



Acoustic Report

Commercial and Residential Development
23 Meares Place & 33 Collins Street, Kiama
Construction and Operational

Prepared for Kennedy Associates Architects
Report Reference: 16SYA0026 R01_4 Acoustic Report



About TTM

For 30 years, we've been at the centre of the Australian development and infrastructure industry. Our unique combination of acoustics, data, traffic and waste services is fundamental to the success of any architectural or development project.

We have over 50 staff, with an unrivalled depth of experience. Our industry knowledge, technical expertise and commercial insight allow us to deliver an exceptional and reliable service.

T: (02) 9418 3033

F: (02) 9418 3112

E: ttmnsw@ttmgroup.com.au



Acoustics



Data



Traffic



Waste

Revision Record

No.	Author	Reviewed/Approved	Description	Date
A	K. Dhayam	K. Hewett	Draft to client	08/08/2016
B	K. Dhayam	K. Hewett	Draft to client	10/08/2016
0	K. Dhayam	K. Hewett	Issue	11/08/2016
1	K. Dhayam	K. Hewett	Issue	20/09/2016
2	K. Dhayam	K. Hewett	Issue	17/10/2016
3	J. Fox	K. Dhayam	Issue – Revised architectural plans	07/08/2018
4	J. Fox	K. Dhayam	Revision 4 – Revised architectural plans, Rev C, dated 18/07/2018	08/08/2018

Executive Summary

TTM conducted a construction and operational noise and vibration impact assessment for the proposed commercial and residential development at 23 Meares Place & 33 Collins Street, Kiama NSW 2533 for Kennedy Associates Architects on behalf of Mr Peter V'landys.

Noise monitoring of the existing acoustic environment were conducted on site to determine applicable acoustic criteria. Construction noise and vibration impact levels were predicted to noise sensitive receivers. Operational noise was also predicted to the local community. Road traffic and rail intrusion onto the development was also investigated.

The development is predicted to comply with Kiama Development Control Plan (DCP) 2012 and other relevant noise standards and guidelines with the implementation of a Construction Noise and Vibration Management Plan. A detailed acoustic assessment of mechanical plant during the detailed design stage is also recommended when the plant specifications are finalised. Road traffic and rail intrusion is not expected to impact the acoustic amenity of the future development.

Contents

1	Introduction.....	6
1.1	Scope.....	6
1.2	Site Description	7
1.3	Proposed Development.....	7
2	Acoustic Criteria.....	9
2.1	DECC Interim Construction Noise Guideline (ICNG)	9
2.1.1	ICNG Noise Management Levels	9
2.2	NSW Noise Policy for Industry.....	10
2.2.1	Intrusive Noise Criteria	11
2.2.2	Amenity Noise Criteria	11
2.2.3	Project Noise Trigger Level.....	12
2.3	Kiama DCP 2012	12
2.4	NSW Department of Planning, State Environmental Planning Policy (Infrastructure) 2007 (SEPP) 12	
2.5	NSW Road Noise Policy	13
3	Existing Noise Environment	14
3.1	Ambient Noise Measurements.....	14
3.1.1	Unattended Measurements	14
3.1.2	Attended Measurements	16
3.1.3	Unattended Road Traffic Noise Measurements	17
4	Construction Noise and Vibration Criteria.....	18
4.1	Construction Noise Criteria	18
4.1.1	Noise Sensitive Areas	18
4.1.2	Evaluation of Construction Noise Criteria	18
4.2	Vibration Criteria	18
4.2.1	Building Damage.....	18
4.2.2	Human Comfort.....	19
4.2.3	Vibration Sensitive Areas.....	20
5	Construction Noise Assessment.....	21

5.1	General Construction Schedule	21
5.2	Plant and Equipment Noise Source Levels	21
5.3	Assessment Methodology	24
5.3.1	Construction Phase – Noise Goals	24
5.4	Assessment Results	25
5.5	Assessment Discussion	25
5.6	Noise Control Recommendations	26
6	Construction Vibration Assessment	29
6.1	Potential Exceedance – 10t Vibratory/foot Roller	29
6.2	Potential Exceedance – Other Plant	30
6.3	Recommendation – Vibration Monitoring	30
7	Operational Noise Impact Assessment	31
7.1	Mechanical Plant Noise	31
7.1.1	Evaluated Noise Criteria – NSW NPI 2017	31
7.1.2	Assessment and Discussion	32
8	Road Traffic and Rail Noise Intrusion	33
8.1	Noise Criteria	33
8.2	Road Traffic Noise Assessment	33
8.2.1	Kiama DCP 2012	33
8.2.2	NSW Road Noise Policy	33
8.3	Rail Noise Assessment	34
9	Conclusion	35
Appendix A	Site and Elevation Plans	37
Appendix B	Graphical Monitoring Results Location 1	45
Appendix C	Graphical Monitoring Results Location 2	50
Appendix D	Construction Noise Contours – Worst-case Scenario	55

