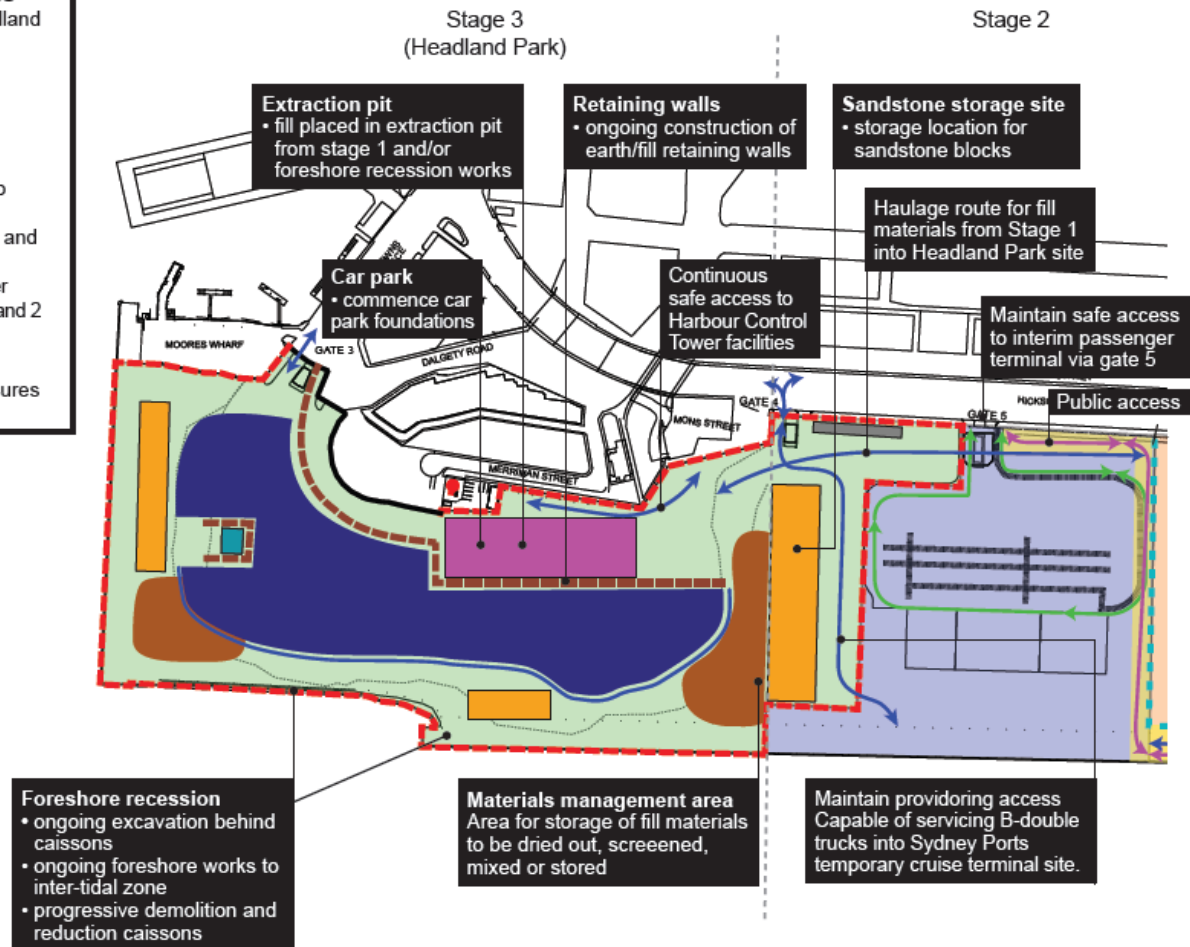
ACOUSTIC LOGIC CONSULTANCY PTY LIMITED  
Victor Fattoretto

## **APPENDIX 1 SITE PLANS**

**Main Works Activities Snapshot****Headland Park - Barangaroo****January to June 2012 – Key activities**

- 1) Fill placement to extraction pit and headland
- 2) Ongoing retaining wall construction
- 3) Filling of sandstone excavation pit
- 4) Car park foundations
- 5) Foreshore recession works - north of Northern Cove
- 6) Ongoing materials management
- 7) Maintenance of Sydney Water access to SPS0014 from Towns Place
- 7) Maintenance of site facilities, hoardings and security arrangements
- 8) Maintenance of public foreshore perimeter pedestrian and cycle way through Stage 1 and 2
- 9) Maintenance of sediment and erosion arrangements

Note: Sediment and Erosion Control measures not shown for clarity



## **APPENDIX 2**

### **NOISE AND VIBRATION MANAGEMENT PLAN**

# ACOUSTIC LOGIC CONSULTANCY

noise and vibration consultants  
abn 11 068 954 343

19 October, 2010

Report: 2010539/1608A/R0/YK

Prepared for: Barangaroo Delivery Authority

## PROJECT 71723.00 – BARANGAROO HEADLAND PARK

### PRELIMINARY MAIN WORKS NOISE AND VIBRATION MANAGEMENT PLAN

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**10. CONCLUSION**

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## **1. EXECUTIVE SUMMARY**

The Noise and Vibration Management Plan (NVMP) outlines the development of controls and safeguards that would be applied to all activity on the site by the contractor. The objective of these controls is to ensure that all work is carried out in a highly controlled and predictable manner that will minimise emissions and protect the amenity of the sensitive receivers surrounding the site.

Likely noise and vibration emissions from likely processes and activities have been assessed. The assessment identified the activities likely to exceed noise and/or vibration goals. The noise and vibration management plan will be used to manage impacts from all activities, with particular reference to those activities that might generate emissions greater than the noise goals.

The controls and safeguards implemented would be reviewed at a number of stages during the extraction period in response to revised methods and equipment, or monitoring and evaluation of actual impacts. This management plan outlines the procedures that would be adopted by the contractor during the detailed planning and execution phases.

## 2. INTRODUCTION

This document presents the noise and vibration plan that will be used to manage noise and vibration from the main works activities at the Barangaroo Headland Park site.

The DECCW Interim Construction Noise Guideline (ICNG) Section 7.2 requires the conceptual description of potential feasible and reasonable work practices to minimise noise impacts. This document is intended to provide a management framework that would be implemented post-project approval, and a conceptual description of potential management methods that should be considered.

## 3. HOURS OF WORK

Work is proposed to be undertaken during the following hours:

- 7am to 6pm Monday to Fridays. These hours are within the DECCW recommended construction times (Section 2.2 of Interim Construction Noise Guideline).
- 8am to 3pm Saturdays. Since most of the work carried out prior to the excavation of sandstone involves earthworks activities, moving fill and stockpiling; noise levels from these activities are less intensive. Loud activities such as saw cutting or excavator mounted hammers would not be permitted within the 1pm to 3pm work windows.
- Exceptions to these hours apply for the delivery of oversize loads or certain materials as required for safety reasons and for emergency response. Furthermore, certain construction activities may be allowed to occur outside the hours above on a planned basis with the prior written approval of the Director-General or as provided for under separate legislation.
- Dewatering plant would need to operate on a 24 hours per day basis to clear groundwater inflow into excavations.
- No works or deliveries would take place on Sundays and public holidays.

## 4. CONSTRUCTION NOISE AND VIBRATION GOALS

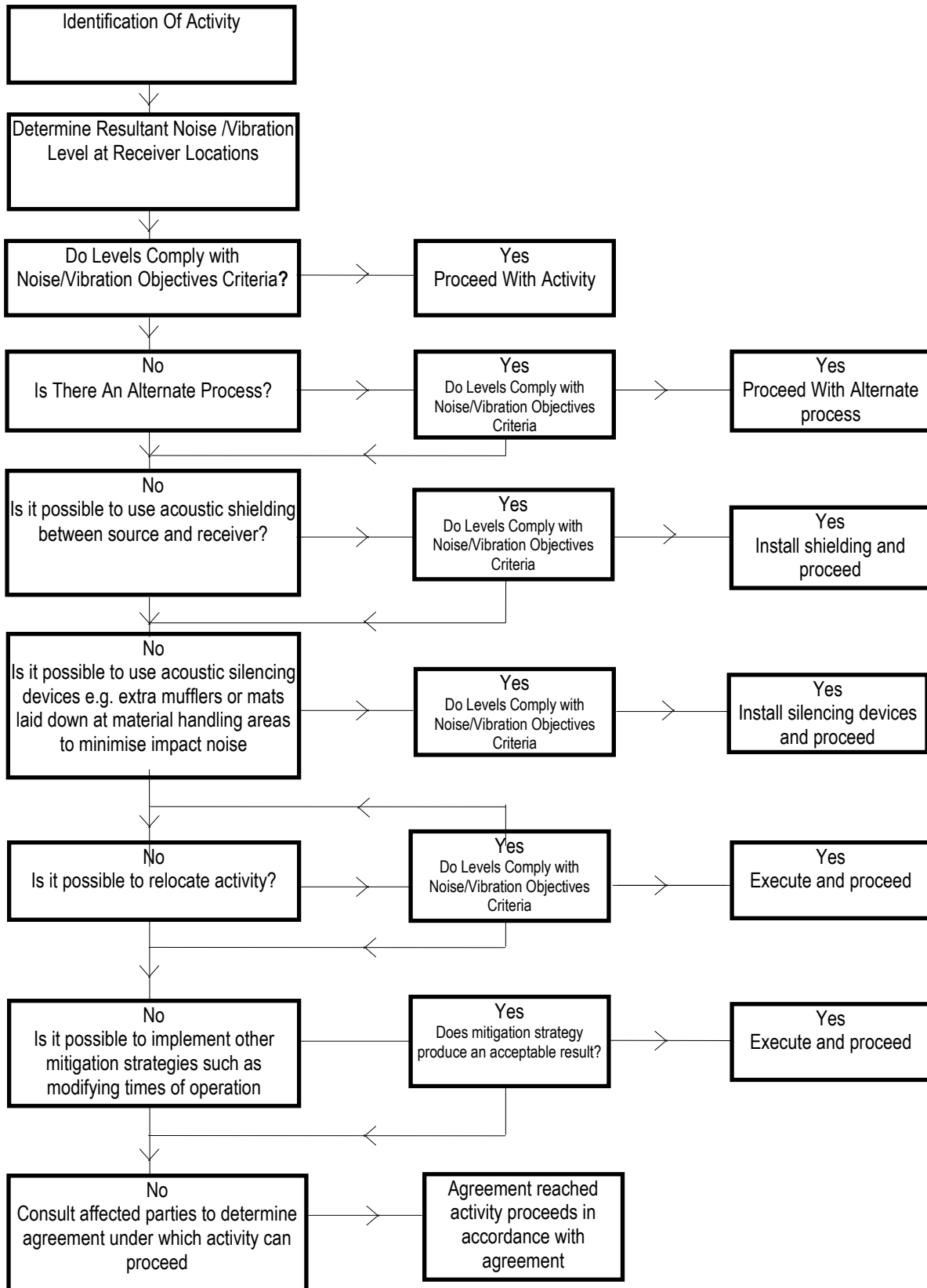
The noise and vibration management levels and limits for the proposed activities have been determined from the noise and vibration assessment conducted and these are indicated in Section 7 of the Main Works Noise and Vibration Assessment.

## 5. ASSESSMENT METHODOLOGY

### 5.1 NOISE ASSESSMENT PROCESS

The flow chart that follows illustrates the process followed to assess extraction and construction activities.

Measures to mitigate sources causing exceedences of the noise and vibration goals have been determined based on the analysis noise and vibration emissions and the process indicated in the following sections. The recommended noise control measures are indicated in the following tables for the various times and operations.

**CONTROL OF NOISE FLOW CHART**

## **5.2 CONCEPTUAL NOISE CONTROL / MITIGATION METHODS**

The determination of appropriate noise control measures will be dependant on the particular activities and extraction appliances. This section provides an outline of available methods.

### **5.2.1 Selection of Alternate Appliance or Process**

Where a particular activity or appliance is found to generate noise levels that exceed the criteria, it may be possible to select an alternative approach or appliance. For example; the use of a hydraulic hammer on certain areas of the site may potentially generate high levels of noise. By carrying this activity by use of pneumatic hammers, bulldozers ripping and/or milling machines lower levels of noise will result.

### **5.2.2 Acoustic Barriers**

Barriers or screens can be an effective means of reducing noise. Barriers can be located either at the source or receiver.

The placement of barriers at the source is generally only effective for static plant (tower cranes). Placing barriers at the source cannot effectively attenuate equipment which is on the move or working in rough or undulating terrain.

Barriers can also be placed between the source and the receiver. The degree of noise reduction provided by barriers is dependent on the amount by which line of sight can be blocked by the barrier. If the receiver is totally shielded from the noise source reductions of up to 15 dB(A) can be effected. Where only partial obstruction of line of sight occurs, noise reductions of 5 to 8 dB(A) may be achieved. Where the barrier does not obstruct line of sight, generally no noise reduction will occur.

As barriers are used to provide shielding and do not act as an enclosure, the material they are constructed from should have a noise reduction performance which is approximately 10 dB(A) greater than the maximum reduction provided by the barrier. In this case the use of a material such as 10 or 15mm plywood would be acceptable for the barriers.

### **5.2.3 Silencing Devices**

Where construction process or appliances are noisy, the use of silencing devices may be possible. These may take the form of engine shrouding, or special industrial silencers fitted to exhausts.

### **5.2.4 Material Handling**

The installation of rubber matting over material handling areas can reduce the sound of impacts due to material being dropped by up to 20dB(A).

### **5.2.5 Treatment of Specific Equipment**

In certain cases it may be possible to specially treat a piece of equipment to reduce the sound levels emitted. These may take the form of engine shrouding, or special industrial silencers fitted to exhausts.

### **5.2.6 Establishment of Site Practices**

This involves the formulation of work practices to reduce noise generation. This includes locating fixed plant items as far as possible from residents as well as rotating plant and equipment to provide respite to receivers.

Construction vehicles accessing the site should not queue in residential streets and should only use the designated construction vehicle routes. Loading of these vehicles should occur as far as possible from any sensitive receiver.

As part of the development of the detailed plans and methods for the works to be carried out, noise emissions of the proposed methods and/or equipment should be reviewed in reference to the noise assessment. Noise emissions requirements for major noise producing plant should be included (where possible) as part of plant procurement requirements and confirmed on site.

### **5.2.7 Strategic Positioning of Processes On-Site**

Where practicable, particular processes of activities can be located in particular positions on site to minimise noise to surrounding sensitive receivers.

For example, stationary plant may be positioned where direct line of sight shielding can be achieved using natural barriers, or may maximise the distance to the nearest sensitive receiver.

### **5.2.8 Combination of Methods**

In some cases it may be necessary that two or more control measures be implemented to minimise noise emissions.

### **5.2.9 Establishment of Direct Communication with Affected Parties**

In order for any construction noise management programme to work effectively, continual communication is required between all parties that may be potentially impacted upon, the builder and the regulatory authority. This establishes a dynamic response process that allows for the adjustment of control methods and criteria for the benefit of all parties.

The objectives of the consultation process are to:

- Inform and educate the groups about the project and the noise controls being implemented.
- Increase understanding of all acoustic issues related to the project and the options available.
- Identify group concerns generated by the project, so that they can be addressed.

It is recommended that a community liaison forum/group be established to facilitate the free flow of information and feedback between the parties. This group would meet at regular intervals (as agreed by the group). The forum also establishes points of contact and channels of communication within affected organisations.

### **5.2.10 Management Training**

All site managers should be made aware of noise and vibration limits, applicable control measures and methods. They should ensure that all agreed noise and vibration measures are carried out by employees and sub-contractors.

### 5.3 SPECIFIC NOISE CONTROL/MITIGATION METHODS

Potential noise impacts and mitigation methods have been assessed in accordance with the procedures outlined above. Following are the recommended specific actions arising from our analysis (including analysis of 24 hr noise sources) to mitigate noise from these activities predicted to significantly exceed the noise management levels. It is noted that noise emissions from other less significant sources will still be subject to analysis using the Control of Noise Flow Chart. However this would be undertaken when more detailed planning regarding including possible actual plant locations, actual plant being used, etc are known.

#### 5.3.1 Typical Activities

Typical noise reduction methods for the primary items of plant exceeding the noise management levels are provided below.

##### **Rock Hammering**

The noise and vibration assessment indicates that exceedences of the noise and vibration management goals would primarily be caused hydraulic hammering operations during the demolition and extraction stages. Hence these activities should be managed as follows:

- Hammering should only be undertaken where non-percussive extraction method is not feasible or reasonable.
- Where hammering is undertaken it should be performed according to the following:
  - ☐ Using the smallest equipment as is practical and provides benefits in terms of the noise/time-to-complete balance. (In other words a smaller hammer may be quieter but may result in significantly extended period of operation, leading to no overall benefit.)
  - ☐ Using hammers with low-noise heads or wrapping the head to minimise radiated noise.
  - ☐ Consider the erection of barriers where these are practical and provide useful sound attenuation.
  - ☐ Where noise emissions exceed the “highly noise affected management level” the duration of this activity throughout the day should be assessed to provide respite periods, or avoiding periods that might be particularly sensitive.
  - ☐ The local community should be informed via a liaison committee (or other method as appropriate) as to the nature, period and times of hammering.
  - ☐ Undertake vibration monitoring to establish safe working distances prior to working near and vibration structures/receivers.

##### **Excavators and Earthmoving Equipment**

- ☐ Using the smallest equipment as is practical and provides benefits in terms of the noise/time-to-complete balance.
- ☐ Selecting lowest noise levels plant available and/or fitting high performance mufflers/noise reduction kits.
- ☐ Consider the erection of barriers where these are practical and provide useful sound attenuation.

- ☐ Where noise emissions exceed the “highly noise affected management level” the duration of this activity throughout the day should be assessed to provide respite periods, or avoiding periods that might be particularly sensitive.
- ☐ The local community should be informed via a liaison committee (or other method as appropriate) as to the nature, period and times of operation.

### **5.3.2 Activities – 24 HR Operations**

It is proposed to undertake some operations outside the normal DECCW construction hours, although no night time extraction is proposed. Additional safeguards are proposed for these periods, as follows:

- Dewatering plant would (and other plant) that needs to operate on a 24 hours per day basis to clear groundwater from the site would be located and treated so that noise emissions would be reduced to levels required for permanently operating plant as per the DECCW Industrial Noise Policy.

Plant should be located as far as practical from the sensitive receivers to minimise noise emissions, notwithstanding that items may not exceed the noise goals.

### **5.3.3 Specific Traffic Movements**

There will be heavy vehicle movements due to spoil being transported to the Headland Park from the southern end of the Barangaroo site (Stage 1). Generally these movements will mostly occur within the Barangaroo site boundary. Some heavy vehicle movements on local roads would occur and these should be in accordance with the construction traffic management plan which should stipulate permissible heavy vehicle routes, peak movements, limits on parking in local streets, etc.

## 6. VIBRATION

The potentially most impacted receivers are the Sydney Ports Harbour Control Tower, Moore's Wharf Facility, residential receivers on Merriman and Bettington Streets and the Universal Music commercial receiver, due to the proximity of these receivers to the extraction and excavation activities. Safeguards are recommended for these receivers.

Due to the significant distance separation between the activities and sensitive structures or occupancies and the nature of the works being undertaken, predictions indicate that the recommended vibration levels will not be exceeded at other receivers and additional mitigation methods are unlikely to be required.

Notwithstanding this, additional safeguards are recommended for sandstone structures in the vicinity because of their age, significance and form of construction.

It is recommended that vibration levels and regenerated noise levels within the nearby buildings be measured to confirm these levels and to establish "safe" working distances that prevent damage or adverse amenity impacts. The activity should occur at 40m from the sensitive structures and the resultant levels measured. The vibration source should then be progressively moved closer to the receiver until the noise/vibration goals are reached.

For nearby sandstone buildings, the same procedure as described above should be carried out, except starting at 50m, to establish safe working distances for plant operation.

If hammering is required to be undertaken closer than the safe zone established by the procedure described above, then an alternative method should be investigated. Where an alternative method is justified as not being feasible or reasonable, then the impact on the particular structure should be further investigated in detail, potentially including a relaxation of vibration limits (to the upper limit in the range, for example) having regard for duration of vibration and the imposition of additional, specific monitoring while works occur within this region.

## 7. COMPLAINTS HANDLING

A register of noise complaints should be maintained within the site office and be made available to interested parties listing the source of the complaint, time and nature of the complaint.

The following procedure should be adopted where complaints are received.

- The particular activity causing the complaint should be suspended pending further investigation.
- Noise and/or vibration monitoring of the activity should be carried out on a trial basis.
- Where monitoring indicates that the noise or vibration emission goal is exceeded then additional noise or management control should be investigated in accordance with the flow chart.
- The activity should proceed with the additional mitigation methods in place and the resultant noise impact reassessed.

## 8. MONITORING

Monitoring would be conducted:

- As an ongoing indicator of noise/vibration emissions from the site.
- In response to complaints.
- Where specific monitoring is needed. For example where ground vibration is produced near sensitive structures to confirm safe working distances.

Attended or unattended long term monitoring may be used as appropriate.

### 8.1 NOISE

For ongoing monitoring it is recommended that, as a minimum, attended measurements at sensitive receiver locations occur at the commencement of noise producing activities and thereafter at monthly intervals. The monitoring should identify the levels of noise emitted from the site and the noise sources present, and comment on the noise levels in relation to the established noise goals.

### 8.2 VIBRATION

It is recommended that continuous unattended vibration monitoring occur the base of the Sydney Ports Harbour Tower, with reporting at maximum 2 week intervals. The monitor should be fitted with an SMS alarm to provide indication when vibration levels exceed the established goals

Regular attended measurements (or continuous unattended measurements) at sensitive receiver locations in Merriman and Bettington Streets, Moore's Wharf Facility, at the Universal Music Building and High Street are recommended when rock hammering (or other similar vibration producing activities) occurs within 20m, and to establish safe working distances as described above. These distances may be modified depending on the results of the initial monitoring recommended.