Table Index

Table 1: Residential and commercial – ICNG noise management levels	10
Table 2: Amenity Noise Levels	11
Table 3: NSW Road Noise Policy criteria	13

Table 4: Summary of unattended noise monitoring results.....	16
Table 5: Attended noise measurement results	17
Table 6: Road traffic noise measurements.....	17
Table 7: Evaluated construction noise criteria	18
Table 8: Recommended conservation vibration criterion – Building damage	19
Table 9: Human comfort vibration levels equivalent to Curve 4 given in AS2670.2	20
Table 10: Plant and equipment used and % use per day for each step of the construction schedule.....	22
Table 11: Sound power levels, SWL, of construction plant and equipment.....	23
Table 12: Approximate maximum distance from pipeline to achieve construction noise goals	25
Table 13: Approximate number of noise impacted residential properties	25
Table 14: Recommended safe working distances for hydraulic hammer rock breaking attachments.....	29
Table 15: NSW NPI Evaluated criteria	31
Table 16: Road traffic noise – Compliance check.....	34
Table 17: Summary of rail noise intrusion assessment	34

Figure Index

Figure 1: Site location and surroundings.....	8
Figure 2: Location of attended and unattended measurements	15
Figure 3: Illustration of a mobile enclosure and barrier.....	27
Figure 4: Photos of demountable noise barriers.....	27

1 Introduction

TTM Consulting has been commissioned by Kennedy Associates Architects on behalf of Mr Peter V'landys to conduct a construction and operational noise and vibration impact assessment report for a proposed commercial and residential development at 23 Meares Place & 33 Collins Street, Kiama NSW 2533. The report is required as part of the Development Application (DA) submission to Kiama Municipal Council (KMC).

TTM initially prepared the construction and operational noise impact assessment report for the development on the site for Kiama Shores Pty Ltd (Report Ref.: 16SYA0026 R01_2, Revision 2, dated 17th October 2016). The development scheme has since been revised. This report is a revision of the previous acoustic report based on the latest set of architectural plans issued by Kennedy Associates Architects, Revision C, dated 18/07/2018.

1.1 Scope

The report addresses the current development proposal and the following acoustic issues:

- Construction noise and vibration management advice for the development:
 - Measurement of existing ambient noise levels in the area
 - Identification of Noise Sensitive Receivers (NSRs), residential and commercial
 - Identification of construction activities including machinery and equipment used during demolition, excavation and construction
 - Noise impact assessment in accordance with the NSW Department of Environment and Climate Change (DECC), Interim Construction Noise Guideline, and
 - Advice on practical and appropriate in-principle noise mitigation and management, where required.
- Operational noise impact assessment from the development:
 - Identification of Noise Sensitive Receivers (NSRs), mainly residential
 - Identification of all air conditioning units and other mechanical plant related to the development;
 - Noise impact assessment in accordance with the NSW Noise Policy for Industry 2017¹ and the Kiama Development Control Plan (DCP) 2012, and
 - Advice on practical and appropriate in-principle noise mitigation and management, where required.
- Road traffic and rail noise assessment:

¹ NSW Environment Protection Authority (2017), Noise Policy for Industry

- Measurement of existing ambient noise levels in the area
- Identification of road traffic and rail noise sources
- Assessment in accordance with the State Environmental Planning Policy (Infrastructure) 2007, and
- Advice on practical and appropriate in-principle noise mitigation and management, where required.

1.2 Site Description

The site is located at 23 Meares Place & 33 Collins Street, Kiama, as shown in Figure 1 below. The site description is Lot 202 DP 1054190 & Lot 1 DP 743509. A site inspection was conducted on 28th June 2016. The bigger lot located at the rear of the site is sloping and currently vacant covered with grass and bushes, while the front lot is currently occupied by a single storey commercial building.