The monitoring should identify the levels of vibration emitted from the site and the vibration sources present, and comment on the measured levels in relation to the established vibration goals.

Where works may be needed to occur within established safe working zones, an additional targeted monitoring regime should be established that should include some form of continuous monitoring of structures.

## 9. ACTION PLAN SUMMARY

The following summarises the action plan that would be implemented during the stages of the project indicating the actions required to fulfil the requirements of the management plan.

### 9.1 PRIOR TO WORKS COMMENCING ON SITE (EXCLUDING PREPARATORY WORK, SITE INVESTIGATIONS, ETC)

The following should occur prior to works commencing on site:

A Noise and Vibration Management Plan should be developed from the preliminary NVMP to a specific management plan. The management plan shall:

- Where identified in the assessment or Preliminary NVMP, develop any additional noise or vibration goals/limits (for example, vibration limits for communications equipment at the Control Tower) or testing.
- Identify those activities that may cause exceedences of the management levels or limits.
- For those activities identified as causing exceedences, provide a summary of the outcomes of the assessment of those processes, including alternative methods and a determination of the “reasonable and feasible” mitigation methods that would be applied, including the items summarised in Sections 5.2.1 to 5.2.8, and a justification for the actions decided. In some cases, mitigation methods may need to be developed in conjunction with the local community. (For example, noise barriers will reduce noise impacts but may block views or cause overshadowing: community feedback may assist in achieving an acceptable compromise.)
- In the event it is not reasonable or feasible to meet the noise or vibration goals, specify other management measures to mitigate impacts such as time management, notification and liaison with local community, monitoring, etc.
- Develop and specify the noise and vibration monitoring to be undertaken including an identification of locations to be monitored and the type and extent of monitoring to be carried out.
- Identify any hold points for verification testing to occur, or safe work distances to be established, prior to work proceeding.
- Develop a community liaison plan including notification of site contacts, complaints procedures, formulation of a community liaison forum/group, notification procedures (when/who/how) for general as well as specific notifications that may be required from time to time, as well as providing feedback.
- Develop complaints handling procedures including a matrix of responses based on the type of complaint (noise/vibration), sensitivity of the receivers, level and extent of the perceived exceedence, etc.
- Specify how the recommendations will be implemented by site staff including, specification and verification of equipment noise levels pre/post procurement, define site responsibilities, ensuring contractors/sub-contractors of noise/vibration are aware of their responsibilities and actions required to fulfil the requirements of the NVMP.

- **PROCUREMENT**

Prior to procuring items of plant/activity, etc the requirements of the NVMP for that plant/activity shall be determined. These should be reviewed to determine if any changes to the recommendations are required based on further information, etc. Where changes are indicated, these should be assessed and justified as in the pre-works commencement NVMP, and the plan updated.

Any noise/vibration limits for plant, other precautions, work methods, required management structures, etc required to be followed by the supplier/subcontractor shall be included in specifications for the works.

- **PRIOR TO AN ACTIVITY COMMENCING ON SITE**

The following should occur prior to any activity occurring on site.

- The requirements of the NVMP for that plant/activity should be reviewed to determine if any changes to the recommendations are required based on further information, etc.
- Carry out verification testing required by the NVMP including noise emission levels, vibration levels at sensitive structures/receivers, etc. Modify the work practices, if needed, in response to the measurement results.
- Provide all relevant training/notification (e.g. at site induction) of all relevant staff to inform them of their roles and responsibilities and any site specific procedures.

## 10. CONCLUSION

The management plan outlines the development of controls and safeguards that would be applied to all activity on the site. The objective of these controls is to ensure that all work is carried out in a highly controlled and predictable manner that will minimise emissions and protect the amenity of the sensitive receivers surrounding the site.

The plan provides a framework for ongoing management of the site including:

- Ongoing assessment and management of processes and activities including selection of processes and mitigation.
- Responding to unforeseen processes not included in this plan as required in response to changed circumstances or in response to monitoring or community reaction.
- Community communication and liaison.
- Training
- Monitoring
- Complaints Handling

The controls and safeguards implemented as a result of the analysis recommended in the plan would be reviewed at a number of stages in response to revised methods and equipment, and to the monitoring and evaluation of actual impacts. This management plan outlines the procedures that would be adopted during the detailed planning and execution phases by the contractor.