The highest elevation point on the site is the northern corner of the site from where the site slopes downhill to the east, south and west.

The site is bounded by residential townhouses and dwellings to the north along Meares Place and Minnamurra Street, and to the west. On the corner of Minnamurra Street and Collins Street, and along Collins Street southeast of the site, are commercial buildings, comprising of retail shops, restaurants and a service station. To the south of the site, is a car parking lot used by members of Kiama League Club. Further to the west of the site is the local shopping centre, with its car parking area located at approximately 50 metres from the western boundary of the site.

Terralong Street is the only major road in the area, located at approximately 120 metres from the south-western boundary of the site. Collins Street is located to the east of the site adjoining the front lot. The South Coast railway line is located to the east of the development with the tracks moving away of the development from the tunnel opening. The closest distance of the railway tracks to the south-eastern boundary of the rear lot is approximately 80 metres.

1.3 Proposed Development

The proposed development involves the construction of a commercial and residential development comprising of one commercial unit, a manager's unit and 57 one to three-bedroom units. Site car parking will be located across two levels of basement car parking.

On the front lot (Lot 1) of the development, a three-level building is proposed with commercial space on the lower level and residential units on the upper floor levels. Four residential building blocks and a communal open area are located on the rear lot (Lot 202).

The proposed site layout and elevation plans are contained in Appendix A of the report.



Figure 1: Site location and surroundings

2 Acoustic Criteria

The main guidelines, standards and other policy documents relevant to the construction, operational, and road traffic and rail noise impact assessment report include:

- DECC Interim Construction Noise Guideline (2009)²
- NSW Noise Policy for Industry (2017)
- Kiama Development Control Plan (DCP) 2012
- NSW Department of Planning, State Environmental Planning Policy (Infrastructure) 2007, and
- NSW Department of Climate Change & Water, Road Noise Policy.

2.1 DECC Interim Construction Noise Guideline (ICNG)

The DECC Interim Construction Noise Guideline (ICNG) provides guidelines for the assessment and management of noise from construction works. Construction activities proposed for this development mean it is considered a major construction project, therefore the quantitative approach has been adopted for the construction noise impact assessment.

2.1.1 ICNG Noise Management Levels

The ICNG suggests the following standard hours for construction activities where noise is audible at residential and commercial premises:

- Monday to Friday, 7am to 6pm
- Saturday, 8am to 1pm, and
- No construction work is to take place on Sundays or public holidays.

Time restrictions on construction works are the primary management tool of the ICNG.

The guideline also provides noise management levels for residential and commercial premises for both the recommended, and outside standard hours of construction. The noise management levels recommended for residential and commercial premises have been extracted from the ICNG and are shown in Table 1.

² Department of Environment and Climate Change (DECC). NSW Government (2009). Interim Construction Noise Guideline.

Table 1: Residential and commercial – ICNG noise management levels

Time of day	Management level, $L_{Aeq(15\text{ min})}$ *	How to apply
<i>Residential</i>		
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. <ul style="list-style-type: none"> Where the predicted or measured $L_{Aeq(15\text{ min})}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. <ul style="list-style-type: none"> Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: <ol style="list-style-type: none"> times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences) if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	<ul style="list-style-type: none"> A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.
<i>Commercial – Offices and retail outlets</i>		
All times	Noise affected 70 dB(A)	The external noise levels should be assessed at the most-affected occupied point of the premises.
Note: * Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5m above ground level. If the property boundary is more than 30m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30m of the residence. Noise levels may be higher at upper floors of the noise affected residence.		

2.2 NSW Noise Policy for Industry

For noise emissions generated on the site resulting from the operational activities at the proposed development, the relevant noise criteria are defined in the NSW Noise Policy for Industry (2017).

The policy sets out the procedure to determine the project noise trigger levels relevant to assess noise from developments. The project noise trigger level applies to existing noise-sensitive receivers.

The project noise trigger level provides a benchmark or objective for assessing a proposal or site. It is not intended for use as a mandatory requirement. The project noise trigger level is a level that, if exceeded, would indicate a potential noise impact on the community, and so ‘trigger’ a management response; for example, further investigation of mitigation measures.

The project noise trigger level is the lower (that is, the more stringent) value of the project intrusiveness noise level and project amenity noise level.