Prepared by

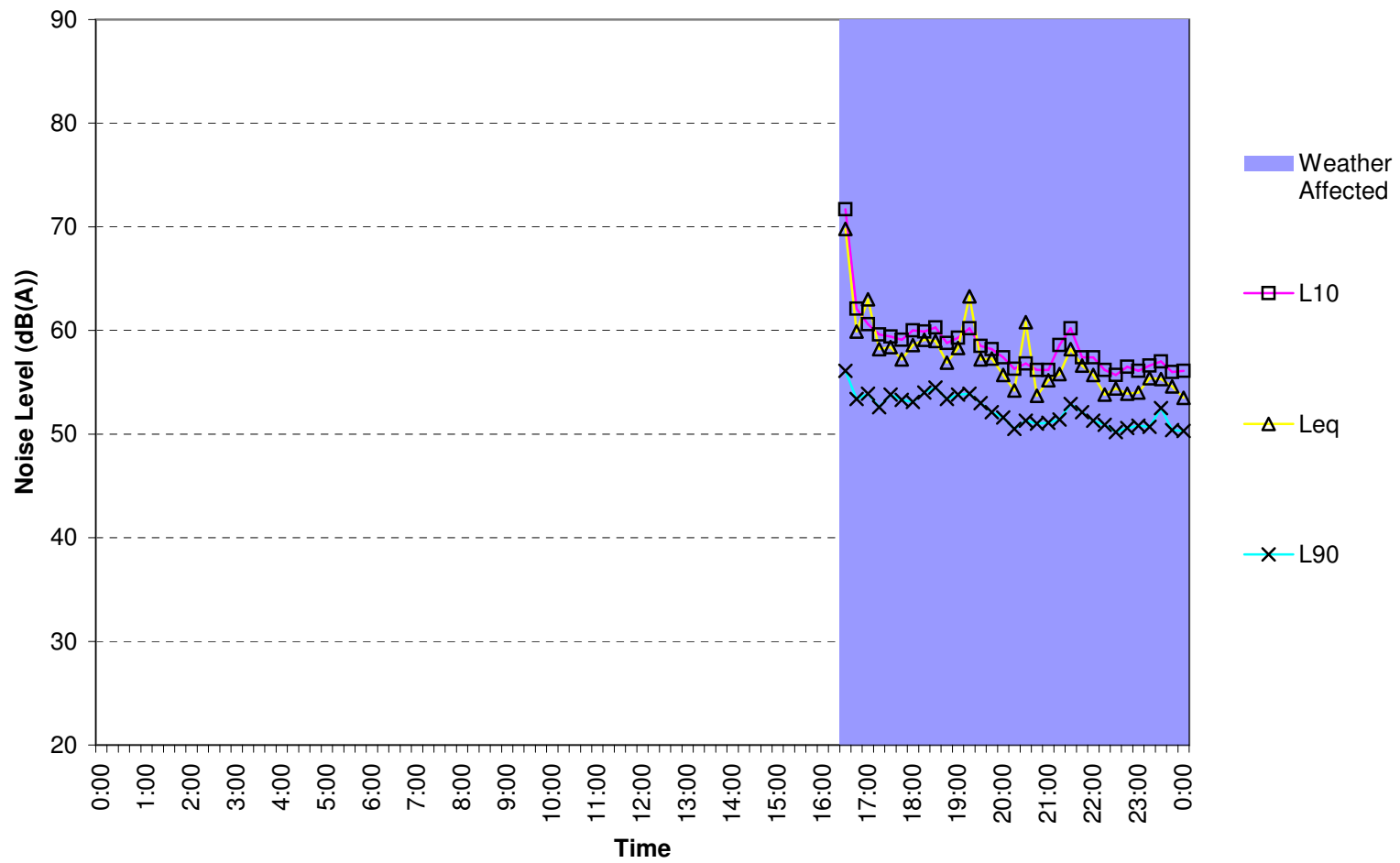


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Victor Fattoretto

## **APPENDIX 3 LONG TERM NOISE MONITORING**

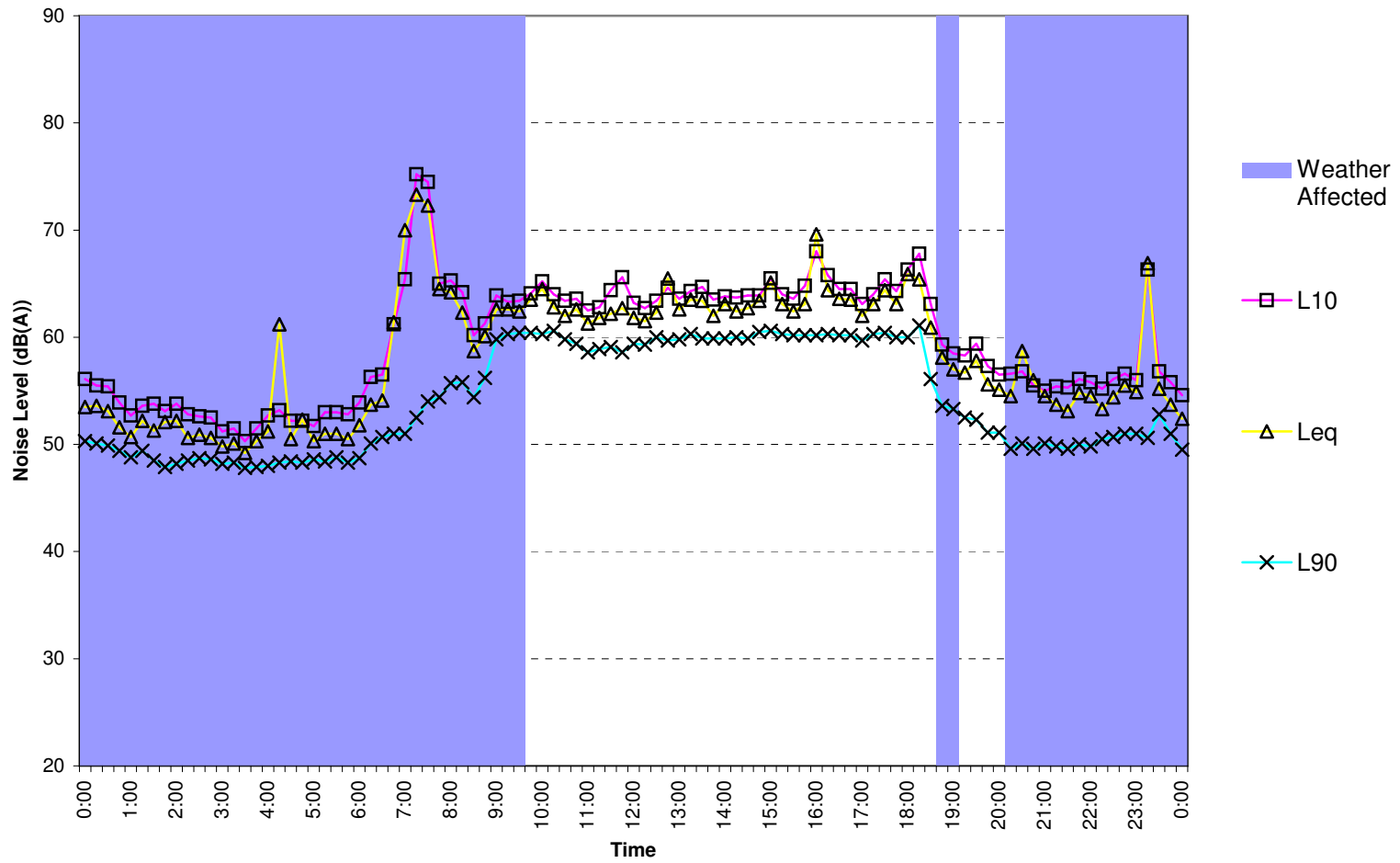
## 28A High Street Millers Point

Thursday September 2,2010



## 28A High Street Millers Point

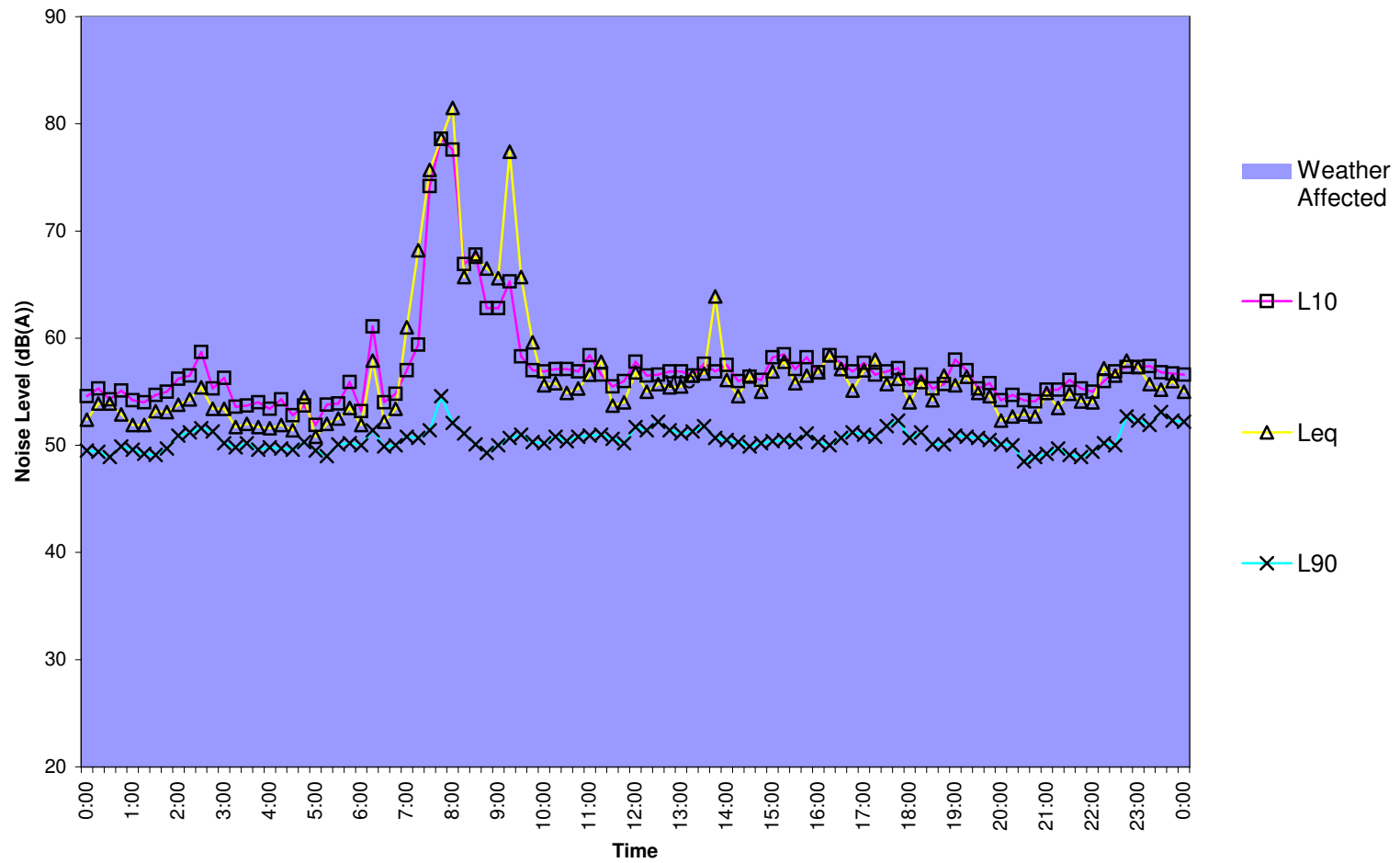
Friday September 3, 2010



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t!R215C11:  
R311C11

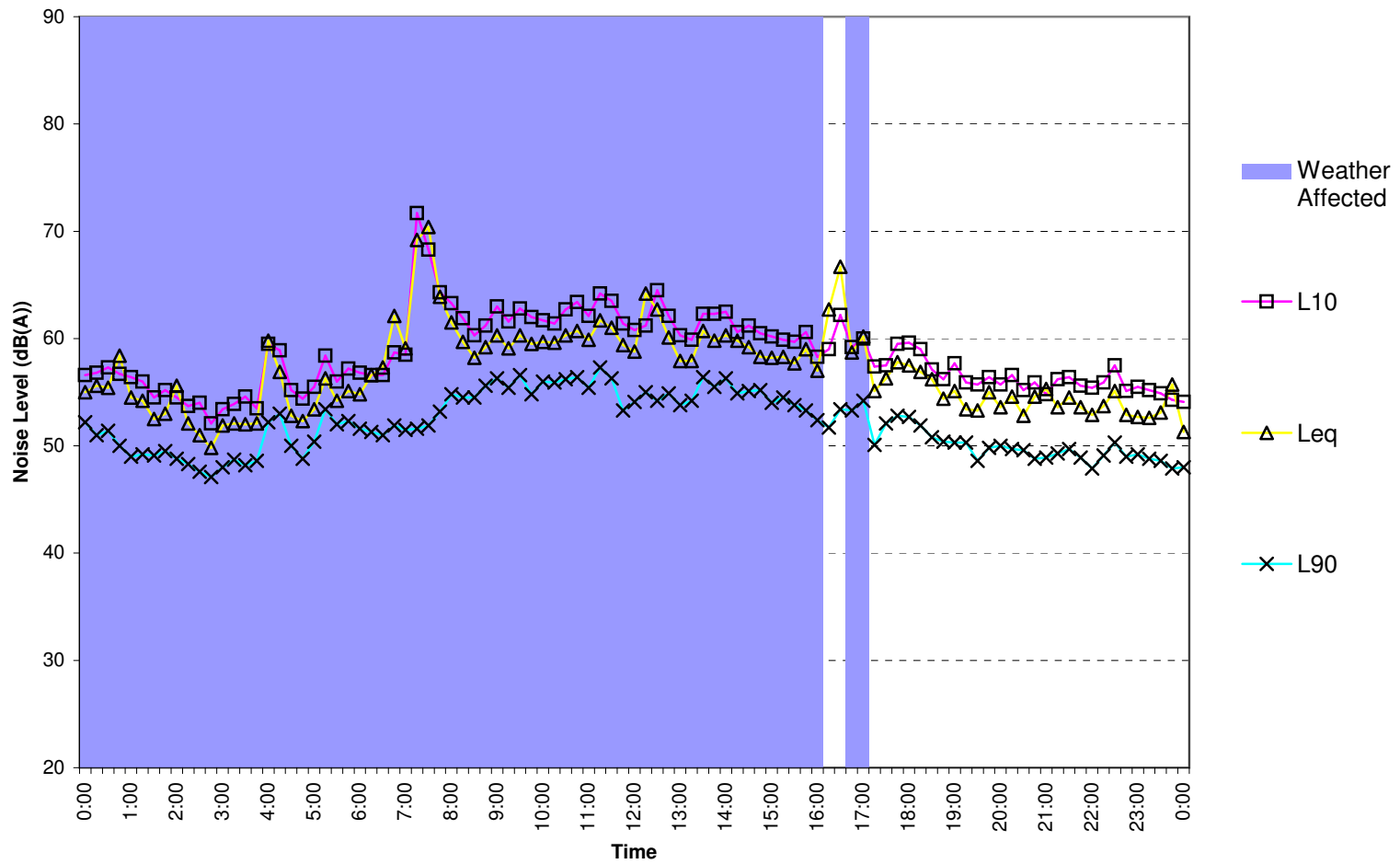
## 28A High Street Millers Point

Saturday September 4,2010



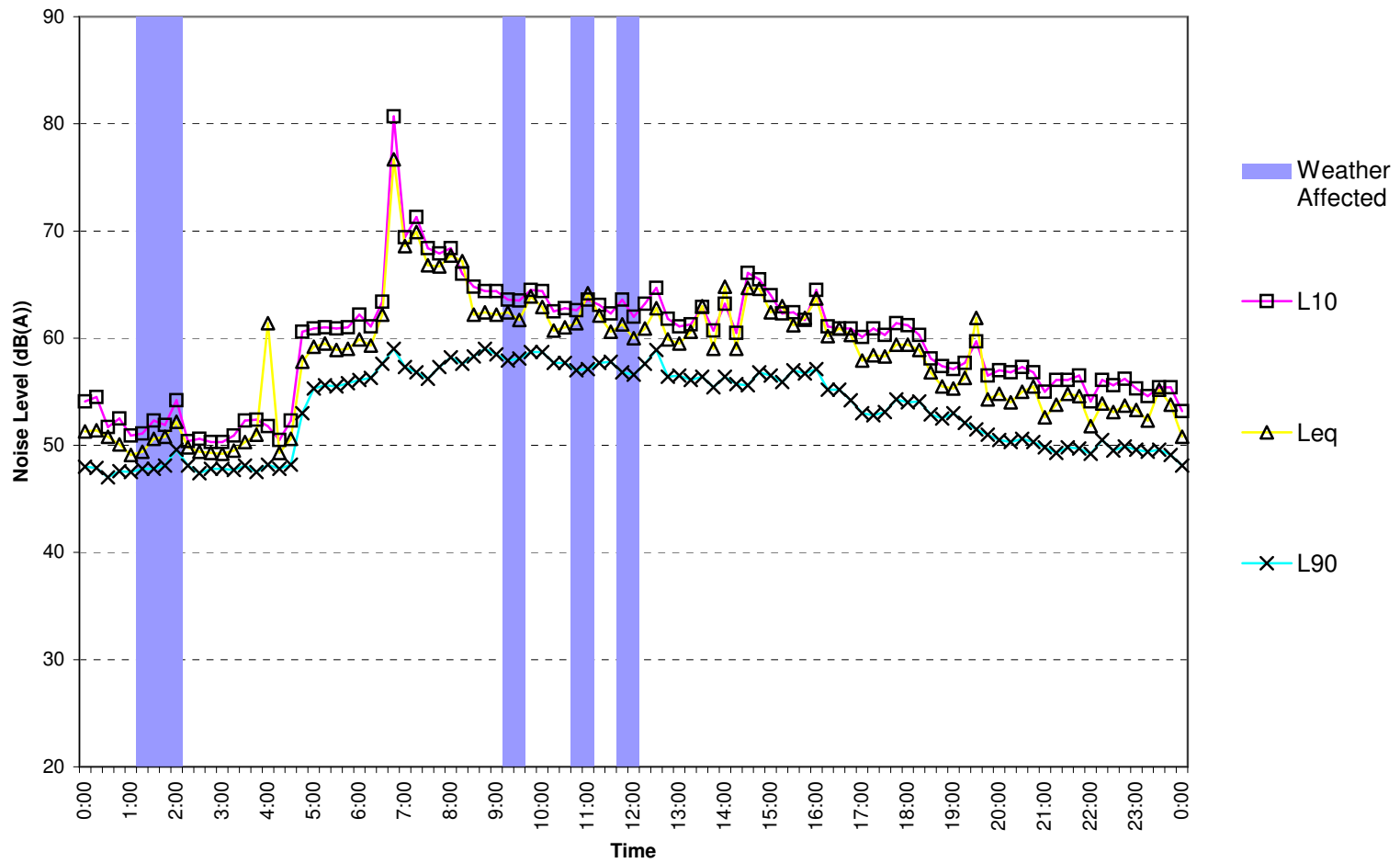
## 28A High Street Millers Point

Sunday September 5, 2010



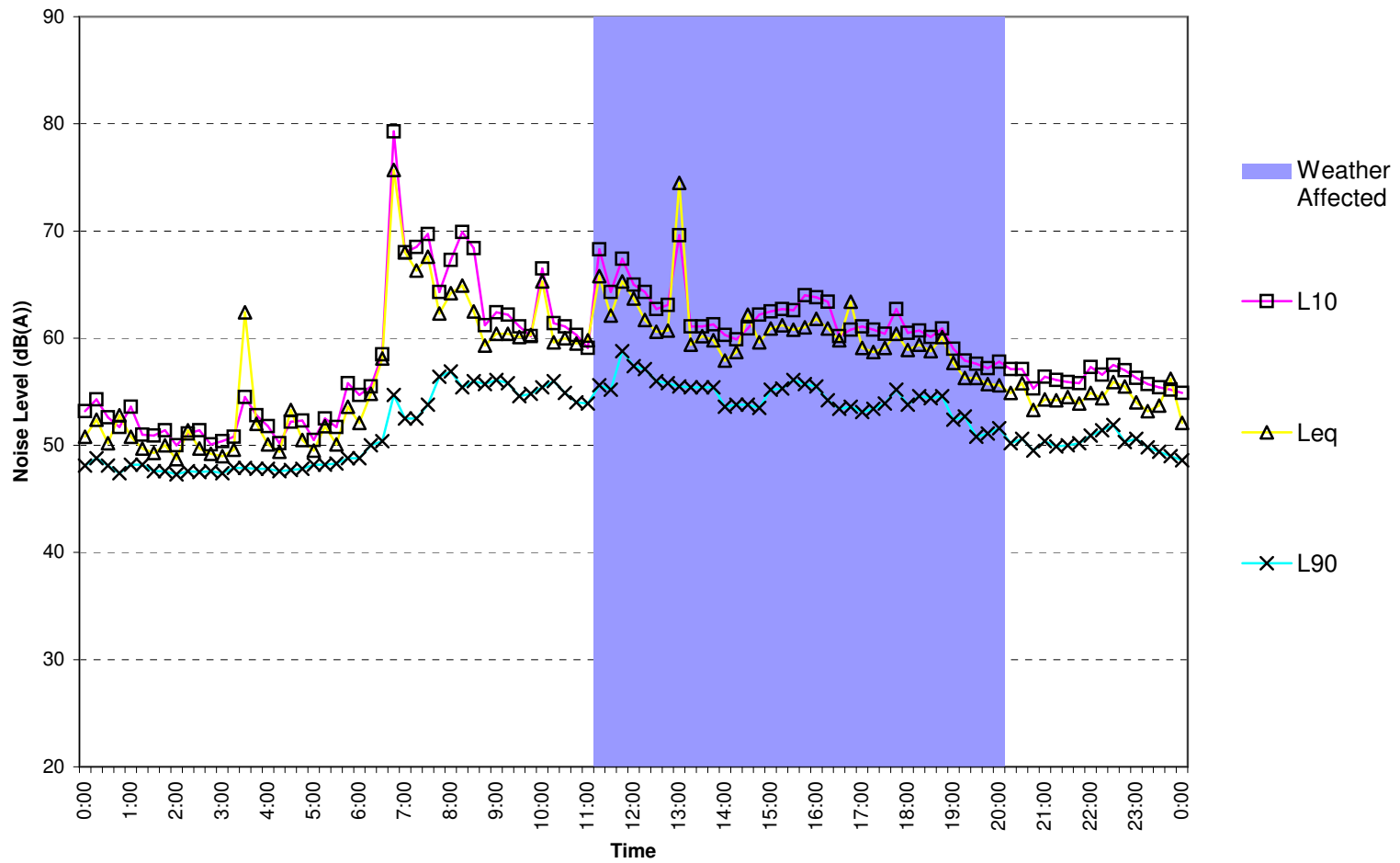
## 28A High Street Millers Point

Monday September 6, 2010



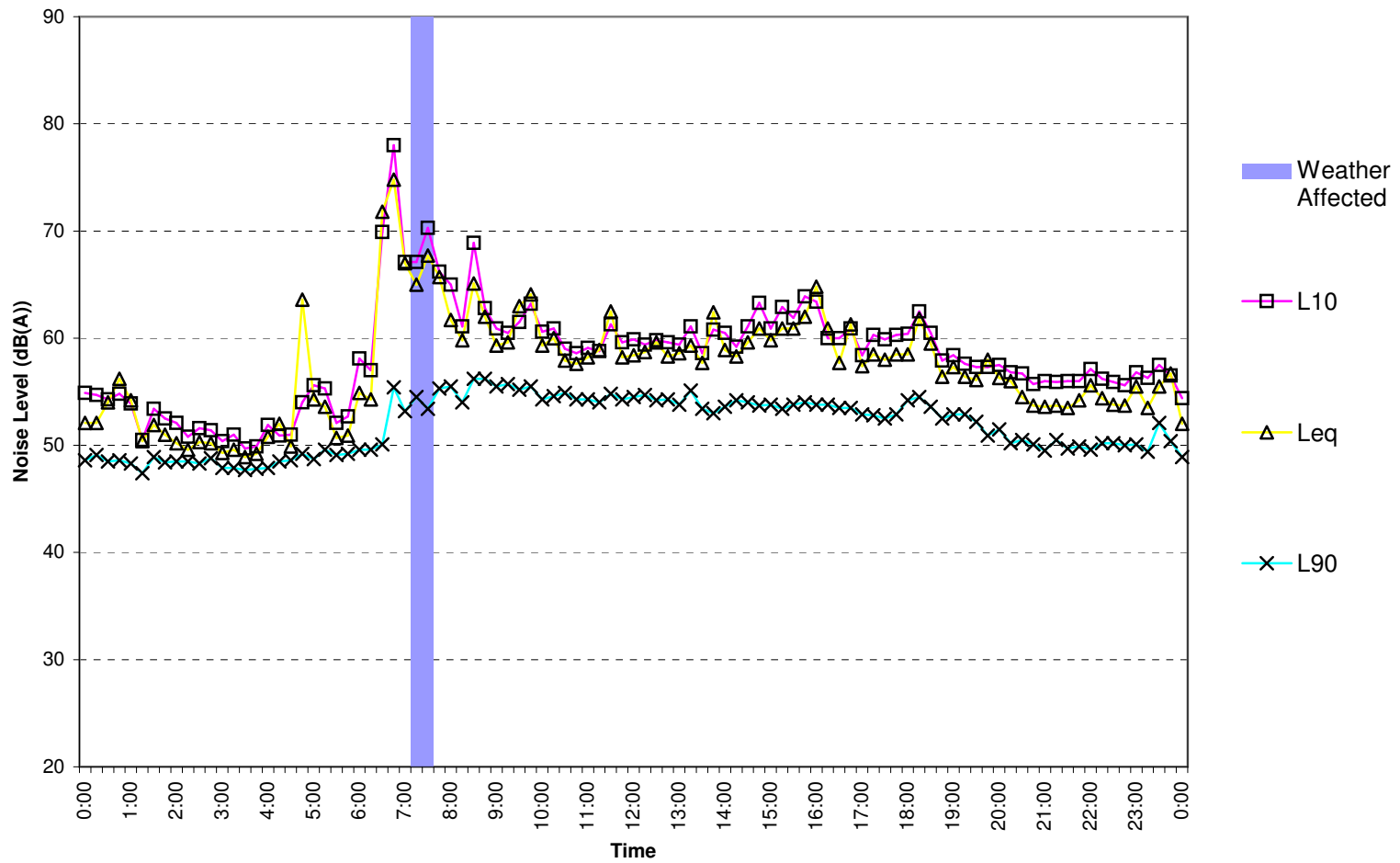
## 28A High Street Millers Point

Tuesday September 7, 2010



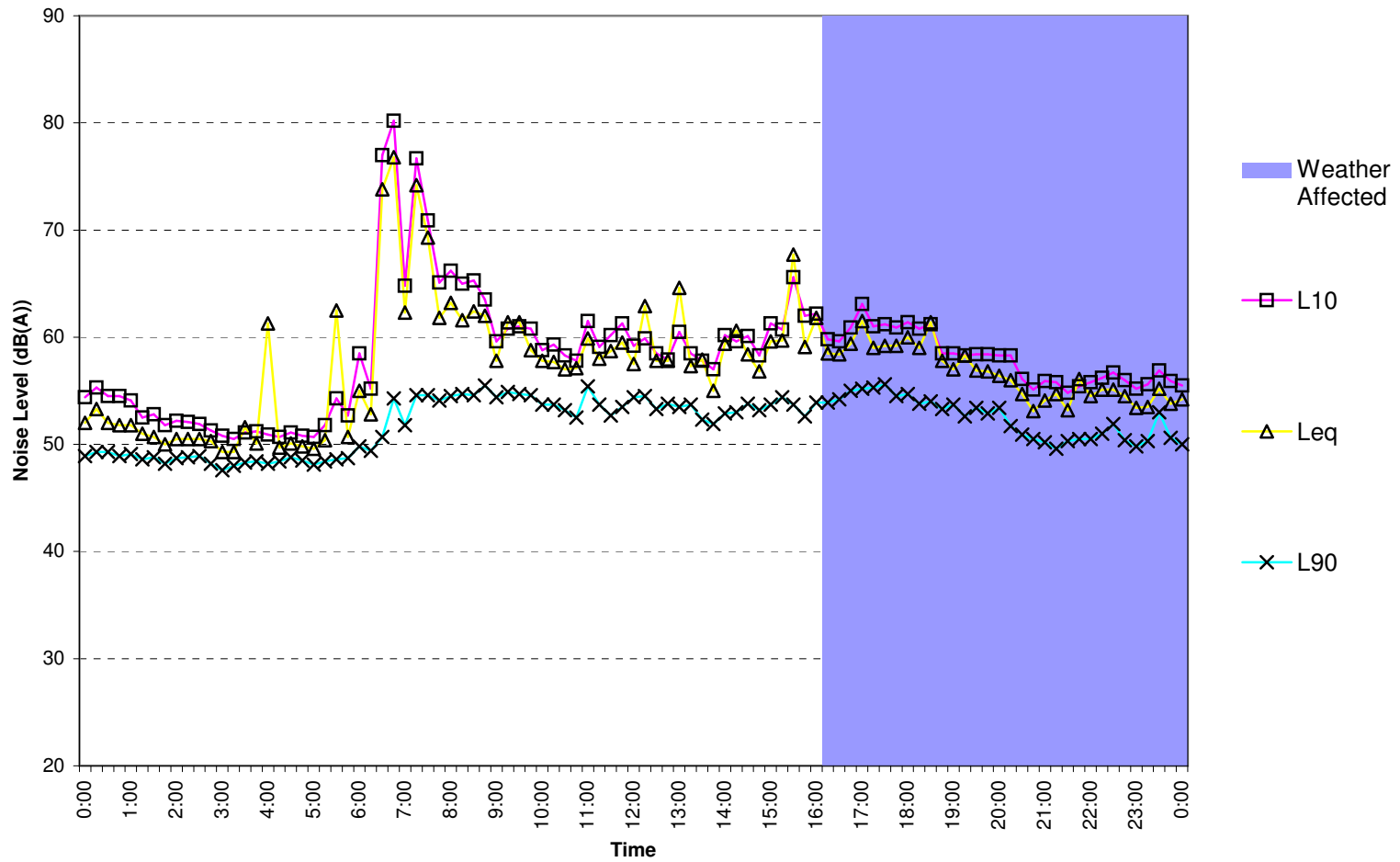
## 28A High Street Millers Point

Wednesday September 8, 2010



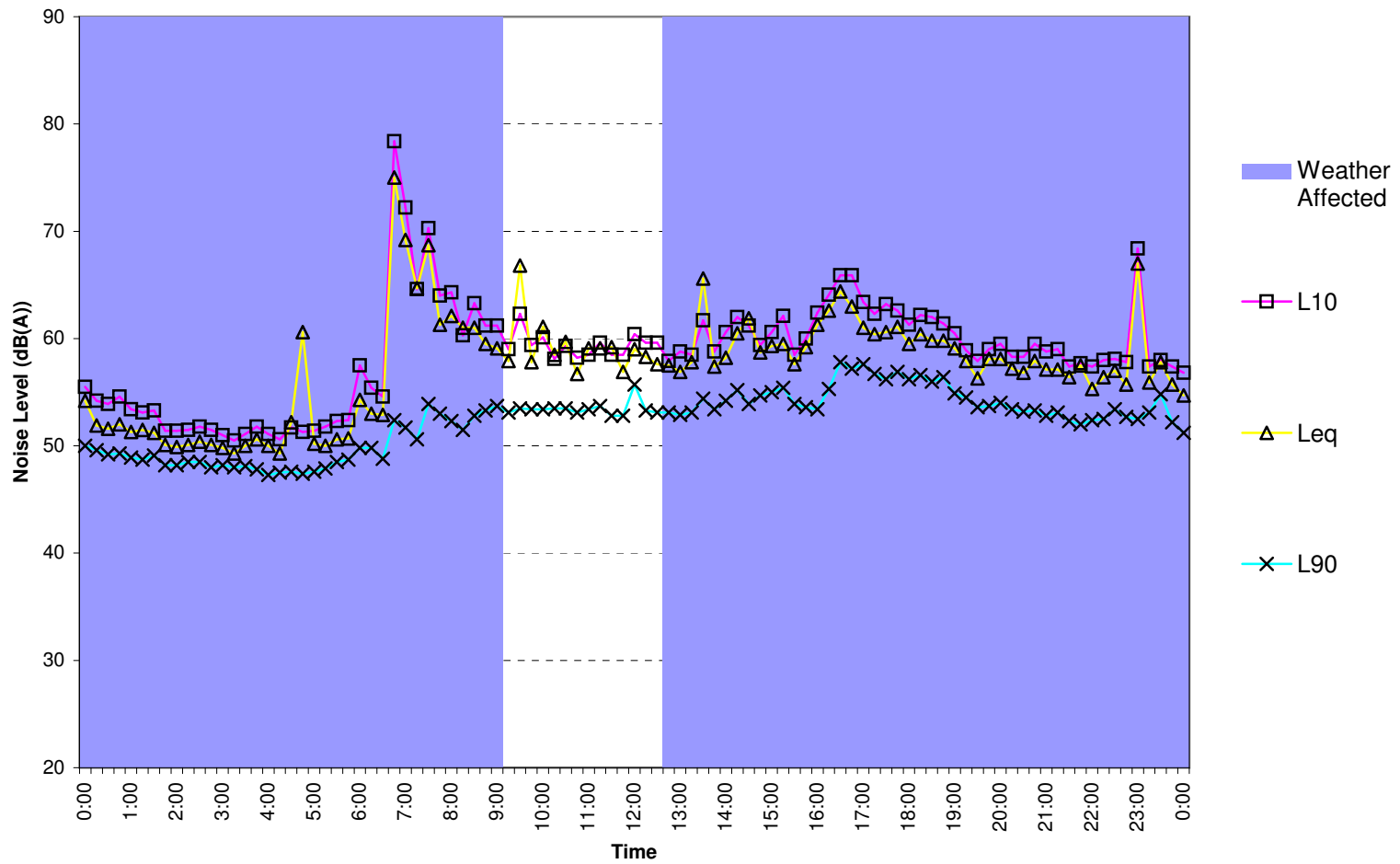
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Thursday September 9, 2010



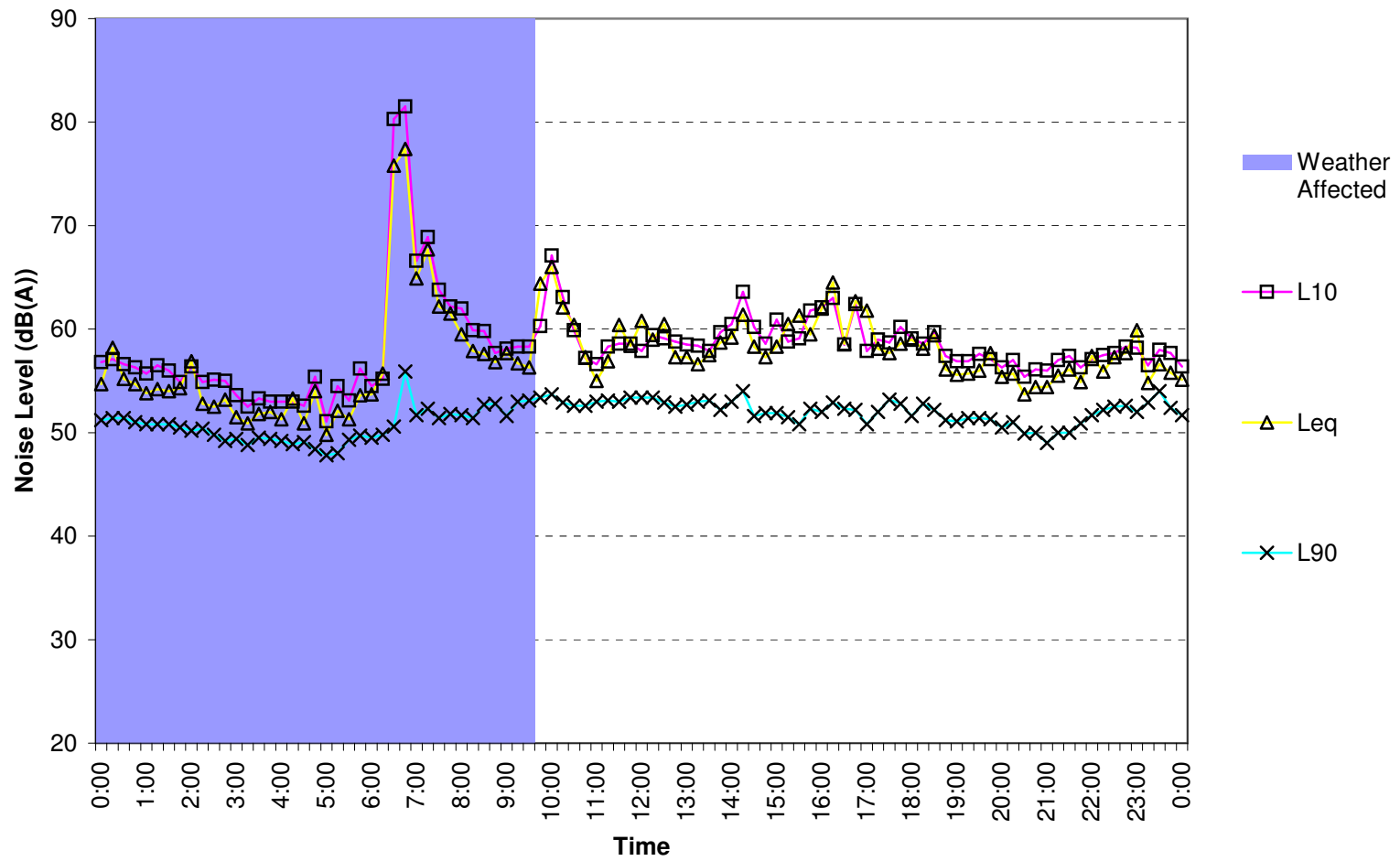
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Friday September 10, 2010