2.2.1 Intrusive Noise Criteria

The Noise Policy for Industry states:

The intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source (represented by the L_{Aeq} descriptor), measured over a 15-minute period, does not exceed the background noise level by more than 5 dB when beyond a minimum threshold. This intrusiveness noise level seeks to limit the degree of change a new noise source introduces to an existing environment.

The intrusiveness noise level is determined as follows:

$$L_{Aeq,15min} \leq \text{Rating Background Noise Level} + 5 \text{ dB}$$

A modifying factor should also be added where appropriate to allow for tonality, impulsiveness, and intermittency or low frequency effects.

2.2.2 Amenity Noise Criteria

To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 2.2 of the *Noise Policy for Industry* where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance. The noise amenity area for the noise sensitive land uses in the area are given in Table 2.

Table 2: Amenity Noise Levels

Receiver/ Noise amenity area	Assessment period	Recommended amenity noise level, L_{eq} dB(A)
Suburban – Residential	Day	55
	Evening	45
	Night	40
Commercial premises	When in use	65
Note: - Day-time period is from 0700 to 1800 (Monday to Saturday) and 0800 to 1800 (Sundays and Public Holidays) - Evening period is from 1800 to 2200 - Night-time period is from 2200 to 0700 (Monday to Saturday) and 2200 to 0800h (Sundays and Public Holidays)		

The recommended amenity noise levels represent the objective for total industrial noise at a receiver location, whereas the project amenity noise level represents the objective for noise from a single industrial development at a receiver location.

To ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area, a project amenity noise level applies for each new source of industrial noise as follows:

Project amenity noise level for industrial developments = Recommended amenity noise level minus 5 dB(A)

The measured $L_{Aeq, period}$ noise levels are detailed in Table 4.

2.2.3 Project Noise Trigger Level

The Project Noise Trigger Level (PNTL) is the target noise emission level from the new noise source as a result of the new development at the boundaries of the identified NSRs. The PNTL is taken to be the lowest and most stringent of the intrusiveness and amenity noise criteria.

2.3 Kiama DCP 2012

Council's acoustic requirements for the development are contained in Chapter 5, Section 6 of the DCP 2012 – *Medium Density Development*. The relevant requirements relate to the noise impact assessment and are as follows:

- All units located in close proximity to: commercial centres, arterial roads, sub arterial major collector roads, railway lines, and highways must meet the following threshold noise transmission standards as measured in the dwelling of 42dB(A)³ for night and 55dB(A)³ during the day time, and
- Any mechanical equipment, such as pumps, lifts, air conditioners, exhaust shafts and mechanisms, should not be located adjacent to bedrooms or living rooms of dwellings on adjoining properties.

2.4 NSW Department of Planning, State Environmental Planning Policy (Infrastructure) 2007 (SEPP)

The SEPP has been referred to investigate the impact of road traffic and rail noise onto the proposed development.

The relevant criteria for road traffic noise impact are contained in *Division 17 Roads and traffic, Subdivision 2 Development in or adjacent to road corridors and road reservations, Paragraph 102 Impact of road noise or vibration on non-road development*.

The relevant criteria for rail noise impact are contained in *Division 15 Railways, Subdivision 2 Development in rail corridors, Paragraph 87 Impact of rail noise or vibration on non-rail development*.

The criteria are summarised as follows:

³ It is noted that the noise levels quoted do not state which parameter is being referred to. Therefore, for the purposes of this assessment it is assumed that the noise levels would be measured in the, 'equivalent continuous level' parameter in A-weighting (L_{Aeq}).

- For the development that is on land in or adjacent to the road corridor with an annual average daily traffic (AADT) volume of more than 40,000 vehicles, the development is likely to be adversely affected by road noise or vibration
- For the development that is on land in or adjacent to rail corridor, the development is likely to be adversely affected by rail noise
- Appropriate measures are required to be taken to ensure that the following LAeq noise levels are not exceeded for both road traffic and rail noise impact:
 - in any bedroom in the building—35 dB(A) at any time between 10 pm and 7am, and
 - anywhere else in the building (other than a garage, kitchen, bathroom or hallway)—40 dB(A) at any time.

2.5 NSW Road Noise Policy

NSW Road Noise Policy has been referred to as a reference for criteria for road traffic noise impact. The criteria are for noise from existing roads to residential development and is summarised in Table 3.

Table 3: NSW Road Noise Policy criteria

Period	Criteria
Day (7am - 10pm)	60 dB(A) $L_{Aeq,15\text{ hour}}$
Night (10pm - 7am)	55 dB(A) $L_{Aeq,9\text{ hour}}$

3 Existing Noise Environment

The acoustic amenity of the area can be described as a medium density transportation area with some commerce or industry according to Australian Standard AS1055 due to its close proximity to Terralong Street, and retail and restaurants along Collins Street.

During the site inspection, no industrial noise sources were observed around the noise sensitive areas. The car parking area of the local club south of the site was observed to be quiet at the time of inspection. The most dominant noise source on the site was road traffic noise from Terralong Street with occasional distant aircraft and rail noise.

3.1 Ambient Noise Measurements

Attended and unattended noise measurements were conducted on site generally in accordance with the recommendations outlined in the Australian Standard AS1055.

3.1.1 Unattended Measurements

Unattended noise measurements were continuously recorded for a period of seven consecutive days from the 28th June to 5th July 2016 on the vacant site at two locations as shown in Figure 2. The noise logging equipment used was NATA calibrated noise loggers as follows:

1. Location 1 – ARL Environmental Noise Logger (S/N 15-302-489):
 - The noise logger was installed on the vacant site at approximately 1 metre from the eastern boundary of the rear lot. The microphone was positioned at approximately 1.5 metres above ground level.
2. Location 2 – ARL Environmental Noise Logger (S/N 16-004-037):
 - The noise logger was installed on the vacant site at approximately 2 metres from the western boundary of the rear lot. The microphone was positioned at approximately 1.5 metres above ground level.



Figure 2: Location of attended and unattended measurements

The loggers were installed at their respective locations to capture representative ambient noise levels of the area and at the nearest NSRs. During the site visit, no audible air conditioning units or other sustained extraneous noise were observed.

Average, maximum and statistical noise parameters were recorded at 15-minute intervals. The weather throughout the monitoring period was described as fine with light wind breeze. The loggers were calibrated using a B&K type 4231 sound calibrator (S/N 3009809) before and after the monitoring period and were found to be within acceptable limits.

The results of the unattended noise measurements at Locations 1 and 2 have been summarised in Table 4. A graphical representation of the unattended monitoring results for Location 1 and Location 2 are provided in Appendices B and C of the report respectively.

Table 4: Summary of unattended noise monitoring results

Period	Rating Background Noise Levels, RBL (L_{A90}) in dB(A)	Existing Noise Levels in dB(A)		
		L_{Aeq}	L_{A10}	L_{A1}
Location 1 – Southeast of site				
Day	42	50	52	66
Evening	39	45	48	56
Night	32	44	49	56
Location 2 – Northwest of site				
Day	44	51	54	66
Evening	40	46	48	56
Night	34	43	47	56
Note: - Day-time period is from 0700 to 1800 (Monday to Saturday) and 0800 to 1800 (Sundays and Public Holidays) - Evening period is from 1800 to 2200 - Night-time period is from 2200 to 0700 (Monday to Saturday) and 2200 to 0800h (Sundays and Public Holidays)				

The unattended noise monitoring results show that the existing noise levels on the site are dominated by traffic noise in the area during the day and evening periods, which is indicated by the typical 2-3dB lower L_{Aeq} than L_{A10} noise levels. The RBL decreases throughout the day as expected.

There is also little difference in long term noise levels between the lowest (Location 1) and highest points (Location 2) of the site.

3.1.2 Attended Measurements

An attended noise measurement was also undertaken on site facing the local club car park, as shown in Figure 2. The measurement was taken using a B&K 2250 Type 1 sound level meter (S/N 3004473). The measurement is used to provide an indication of the influence of the car parking noise which may affect the proposed development and to verify and supplement the unattended noise logger data. The sound level meter was checked for calibration before and after the measurement and no significant drift was observed.

The results of the attended noise measurements are summarised in Table 5.

Table 5: Attended noise measurement results

Start Date/Time	Duration of measurement in minutes	Acoustic parameter	Measured Attended Noise Level in dB(A) close to club car park boundary	Measured Unattended Noise Level, in dB(A)	
				Location 1	Location 2
28/06/2016 15:15	15	L _{A90}	47	46	48
		L _{Aeq}	51	50	51
		L _{A10}	53	53	53
		L _{A1}	58	58	58

During the attended measurement, the area was observed to be quiet with intermittent road traffic noise from Terralong Street. The weather conditions were fine with a light wind breeze. During the 15-minute measurements, aircraft, rail and construction noise at a distance, was also audible. The car parking area of the local club was quiet with less than 10 vehicles entering and leaving the car park in the 15-minute period. No raised or loud voices could be heard from the car park from the attended measurement location.