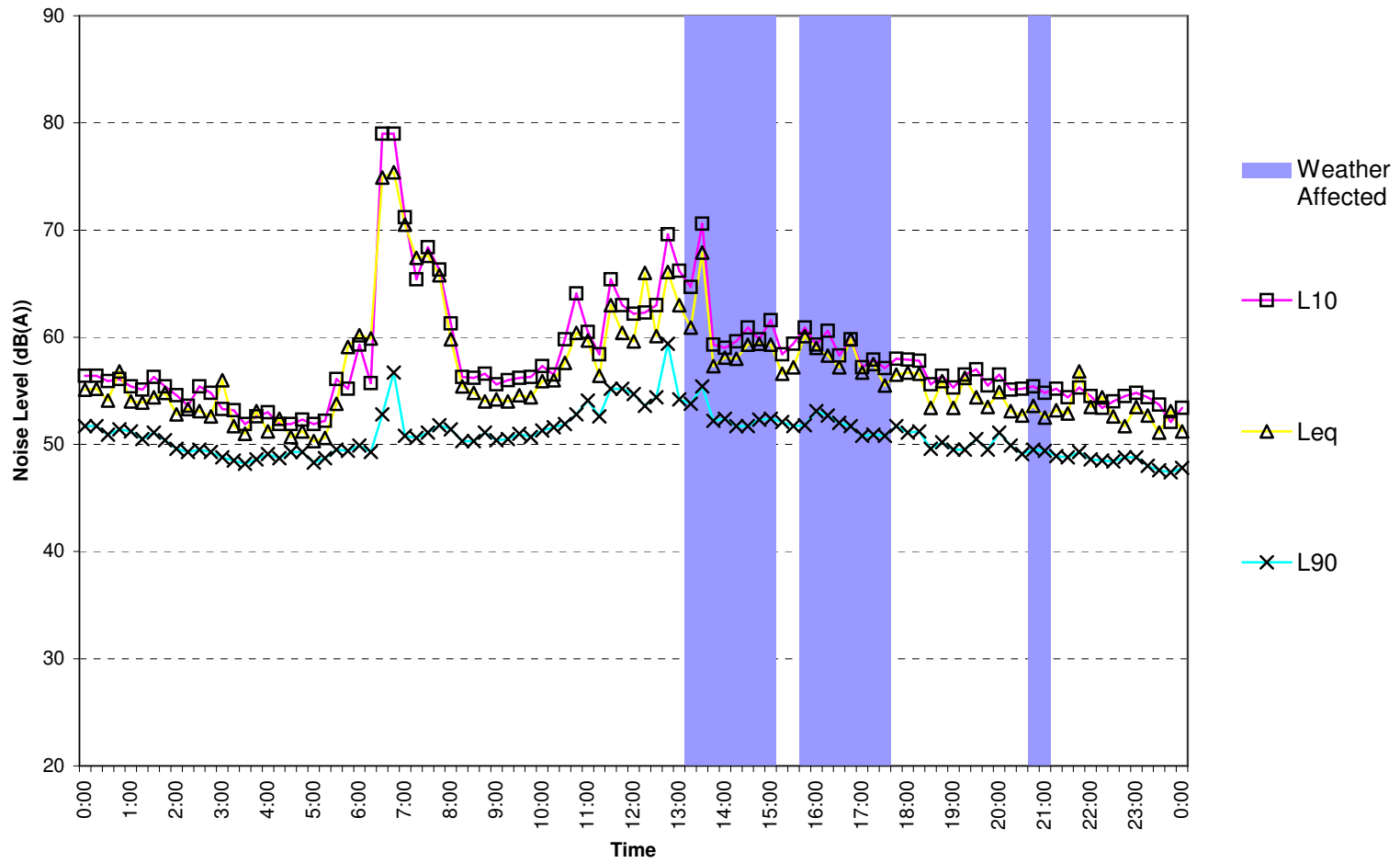
## 28A High Street Millers Point

Saturday September 11, 2010



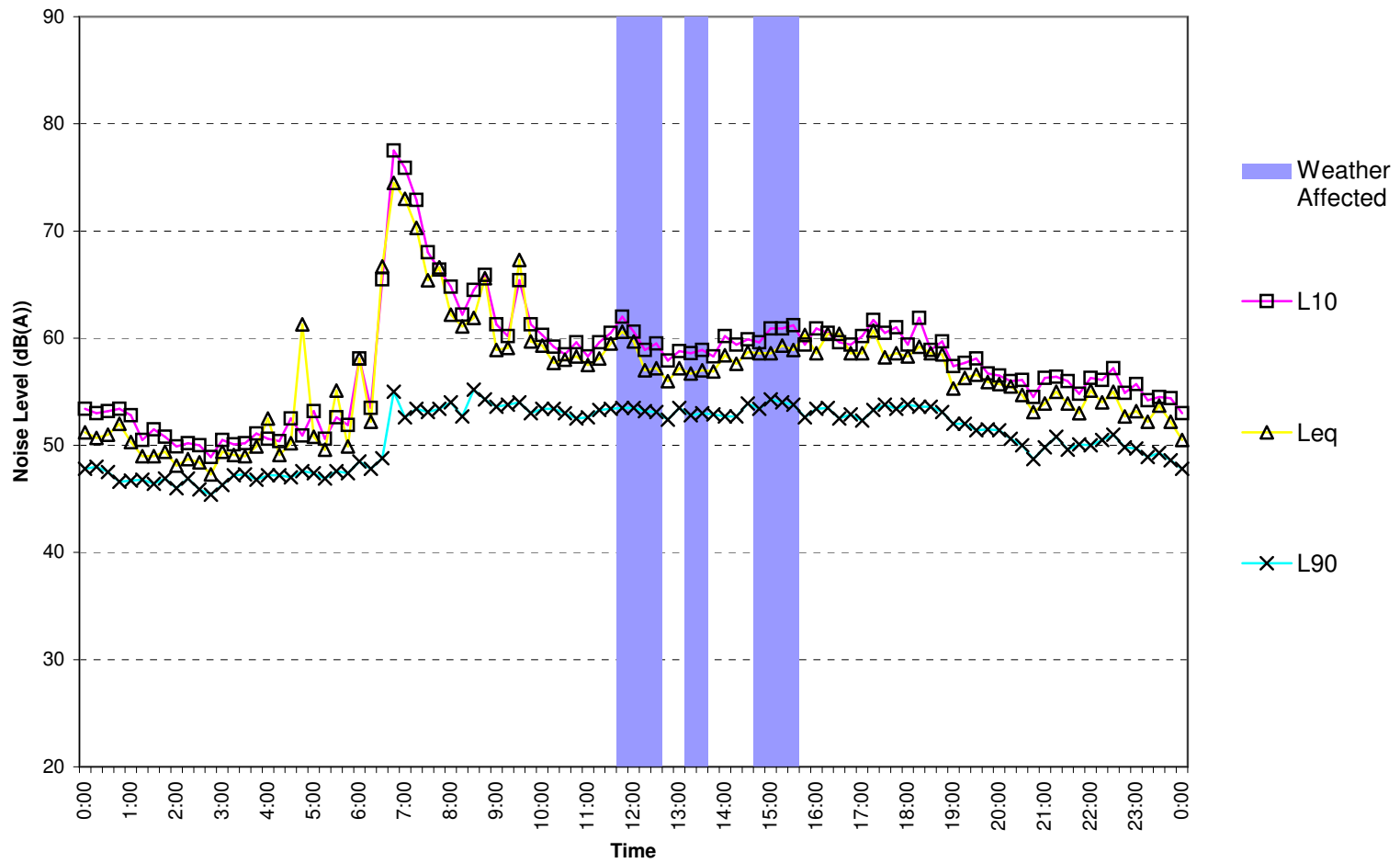
## 28A High Street Millers Point

Sunday, September 12, 2010



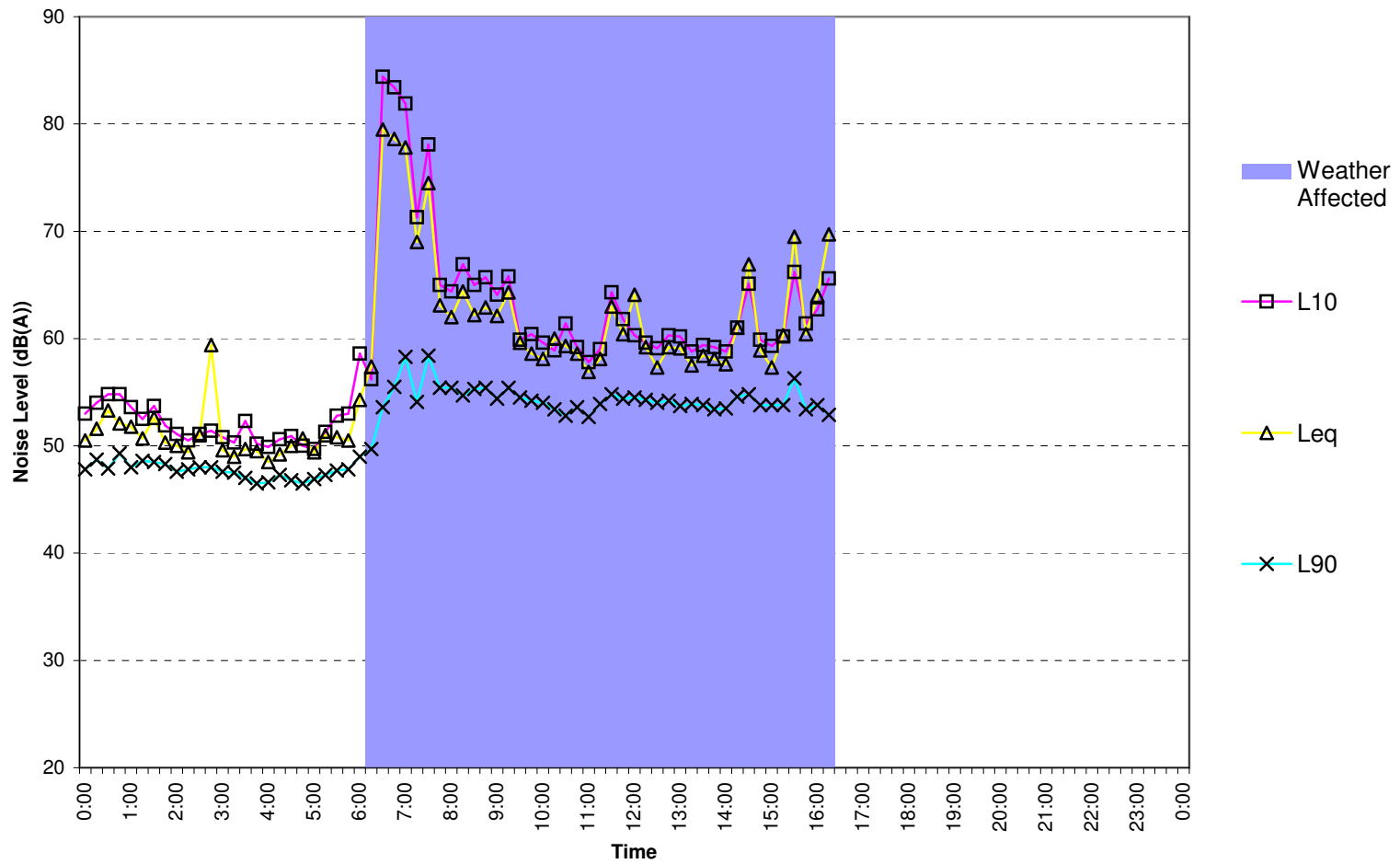
## 28A High Street Millers Point

Monday September 13, 2010



## 28A High Street Millers Point

Tuesday September 14, 2010

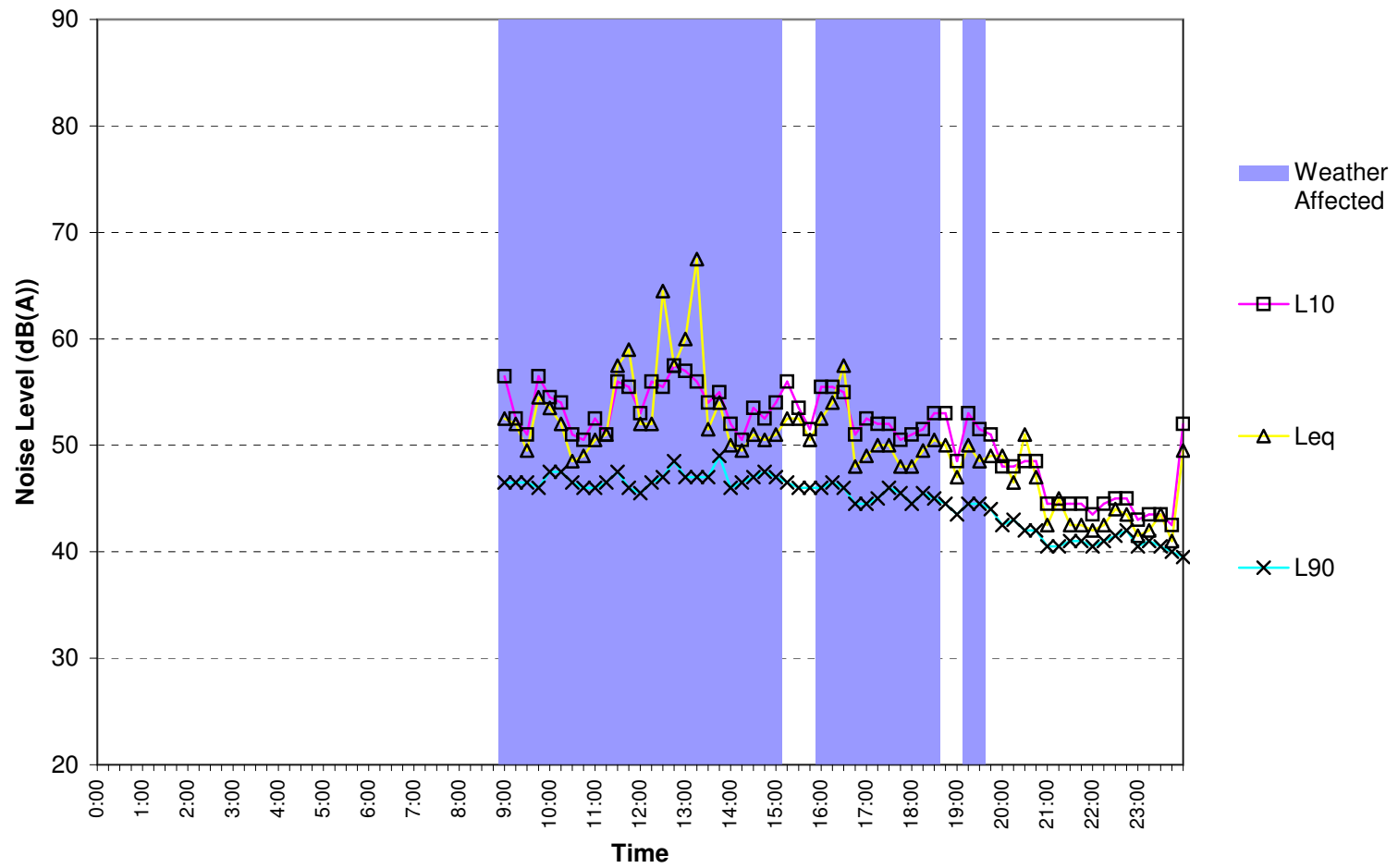


## **Merriman Street Millers Point**

Wednesday August 25, 2010

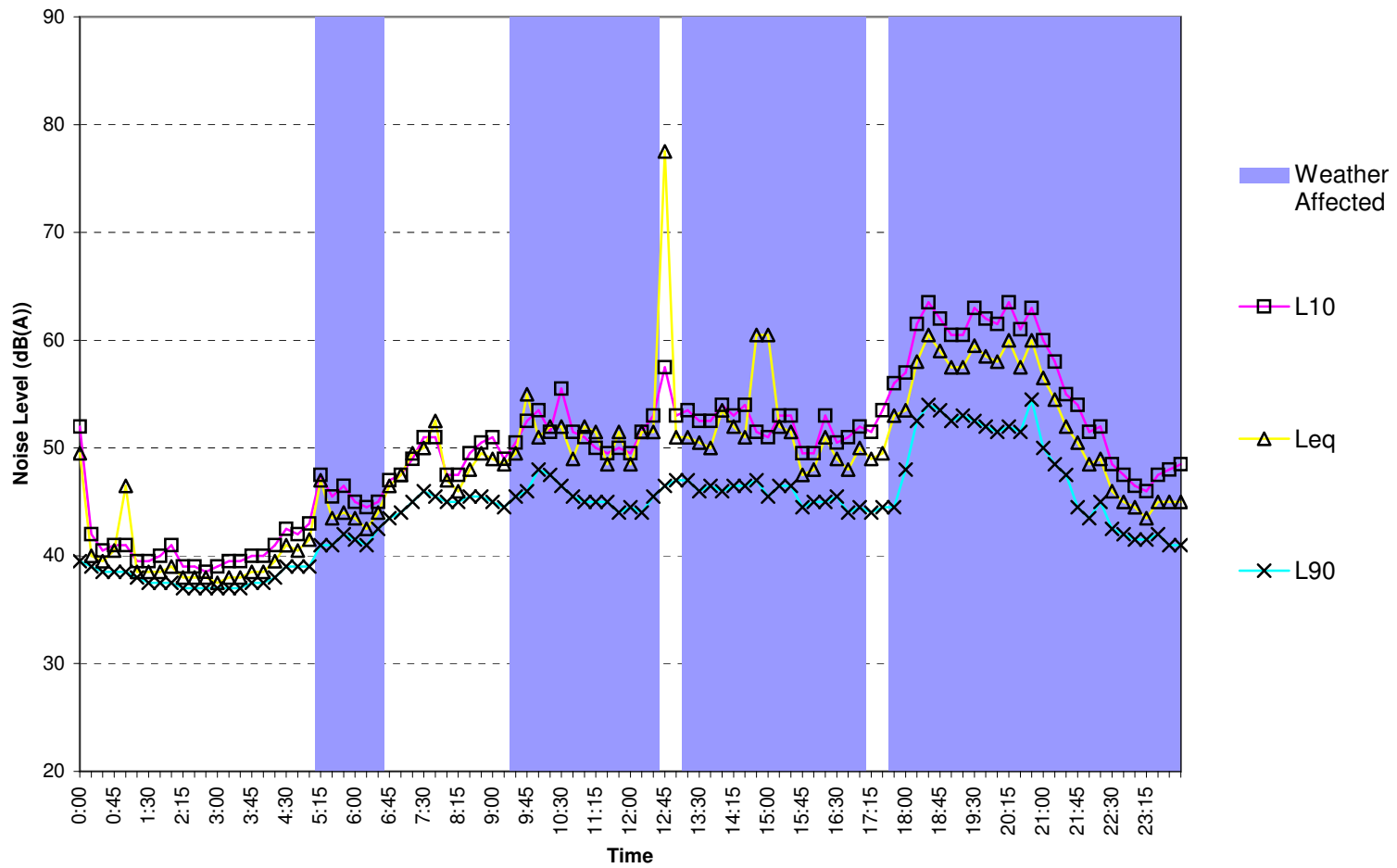
## Merriman Street Millers Point

Thursday August 26, 2010



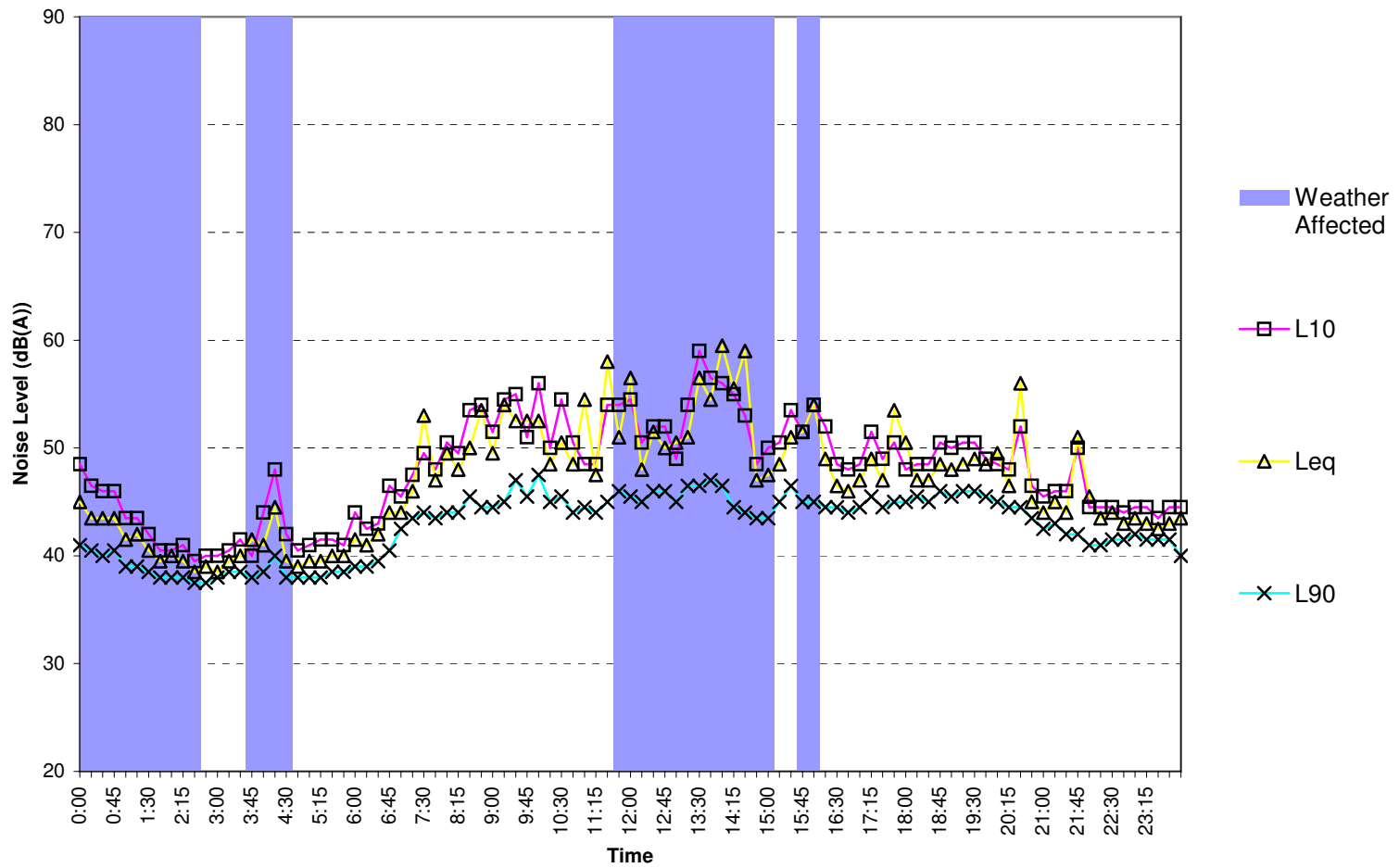