The measured attended noise measurement shows a snap-shot sample of the noise environment in the area. The sample measurement taken during the day-time period is similar to the unattended noise monitoring results, which confirms the validity of the unattended noise results for the purpose of the noise impact assessment.

The influence of activities from the car park on the unattended noise logging data are insignificant, as shown by the similarity in the L_{Aeq} and L_{A1} noise levels of the attended measurement location close to the car park and noise logging data located further away.

3.1.3 Unattended Road Traffic Noise Measurements

The results of the unattended noise measurements at Locations 1 and 2 have been summarised in terms of road traffic noise descriptors in Table 6.

Table 6: Road traffic noise measurements

Period (T)	Noise level L _{Aeq,T} in dB(A)
Location 1 – Southeast of site	
Day (7am - 10pm)	49
Night (10pm - 7am)	45
Location 2 – Northwest of site	
Day (7am - 10pm)	50
Night (10pm - 7am)	43

4 Construction Noise and Vibration Criteria

4.1 Construction Noise Criteria

For noise generated on a construction site, the relevant noise criteria are provided in the *NSW Interim Construction Noise Guideline*. The transient nature of the construction stage means that the concept of ‘best practice’ should prevail when managing noise impact. The guideline provides noise goals as shown in Table 1.

4.1.1 Noise Sensitive Areas

Residential and commercial properties have been identified around the site which may potentially be impacted by the construction activities related to the development. The closest residential property is approximately 5 metres from the boundary of the site while the closest commercial property shares a boundary with the site.

The management of construction noise at the closest properties are applicable to the other properties located further away from the site.

4.1.2 Evaluation of Construction Noise Criteria

Construction noise criteria have been derived relative to the measured L_{A90} background noise levels on site. The criteria are summarised in Table 7.

Table 7: Evaluated construction noise criteria

Measurement location	RBL, dB(A)	Management levels, dB(A)	‘Highly Noise Affected’ Maximum levels, dB(A)
Location 1 – Southeast of site	42	52	75
Location 2 – Northwest of site	44	54	75

4.2 Vibration Criteria

4.2.1 Building Damage

The likelihood of structural or even cosmetic damage to buildings located around the site is considered highly unlikely given the machinery and equipment proposed to be used in the construction activities. However, for the sake of completeness a building damage vibration criterion has been provided below.

There is little reliable data on the threshold of vibration-induced damage in buildings. Although vibrations induced in buildings by ground-borne excitation are often noticeable, there is little evidence that cosmetic damage⁴ are actually produced. The lack of data is one of the reasons that there is variation between International Standards.

⁴ Building Research Establishment (1995), ‘Damage to Structures from Ground-borne Vibration’, BRE Digest

Vibration will be felt by the occupants of a dwelling at levels far lower than those at which damage is likely to occur. Therefore, for the purposes of the project, it is recommended to set a building damage vibration criterion that is conservative. In doing so, in the unlikely event that the criterion is exceeded, the works can be stopped and any vibration damage can be established. If no damage is observed and the resident’s fears have been allayed, the construction works can resume.

Construction vibration levels are to be measured on or close to the foundations of the closest building to where the vibration causing work is taking place. A recommended conservative vibration criterion for building damage is provided in Table 8.

Table 8: Recommended conservation vibration criterion – Building damage

Criteria	Vibration Limit, Peak Particle Velocity (PPV), mm/s	Comments
Structural/Cosmetic Damage	5	Set as an initial limit, to be monitored during construction for excavation, use of hydraulic hammers and compaction plant.

4.2.2 Human Comfort

Vibration criteria for human comfort are given by the Office of Environment and Heritage (OEH) “Assessing Vibration” guideline⁵. The criteria are for guidance and represent non-mandatory goals for new developments.

The human comfort vibration criterion is significantly below the building damage vibration criterion, and therefore achieving the human comfort condition generally results in the building damage condition being met.

For intermittent vibration sources, such as from the hydraulic hammer and other construction plant, the concept of a “vibration dose value” (VDV) has been adopted. For residences, the acceptable VDV range is as follows:

- Preferred value: $0.2 \text{ m/s}^{1.75}$, and
- Maximum value: $0.4 \text{ m/s}^{1.75}$.

The OEH’s vibration guidance is generally based on British Standard *BS6472*⁶. *BS6472* and its Australian equivalent, Australian Standard *AS2670.2*⁷ give a series of rating curves to assess human exposure to vibration and provide further guidance on acceptable vibration levels.

⁵ NSW Department of Environment and Conservation (2006) – *Assessing Vibration: a technical guideline*

⁶ British Standard BS6472.2 (1992) Guide to evaluation of human exposure to vibration in buildings (1 to 80 Hz)

⁷ Australian Standard AS2670.2 (1990) – Evaluation of human exposure to whole-body vibration. Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz)

Table 2 of AS2670.2 recommends day-time continuous or intermittent human comfort vibration limits for residential receivers that should not be exceeded. The human comfort vibration limits for the day-time period are summarised in Table 9.

Table 9: Human comfort vibration levels equivalent to Curve 4 given in AS2670.2

Criteria (Day-time period)	Vibration Limit, rms in mm/s		Comments
	Continuous or intermittent	Transient vibration with several occurrences per day	
Human comfort in residences	0.2 – 0.4	3 – 9*	To be monitored and reported should a complaint be received.
Note: *AS2670 suggests that for transient vibration people may not elicit an adverse reaction to vibration levels 30 to 90 times to the threshold of perception (0.1 mm/s).			

4.2.3 Vibration Sensitive Areas

An adverse vibration impact is not a high risk for the construction of the development in terms of damage to buildings or human comfort for the majority of construction activities and machinery/equipment being used. However, there may be some activities, such as the use of hydraulic hammers and vibratory/foot rollers during the excavation, and landscape and restoration stages respectively that may exceed the human comfort criteria at properties located at up to 40m from the construction site.

Therefore, vibration sensitive areas are defined as any residential or commercial property within 40m of the construction site where hydraulic hammers and compactors/vibratory/foot rollers are being used.

5 Construction Noise Assessment

5.1 General Construction Schedule

The expected construction schedule below outlines the basic steps involved in the construction program of the development:

1. Project Approvals
2. Possession of Site
3. Design & Procurement
4. Mobilisation to Site
5. Demolition & Preparation works
6. Pre-clearing surveys
7. Excavation
8. Construction – Structure
9. Construction – Finishes, and
10. Testing, Commissioning & Handover.

5.2 Plant and Equipment Noise Source Levels

The expected plant and machinery information for each step of the construction schedule are summarised in Table 10. The information has been used to predict construction noise levels onto noise sensitive areas.

The plant selected and percentage on-times during the working day have been estimated based on previous experience. The approximate percentage on-times are deemed appropriate due to the transient and changing nature of the construction noise activities, which are dependent upon site-conditions, timelines, delays and other unexpected occurrences.

Table 10: Plant and equipment used and % use per day for each step of the construction schedule

Construction schedule	Noise impact	Equipment	% use per day
Project Approvals	Not expected	-	-
Possession of Site	Not expected	-	-
Design & Procurement	Not expected	-	-
Mobilisation to site	Not expected	-	-
Demolition & Preparation works	To be investigated	2 x Chainsaw	20
		1x Chipper	20
		1 x Stump grinder	20
		2 x 30T excavator	80
		2 x D6 Loader	70
		1 x 10T Truck	50
		1 x Water truck	50
		1 x Diesel generator	100
Pre-cleaning survey	Not expected	-	-
Excavation	To be investigated	2 x 30T Excavator	80
		1 x D6 loader	70
		1 x 10T Truck	50
		1 x Material delivery truck	20
		1 x Water truck	50
		2 x Petrol water pump	100
		1 x Concrete boom pump	30
		2 x Hydraulic hammer	50
		1 x Tandem tipper	30
		1 x Diesel generator	100
Construction – Structure	To be investigated	1 x Tower crane	70
		2 x 10T Truck	60
		2 x Material delivery truck	30
		1 x Concrete boom pump	40
		2 x Hydraulic hammer	40
		1 x Tandem tipper	40
		1 x 10T foot roller	70
		1 x Diesel generator	100
		1 x Brick saw	40
		1 x Air compressor	40
Construction – Finishes	To be investigated	1 x Tower crane	70
		1 x Concrete/ring saw	40
		1 x Scissor lift	70
		1 x 10T Truck	40
		2 x Material delivery trucks	40
		1 x Diesel generator	100
Testing, Commissioning & Handover	Not expected	-	-

The source sound levels for each of the items of plant and equipment are provided in Table 11.