## Merriman Street Millers Point

Friday August 27, 2010



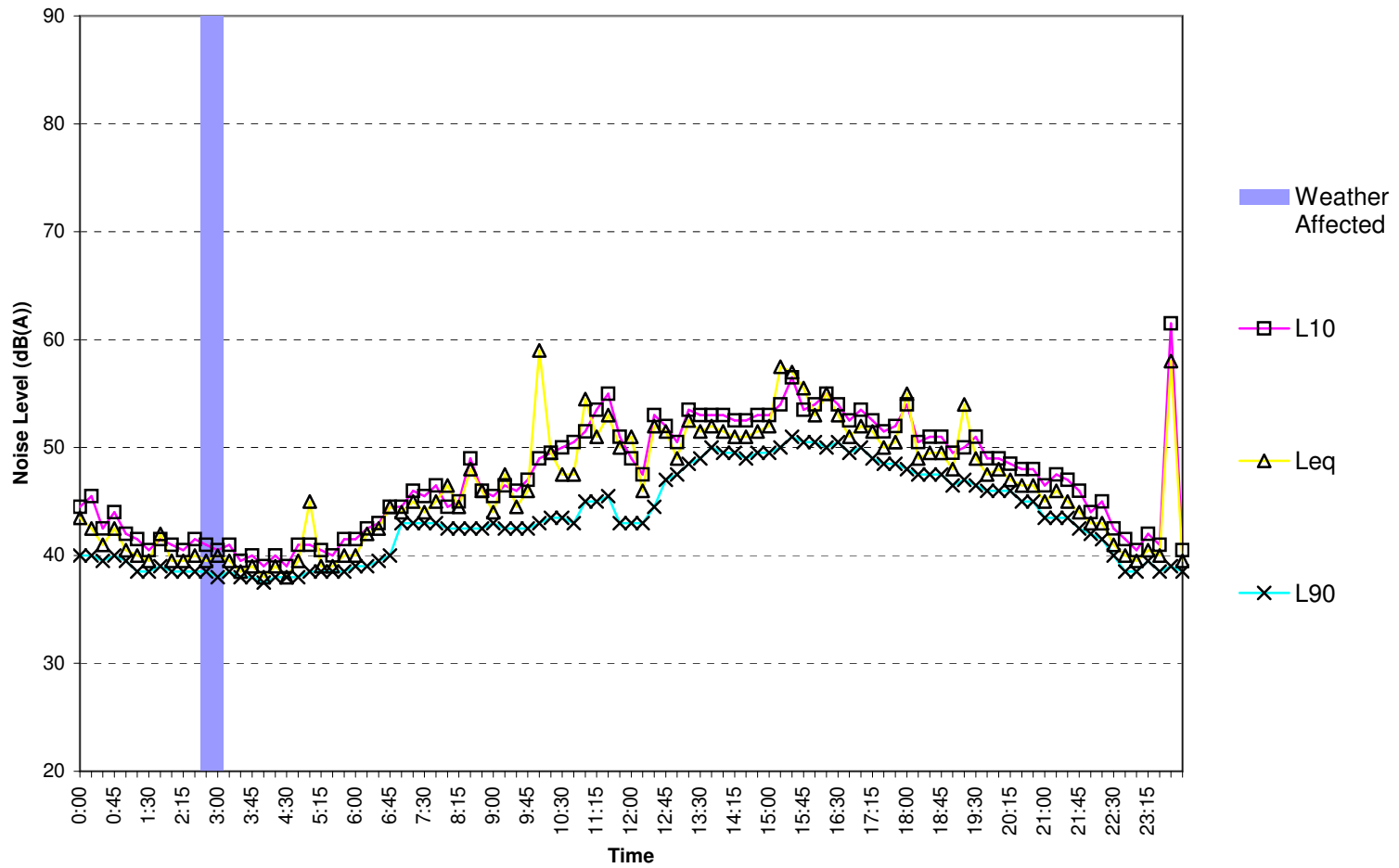
## Merriman Street Millers Point

Saturday August 28, 2010



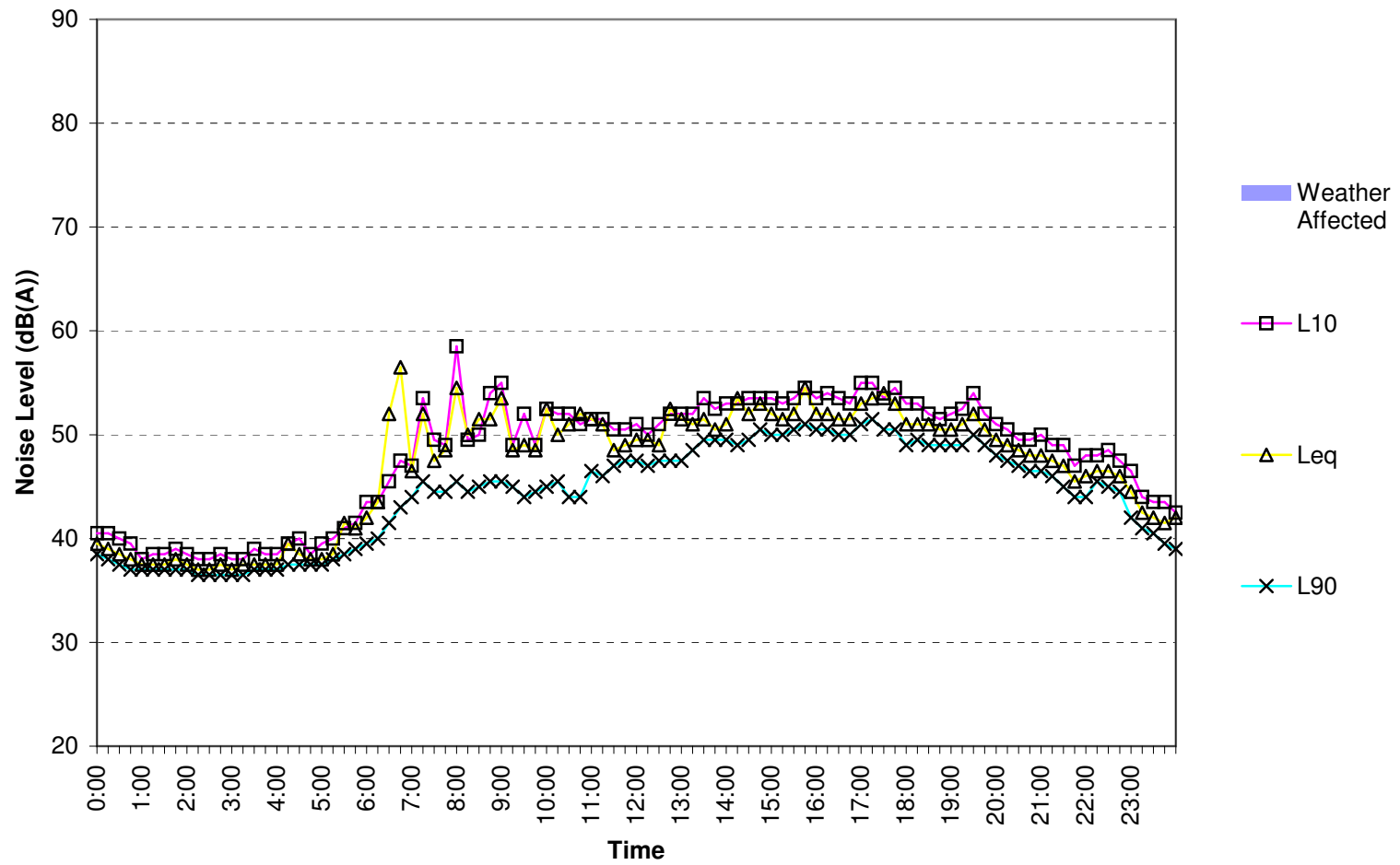
## Merriman Street Millers Point

Sunday August 29, 2010



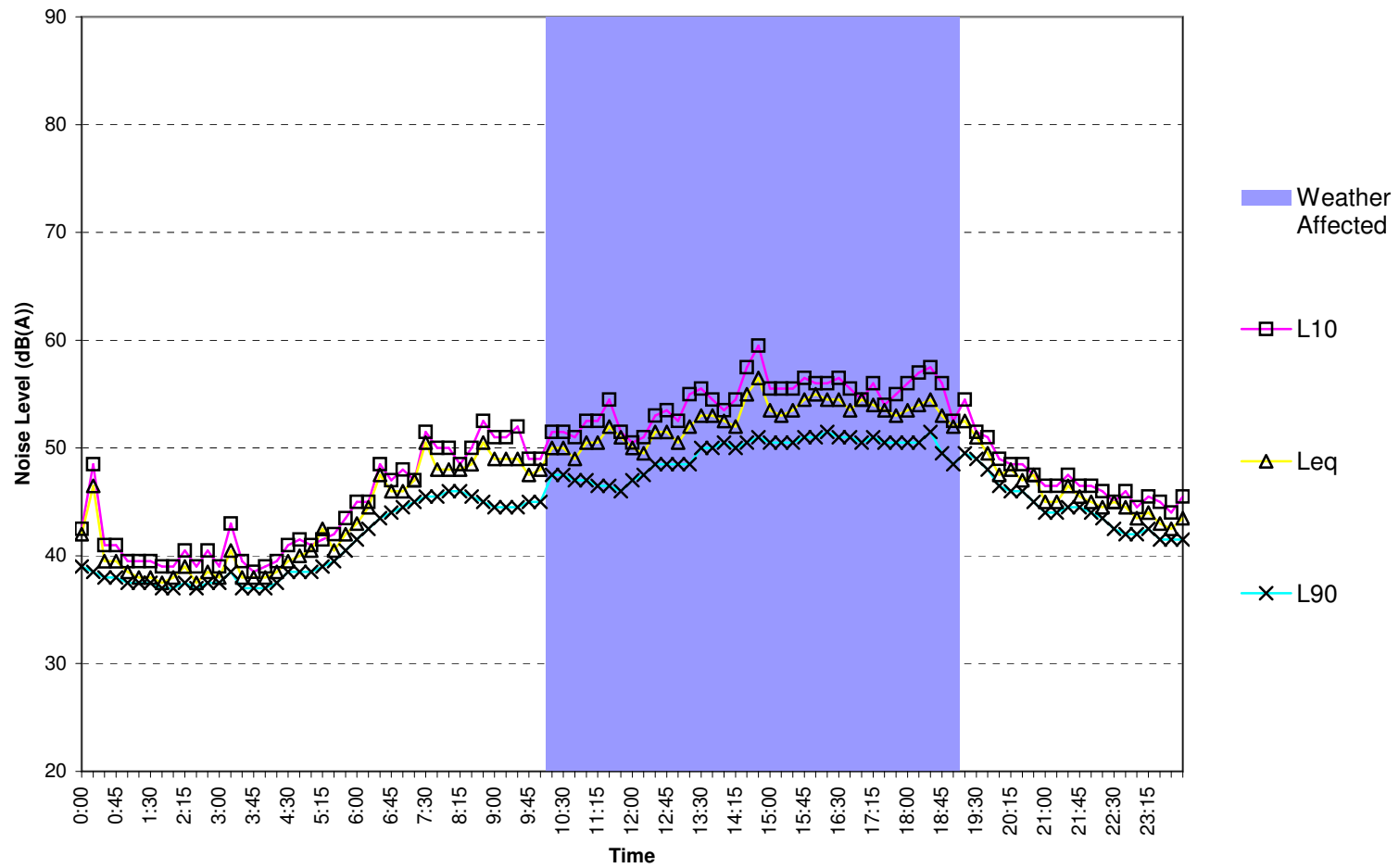
## Merriman Street Millers Point

Monday August 30,2010



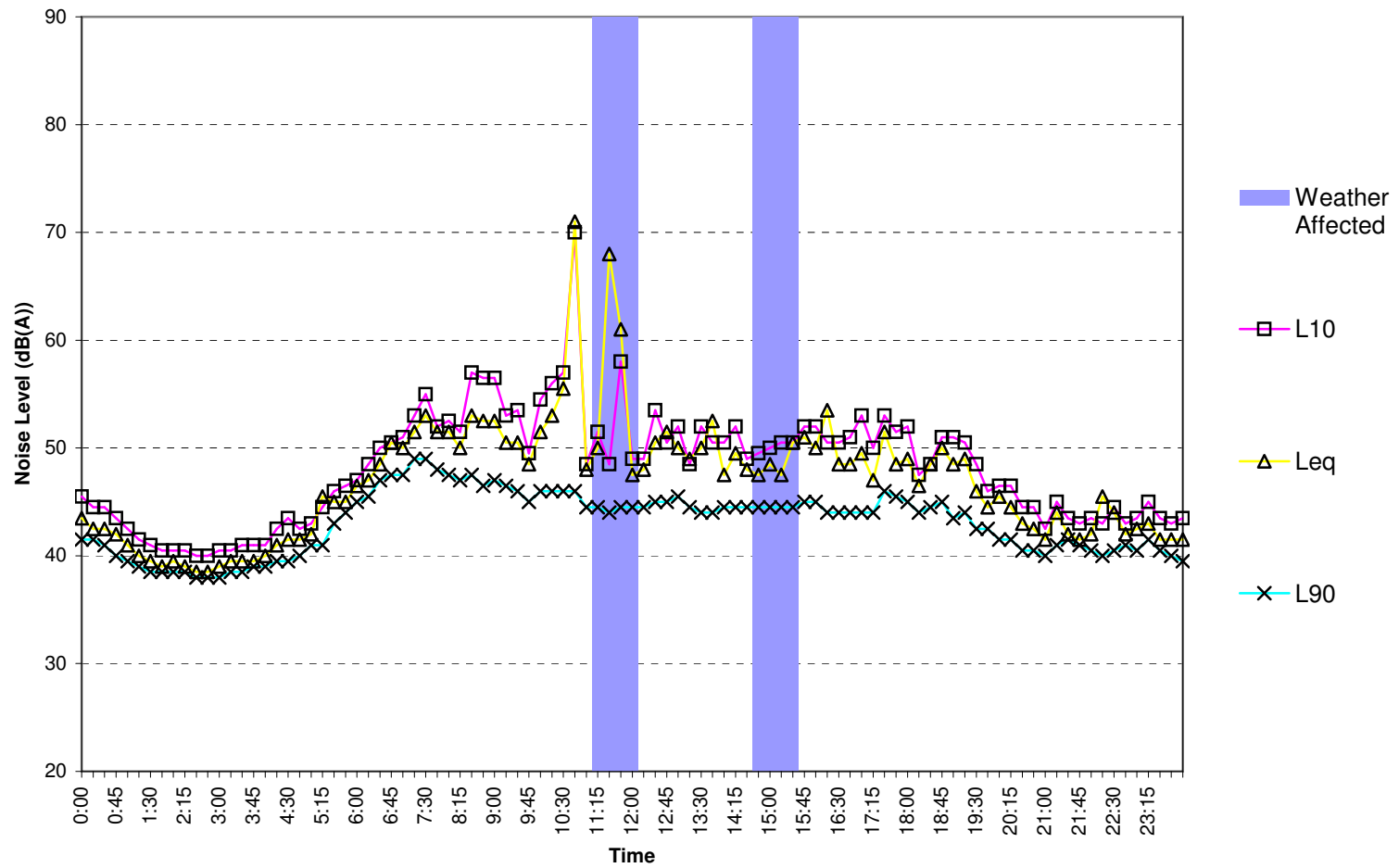
## Merriman Street Millers Point

Tuesday August 31, 2010



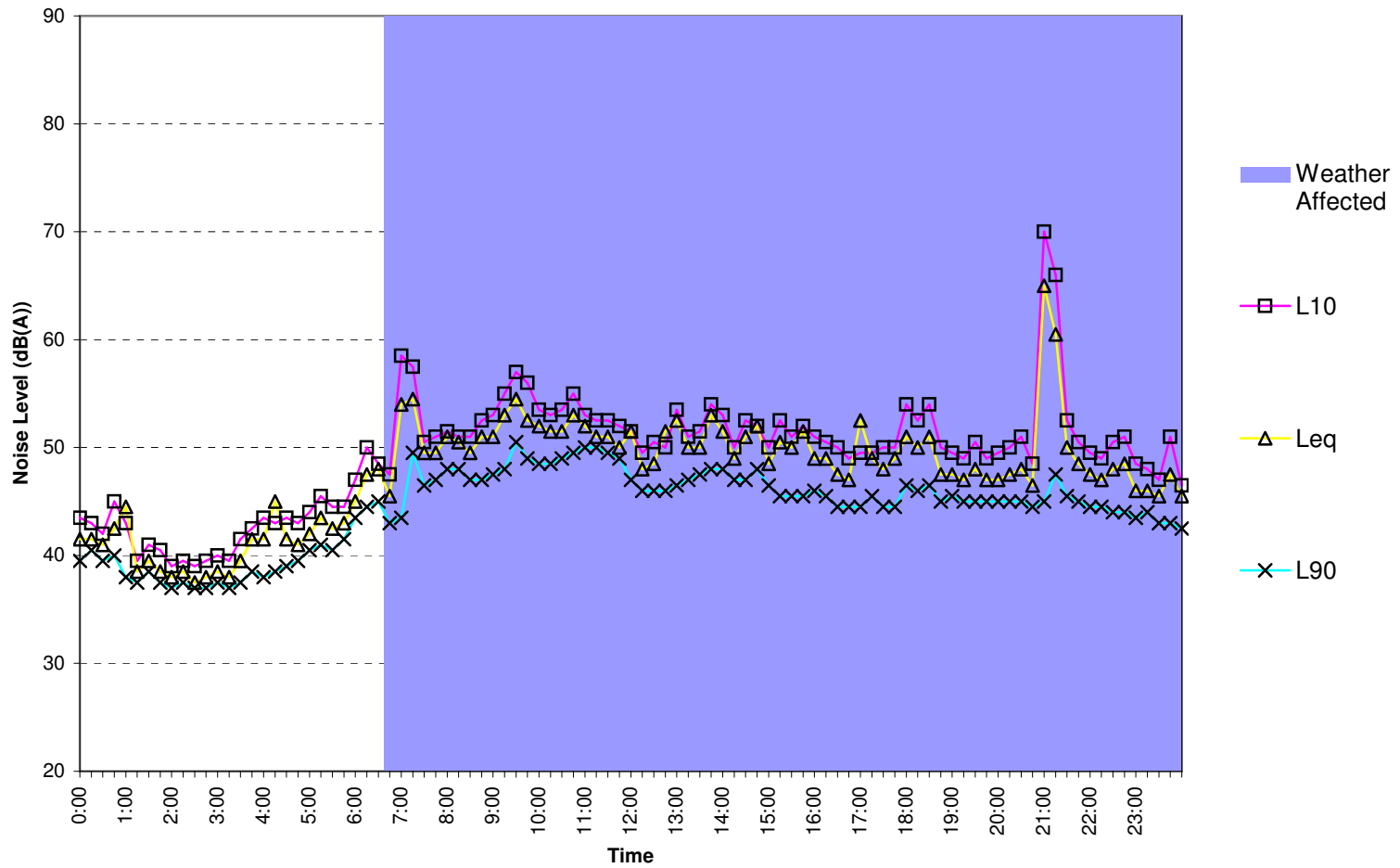
## Merriman Street Millers Point

Wednesday September 1, 2010



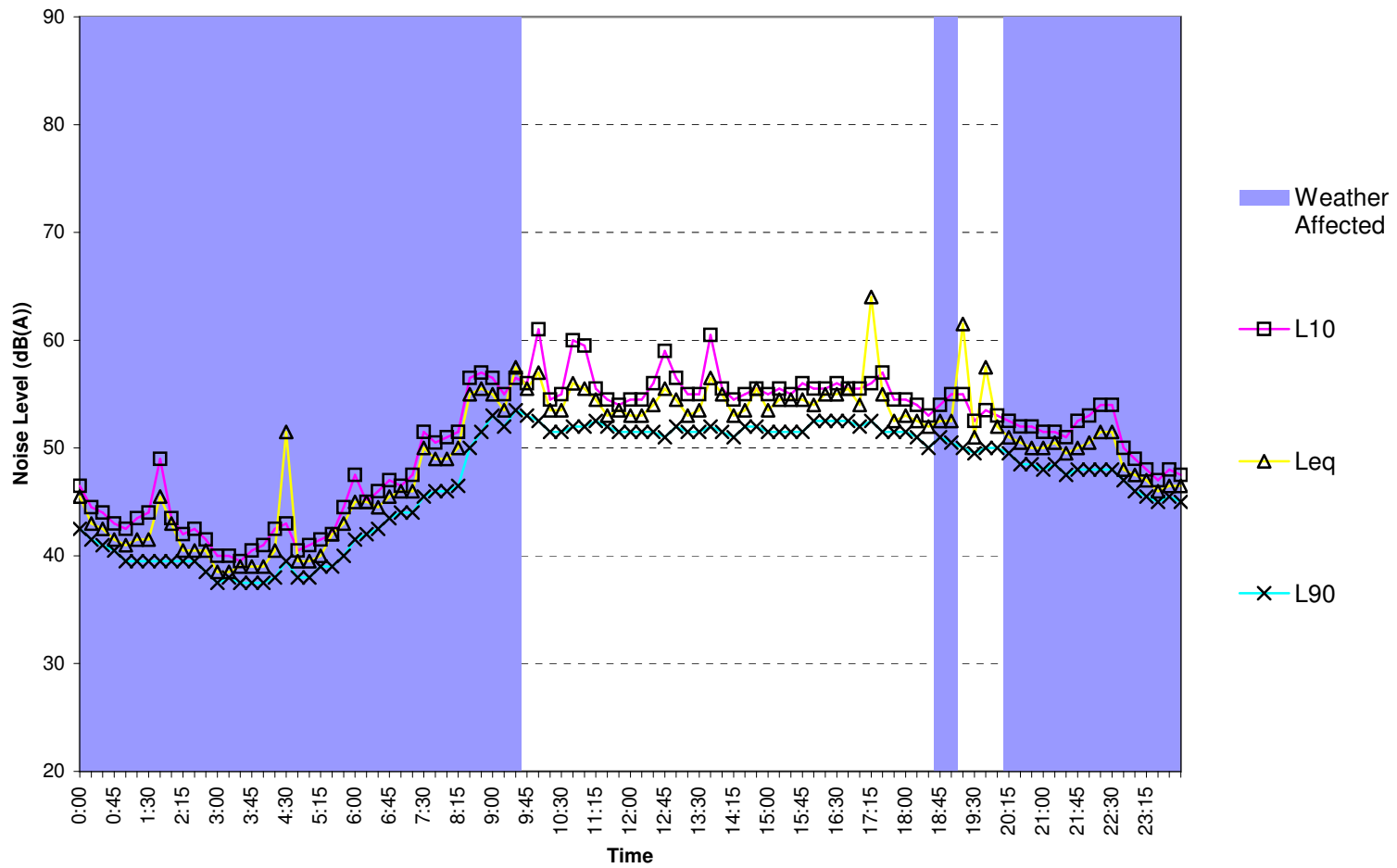
## Merriman Street Millers Point

Thursday September 2,2010



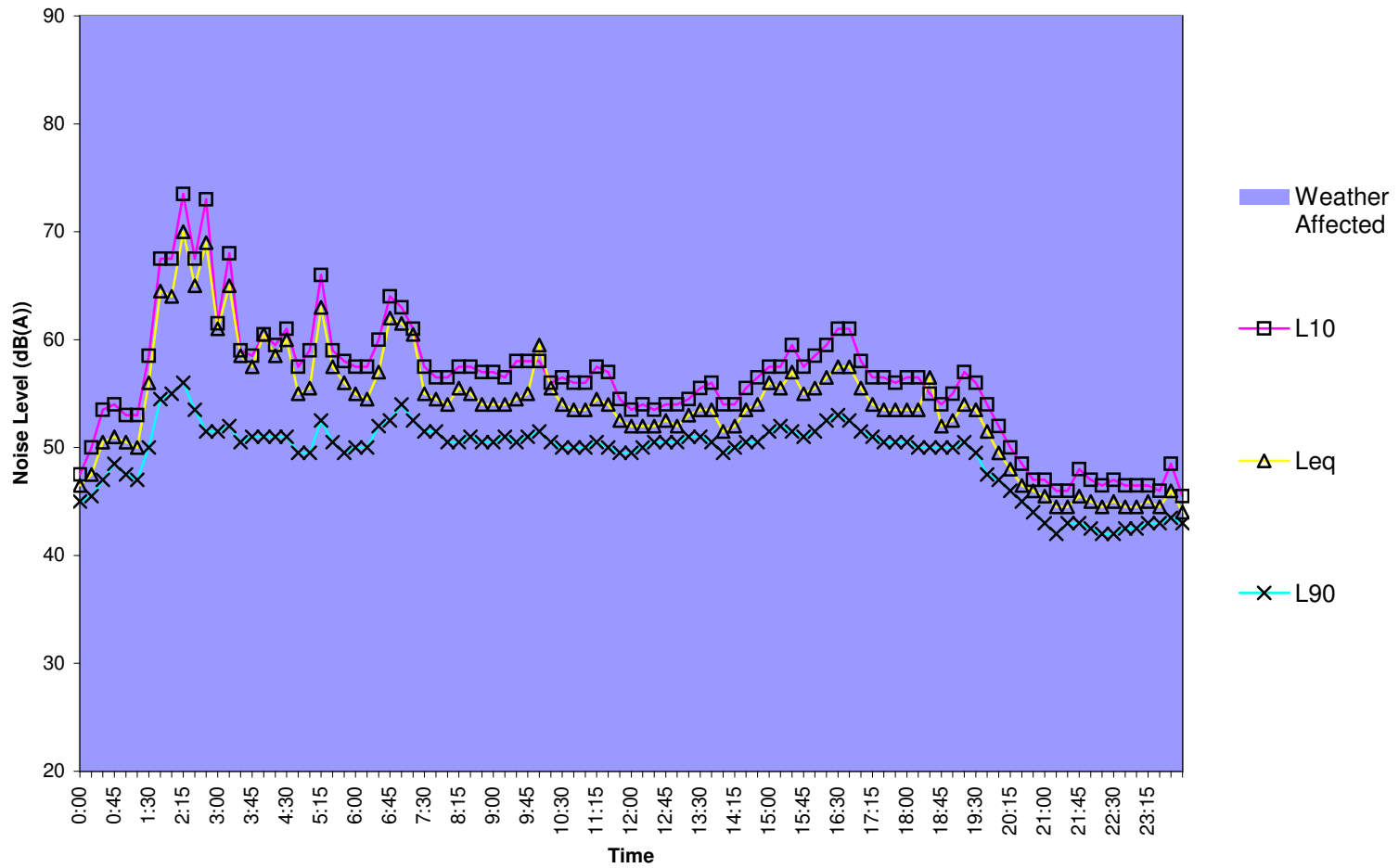
## Merriman Street Millers Point

Friday September 3, 2010



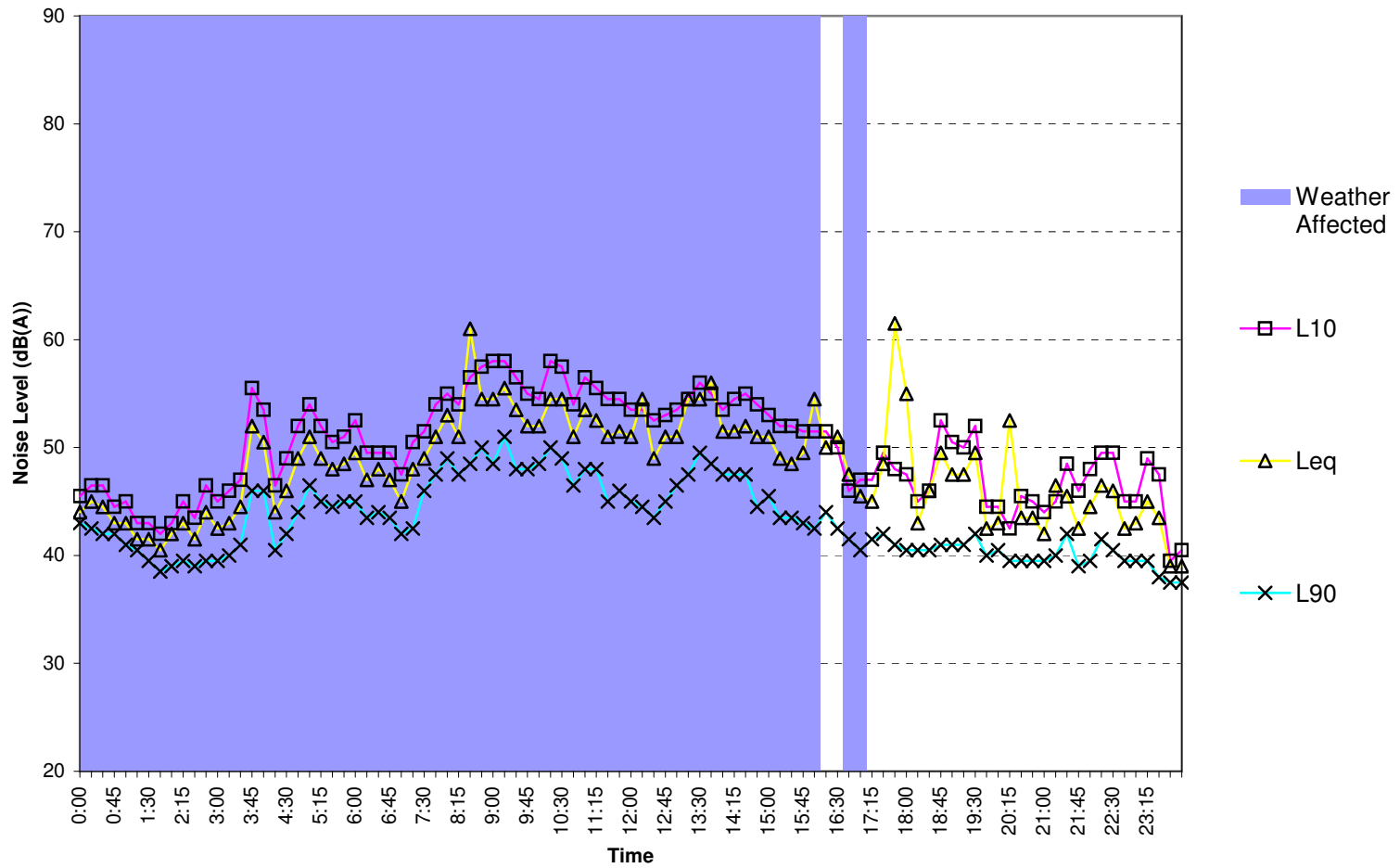
## Merriman Street Millers Point

Saturday September 4, 2010



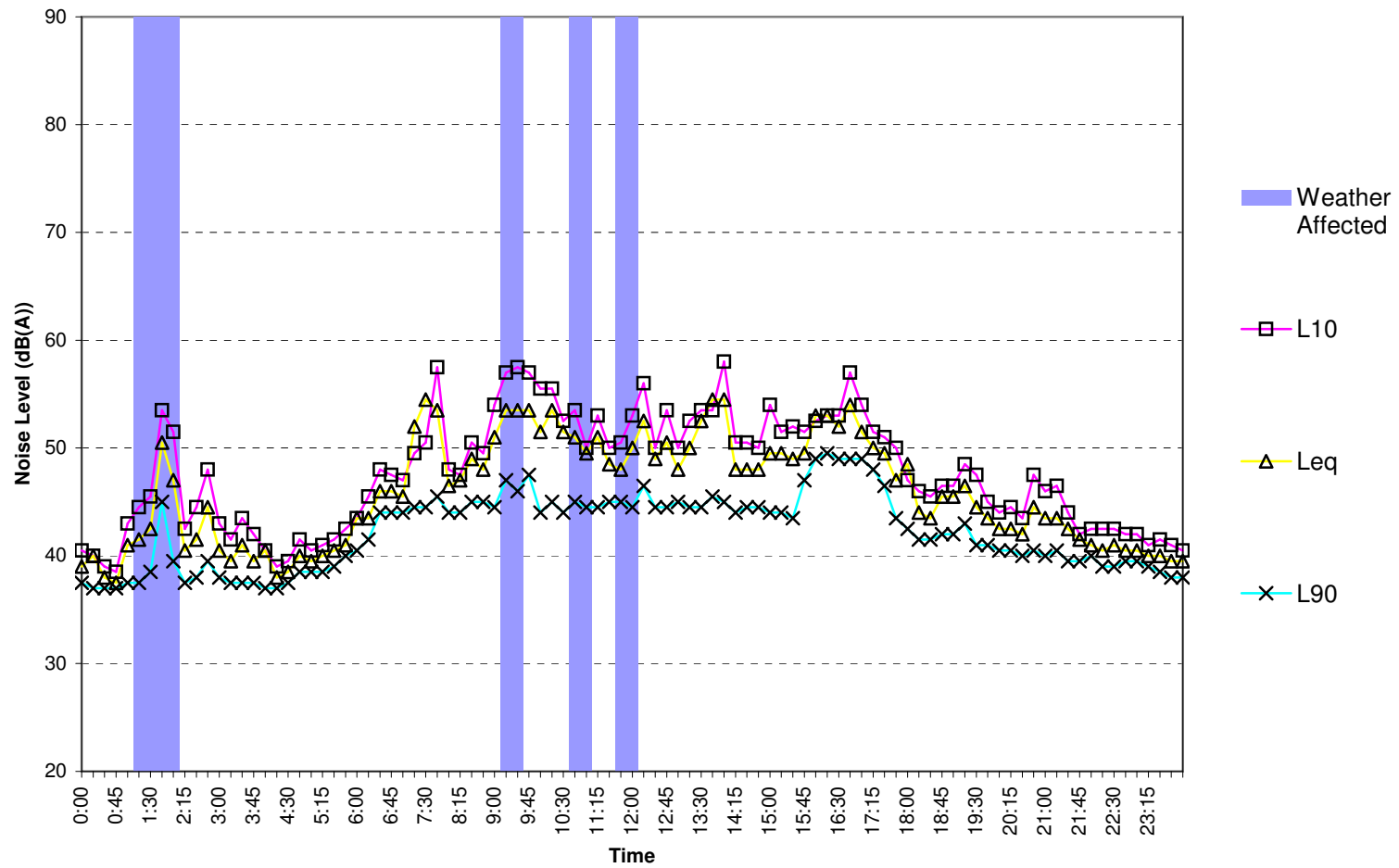
## Merriman Street Millers Point

Sunday September 5,2010



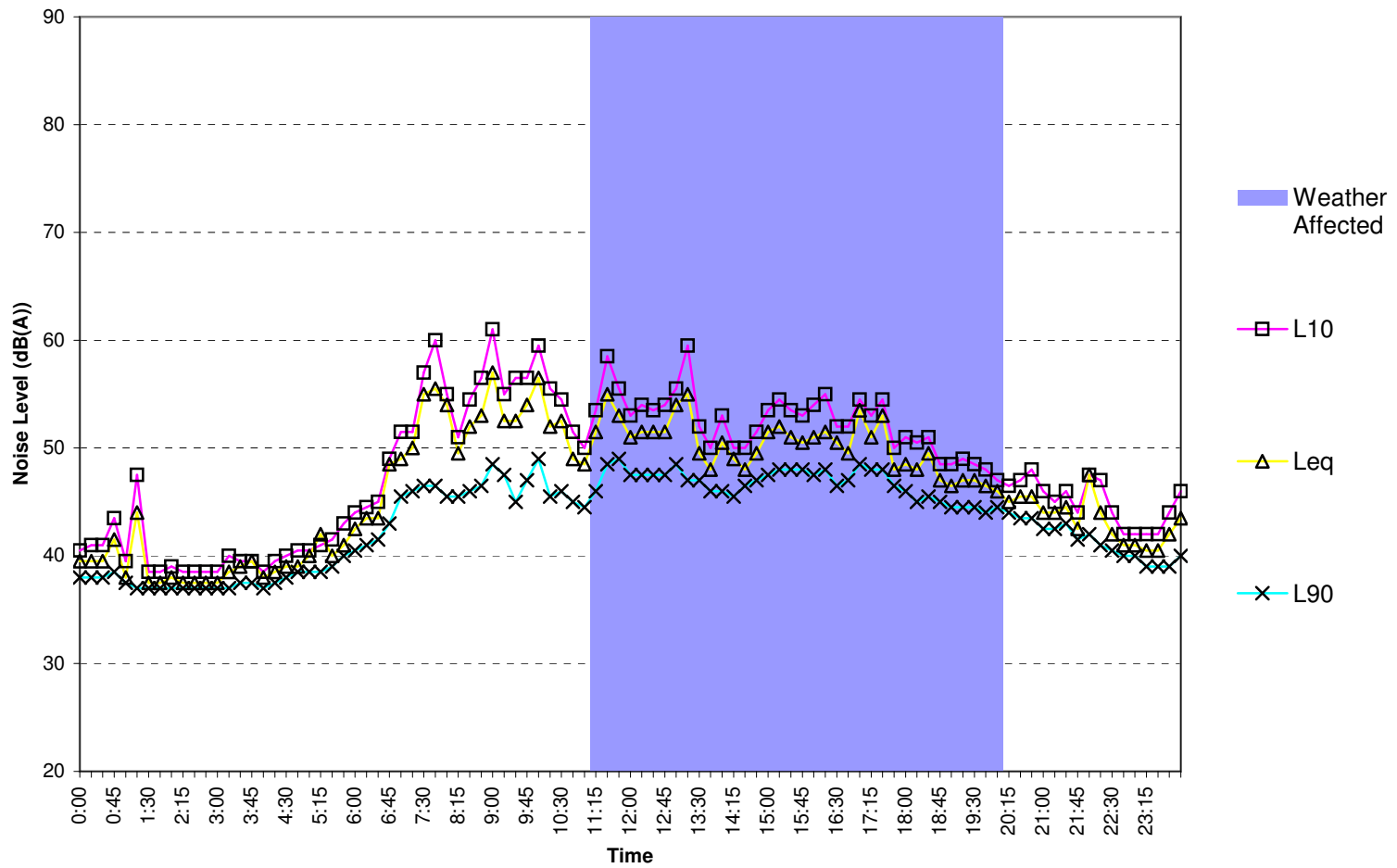
## Merriman Street Millers Point

Monday September 6,2010



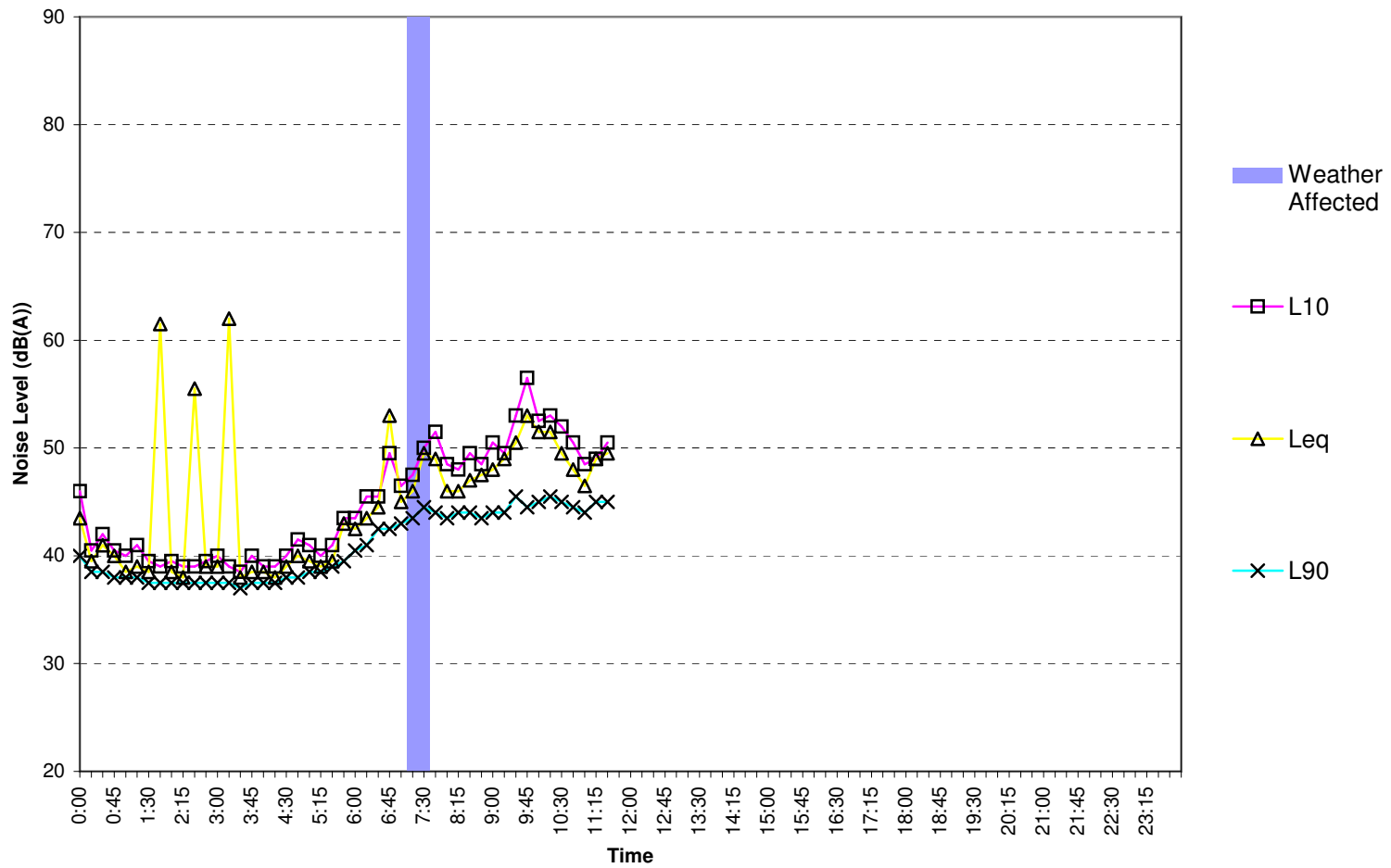
## Merriman Street Millers Point

Tuesday September 7, 2010



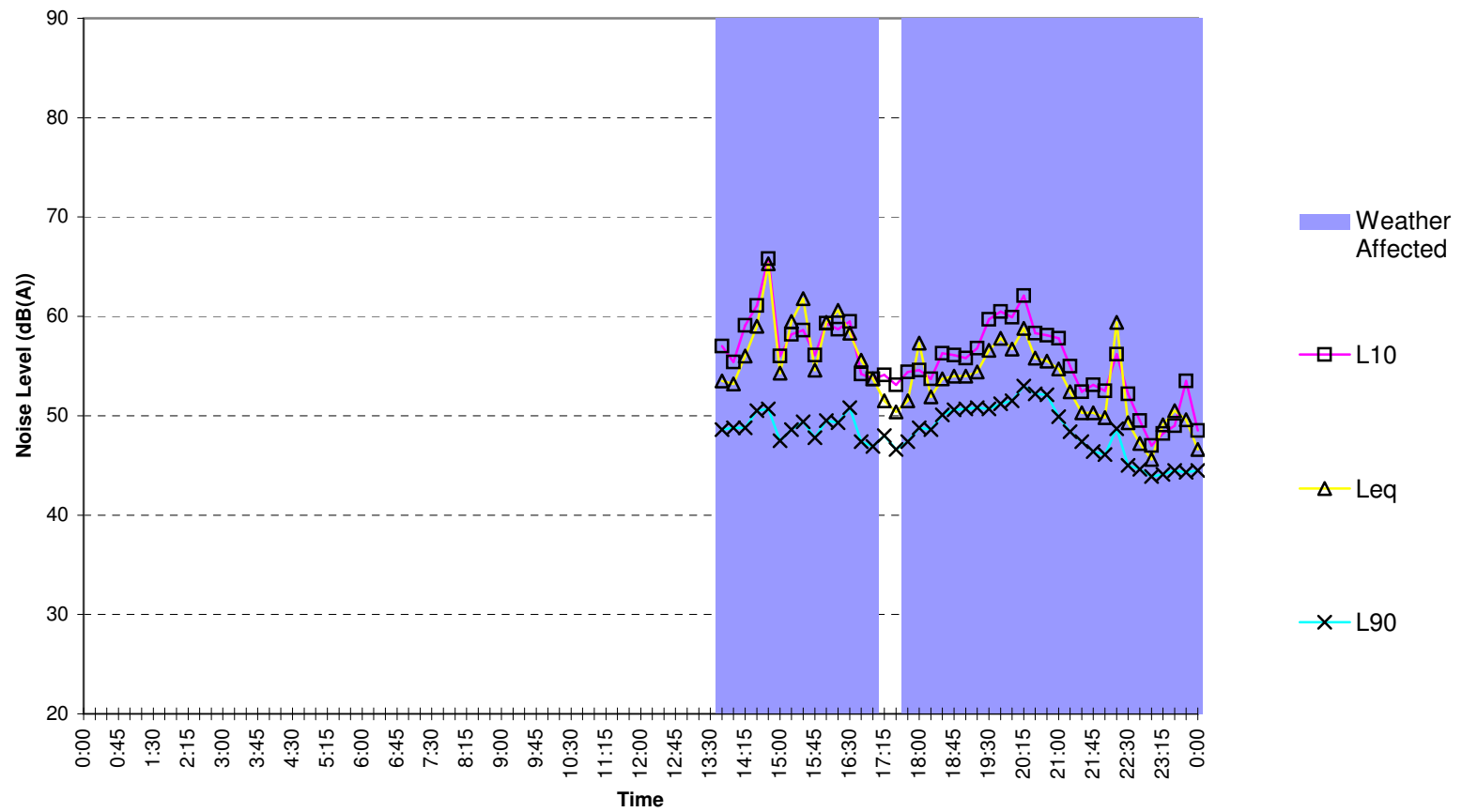
## Merriman Street Millers Point

Wednesday September 8, 2010



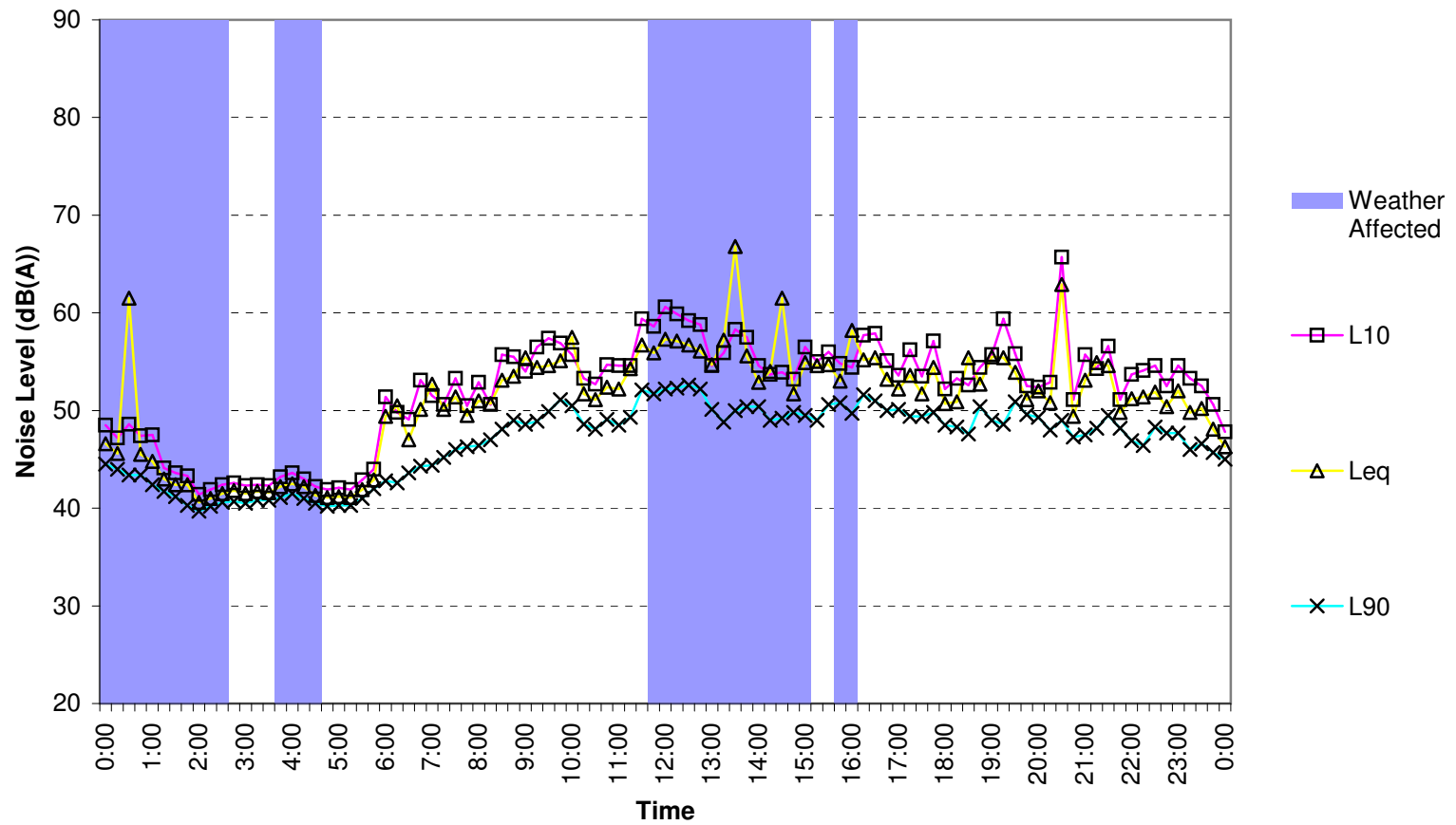
## 25 Edward Street Balmain

Friday August 27,2010



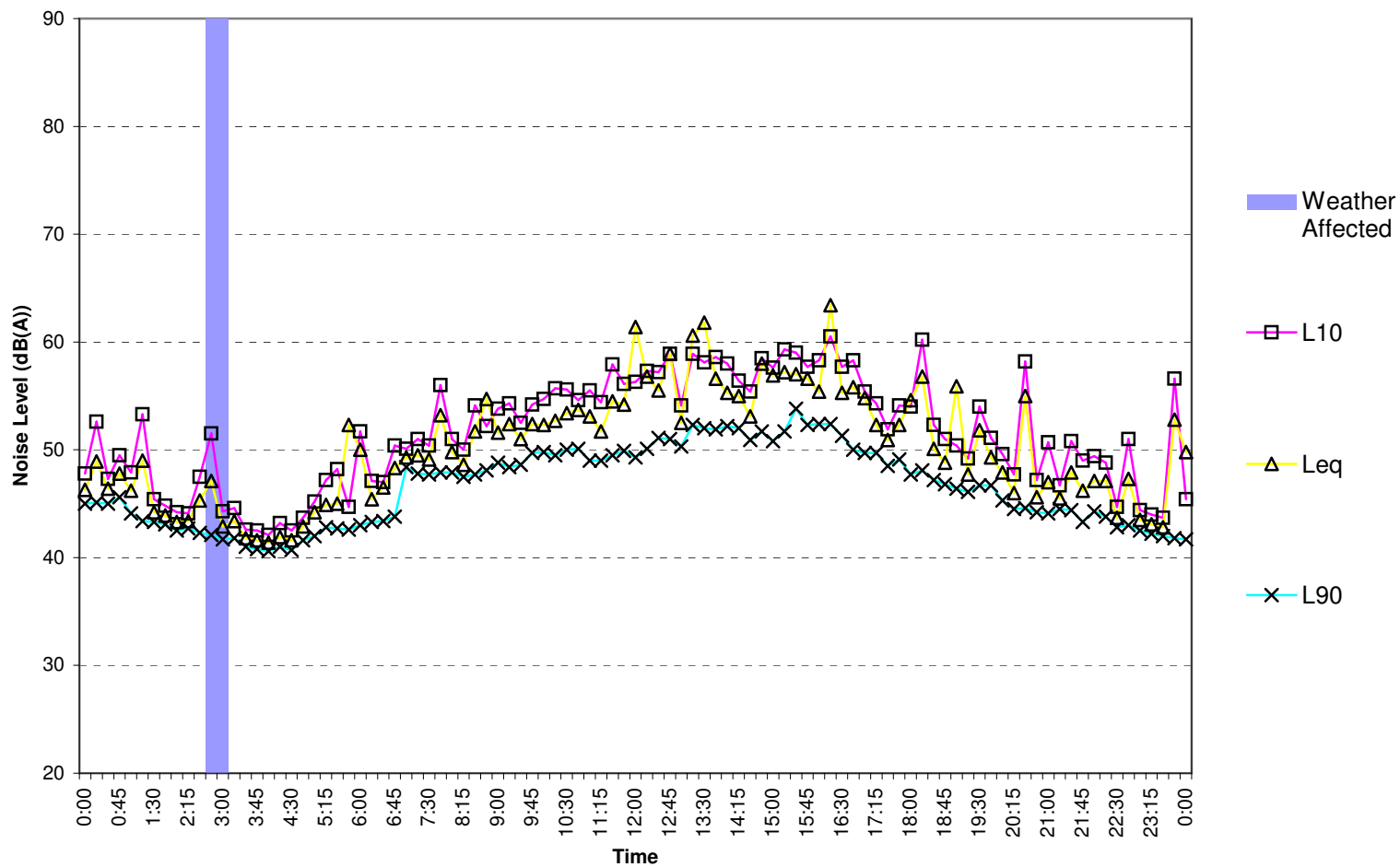
## 25 Edward Street Balmain

Saturday August 28, 2010



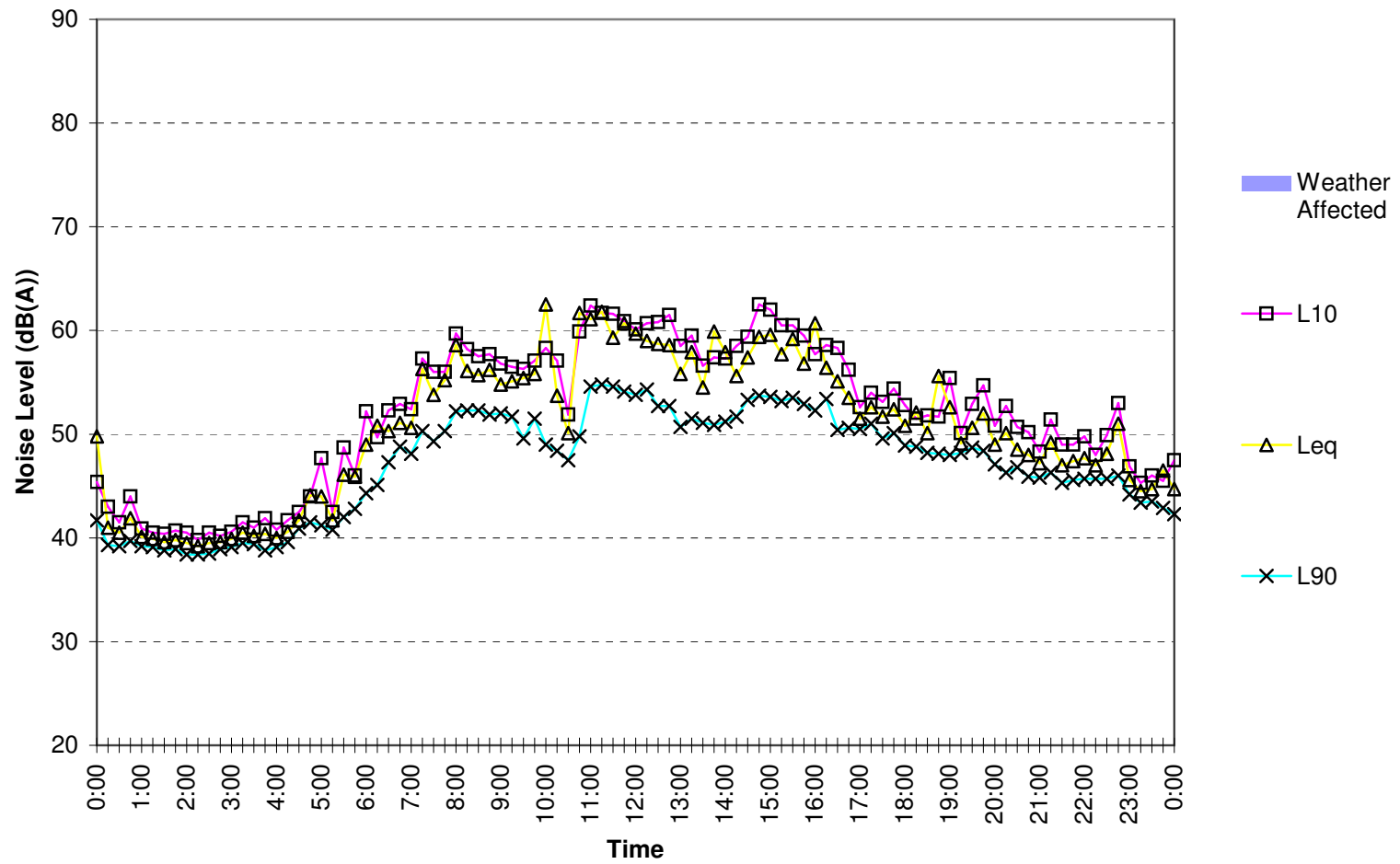
## 25 Edward Street Balmain

Sunday August 29,2010



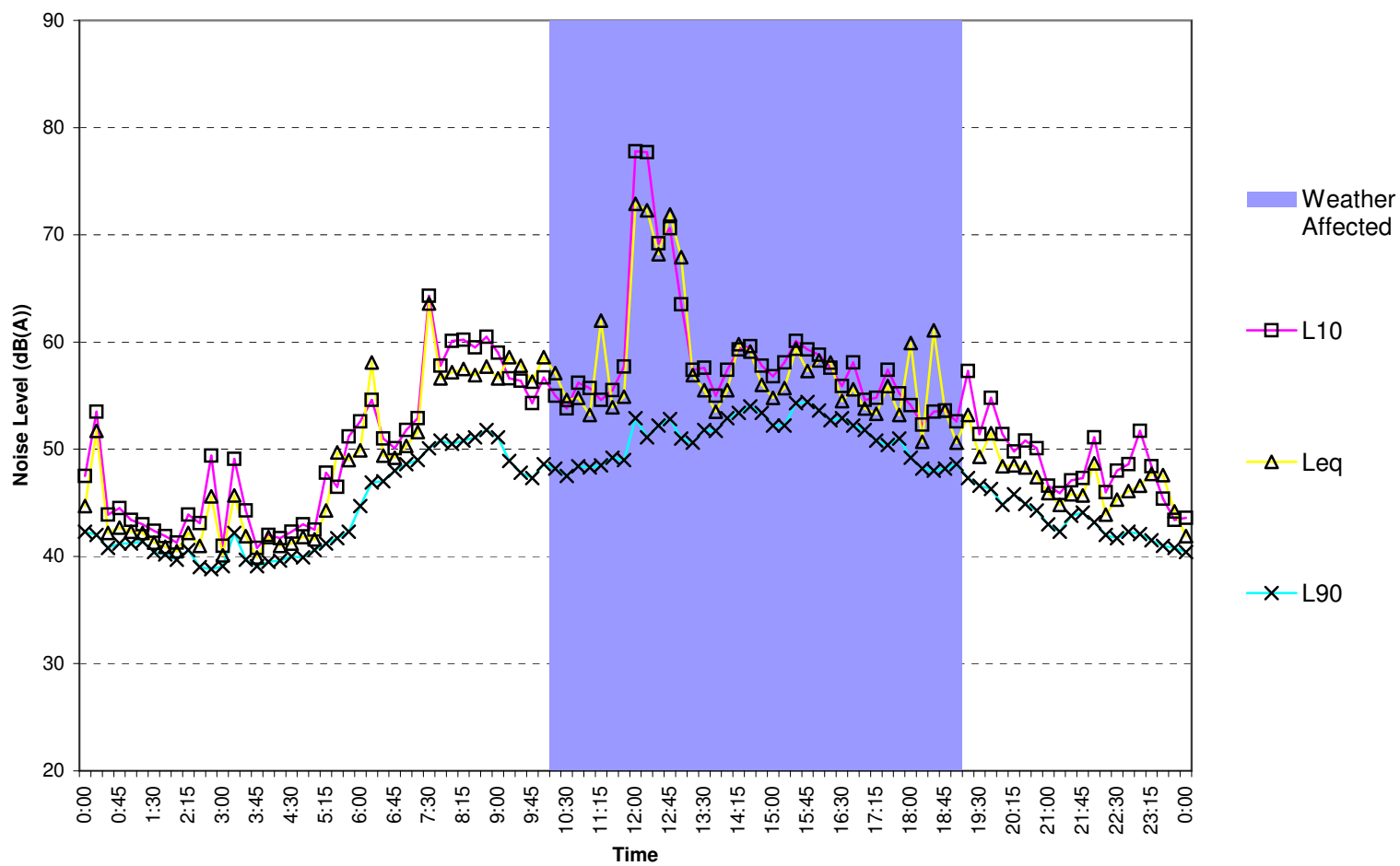
## 25 Edward Street Balmain

Monday August 30,2010



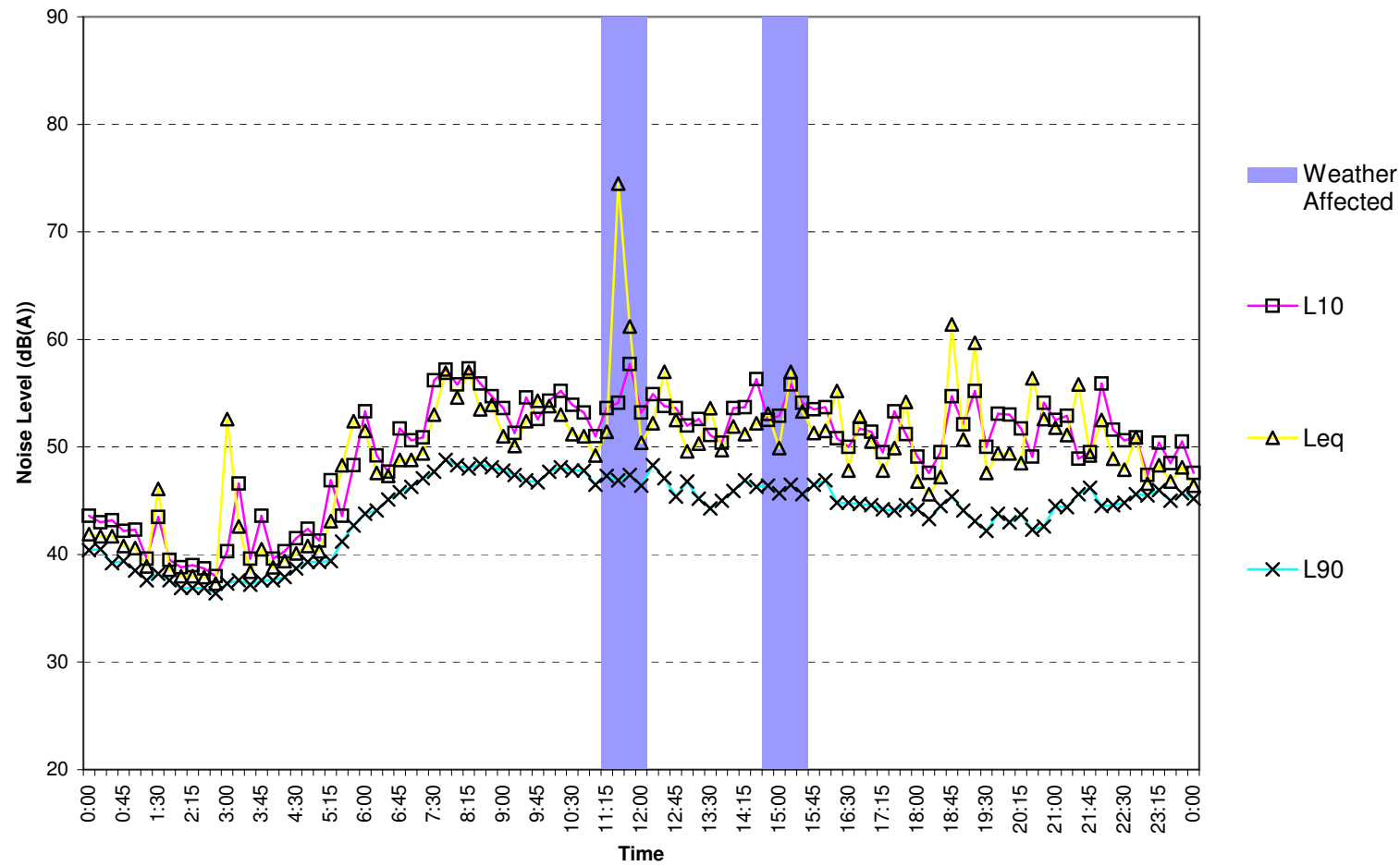
## 25 Edward Street Balmain

Tuesday August 31,2010



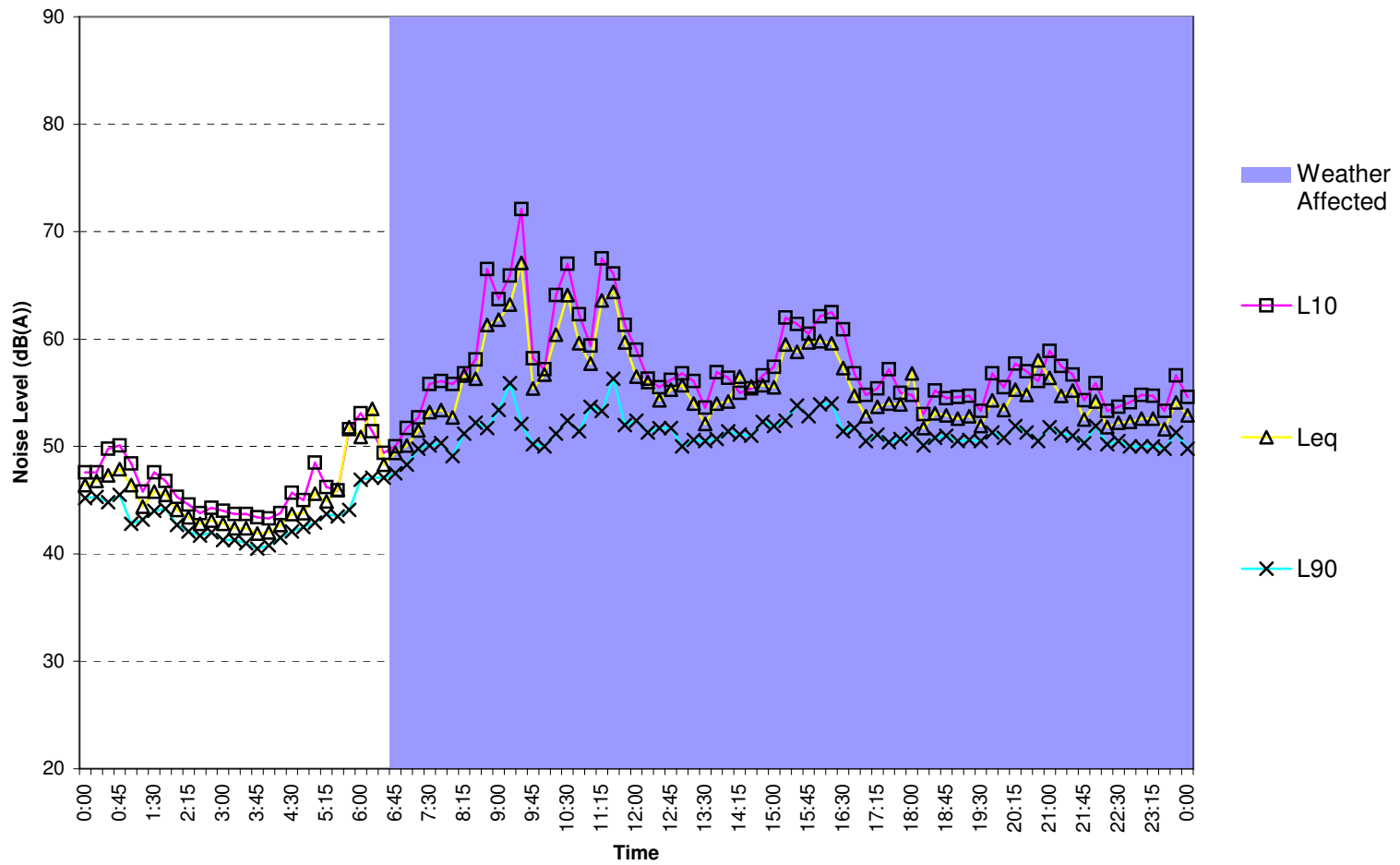
25 Edward Street Balmain

Wednesday September 1,2010



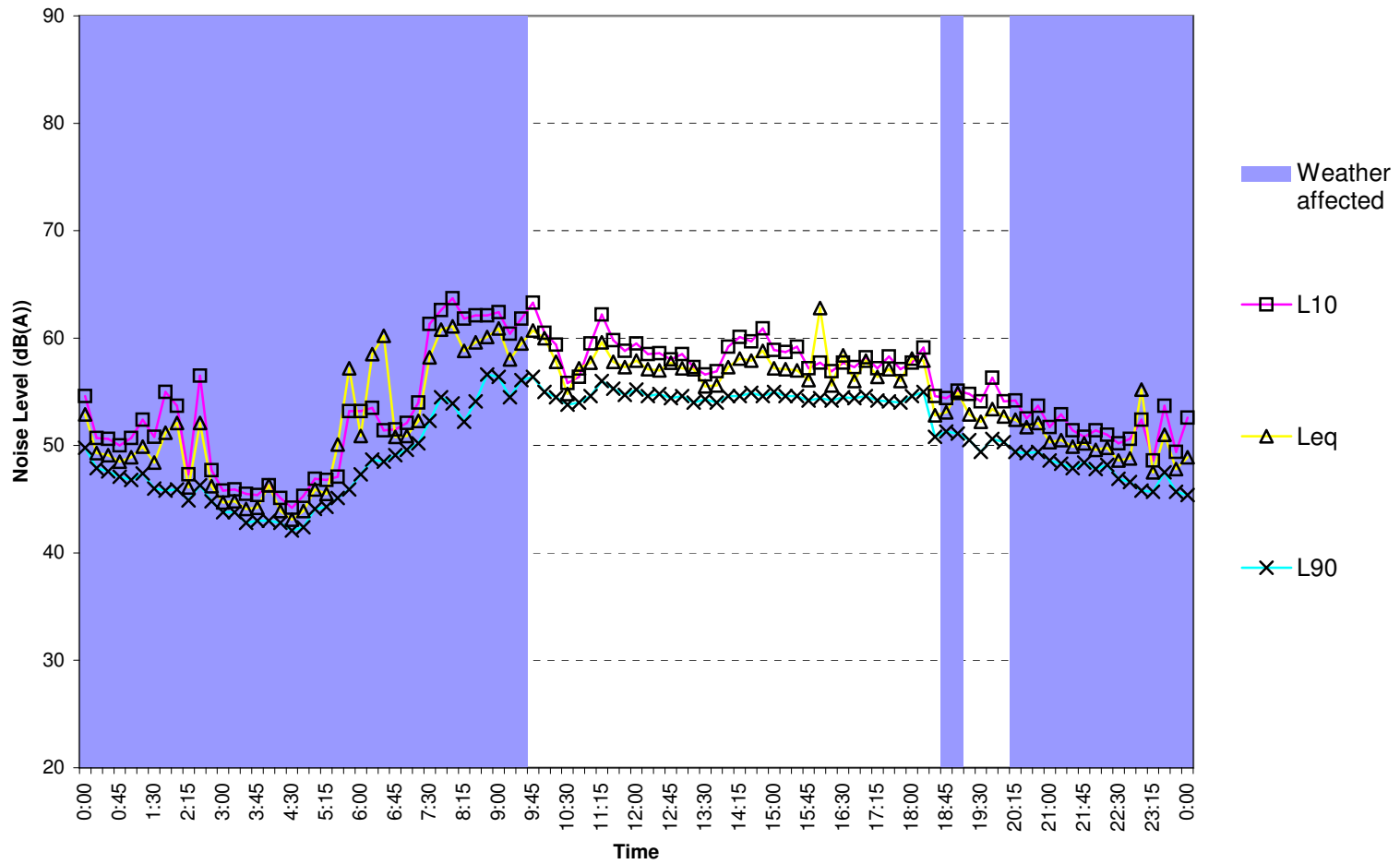
## 25 Edward Street Balmain

Thursday September 2, 2010



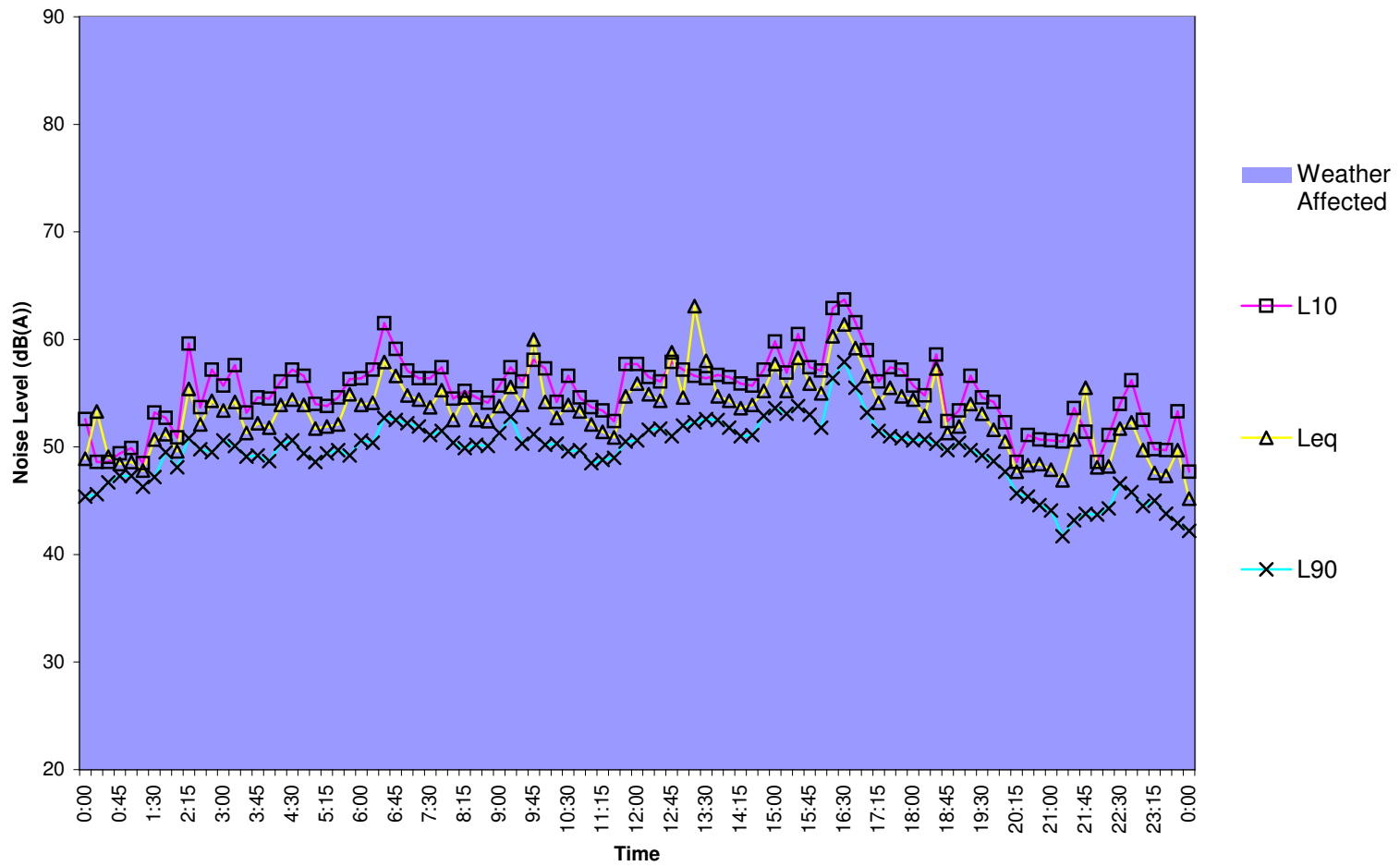
## 25 Edward Street Balmain

Friday September 3, 2010



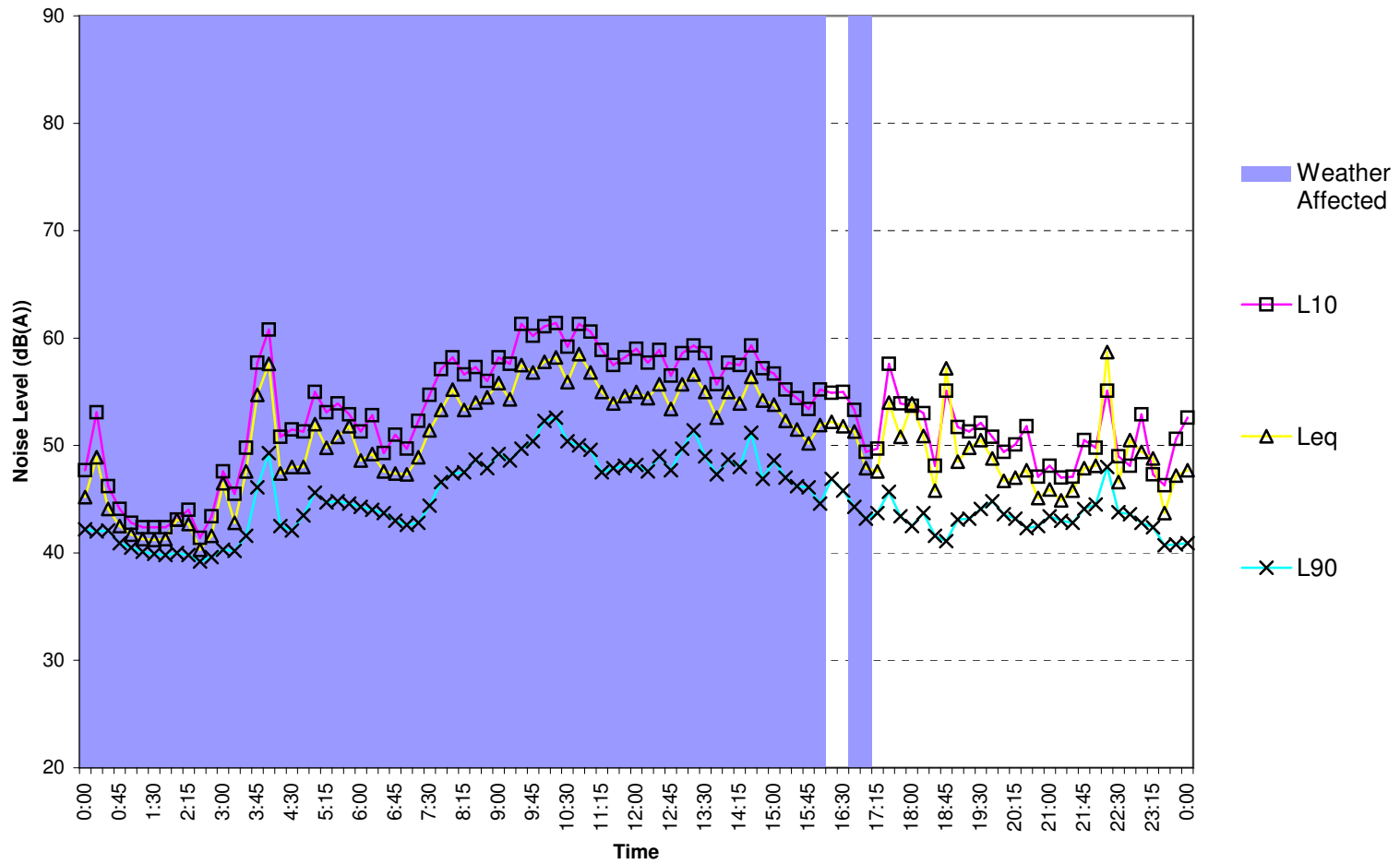
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Saturday September 4, 2010



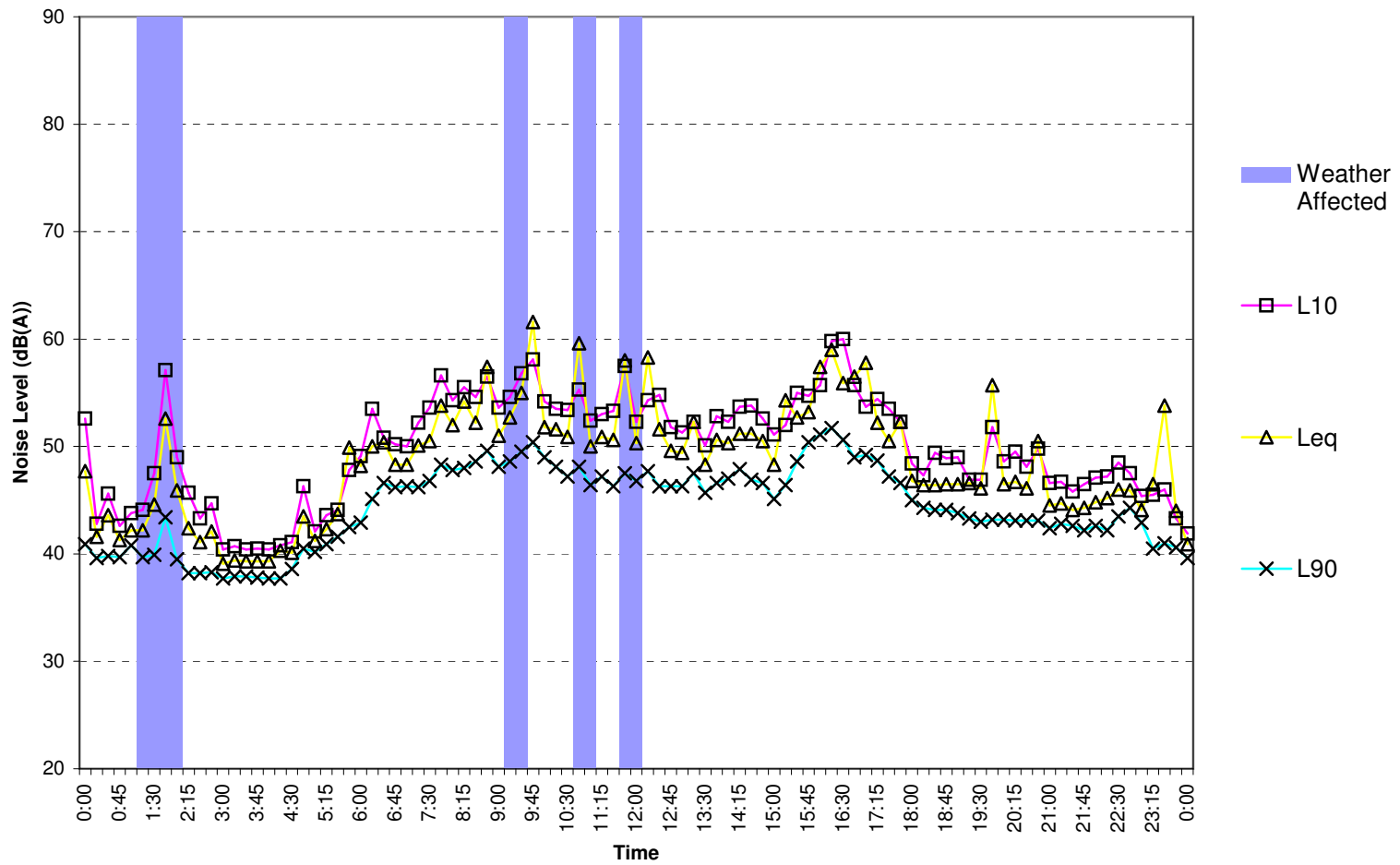
## 25 Edward Street Balmain

Sunday September 5, 2010



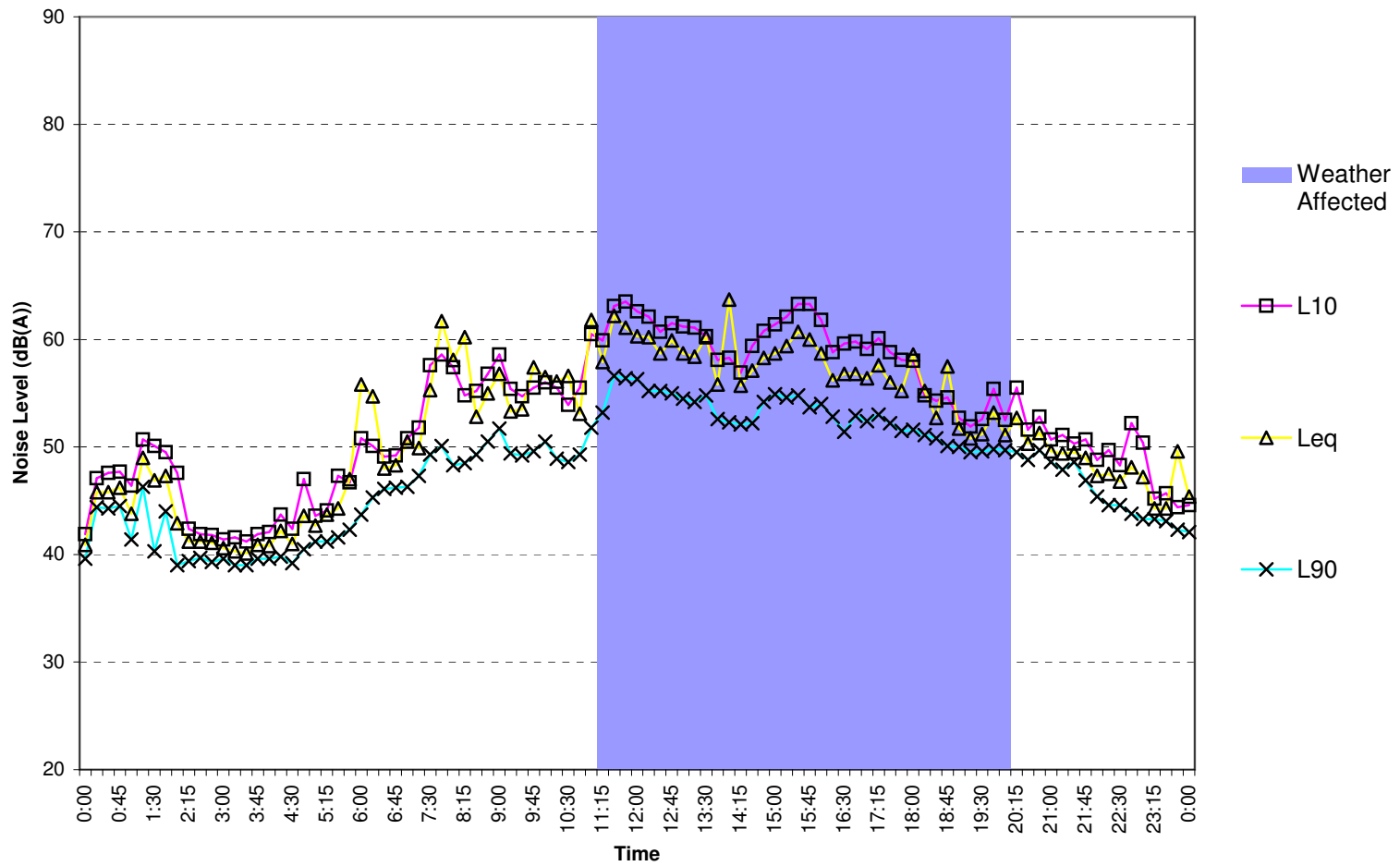
## 25 Edward Street Balmain

Monday September 6, 2010



## 25 Edward Street Balmain

Tuesday September 7, 2010



## 25 Edward Street Balmain

Wednesday September 8, 2010