Table 11: Sound power levels, SWL, of construction plant and equipment

Construction phase	Plant and equipment	SWL, dB(A)	Reference
Demolition & Preparation works	Chainsaw	107	https://webgate.ec.europa.eu/growth-portal/noise/reports/EN/EN_EQUIPMENT28.PDF
	Chipper	115	https://webgate.ec.europa.eu/growth-portal/noise/reports/EN/EN_EQUIPMENT58.PDF
	Stump grinder	107	http://www.barretomfg.com/documents/operating_instructions/30SG-CP_OperatorsManual-20140404.pdf
	30T Excavator	107	AS2436
	D6 Loader	113	AS2436
	10T Truck	107	AS2436
	Water truck	107	AS2436
	Diesel generator	99	AS2436
	TOTAL SWL including % on-times	117	-
Excavation	30T Excavator	107	AS2436
	D6 Loader	113	AS2436
	10T Truck	107	AS2436
	Material delivery truck	106	AS2436
	Water truck	107	AS2436
	Petrol water pump	85.0	https://webgate.ec.europa.eu/growth-portal/noise/reports/EN/EN_EQUIPMENT63.PDF
	Concrete boom pump	108	AS2436
	Hydraulic hammer	113	AS2436
	Tandem tipper	117	AS2436
	Diesel generator	99	AS2436
	TOTAL SWL including % on-times	118	-
Construction – Structure	Tower crane	105	AS2436
	10T Truck	107	AS2436
	Material delivery truck	106	AS2436
	Concrete boom pump	108	AS2436
	Hydraulic hammer	113	AS2436
	Tandem tipper	117	AS2436

Construction phase	Plant and equipment	SWL, dB(A)	Reference
	10T foot roller	108	AS2436
	Diesel generator	99	AS2436
	Brick saw	117	AS2436
	Air compressor (Silenced)	101	AS2436
	TOTAL SWL including % on-times	119	-
Construction – Finishes	Tower crane	105	AS2436
	Concrete/ring saw	117	AS2436
	Scissor lift	105	AS2436
	10T Truck	107	AS2436
	Material delivery truck	106	AS2436
	Diesel generator	99	AS2436
	TOTAL SWL including % on-times	117	-

5.3 Assessment Methodology

5.3.1 Construction Phase – Noise Goals

The construction noise level for each applicable construction phase has been predicted to the surrounding noise sensitive areas for a worst-case scenario and average-case scenario. The noise prediction has been based on the following:

- Plant and equipment source sound level information given in Table 10 and Table 11
- Distance loss, and
- Air absorption.

The **worst-case** scenario represents the use of all the plant and equipment for each activity at the same time and located along the nearest boundary to each NSR. This scenario represents an unrealistic scenario, which is unlikely to happen, but does represent the maximum possible impact of construction noise for a short duration before the work moves to another location.

An **average-case** scenario assumes over a longer period of time, that the average position of the plant and equipment will be at the centre of the site. The noise source levels of the plant and equipment are therefore assumed to be around the middle of the site for predicting an average-case scenario. This scenario is considered to be more realistic scenario.

The predicted noise levels for both scenarios were then compared to the construction noise goals for each section and the approximate distance at which they are achieved have been determined and are presented in Table 12.

Table 12: Approximate maximum distance from pipeline to achieve construction noise goals

Construction phase	Approximate maximum distance to be above management level (metres) – Both worst-case and average-case scenarios	Approximate maximum distance from site boundary to be below ‘Highly Noise Affected’ maximum level (metres)	
		Worst-case	Average-case
Demolition & Preparation works	>250*	50	22 (NE & SW) 8 (NW & SE)
Excavation	>250*	58	30 (NE & SW) 16 (NW & SE)
Construction – Structure	>250*	60	32 (NE & SW) 18 (NW & SE)
Construction – Finishes	>250*	50	22 (NE & SW) 8 (NW & SE)

Note: * The construction noise assessment has considered noise sensitive areas located to up to 250m.

5.4 Assessment Results

The approximate number of noise impacted residential properties by each construction phase has been determined. The results are summarised in Table 13. Noise contours representing areas affected by the maximum levels for each construction activity are attached in Appendix D.

Table 13: Approximate number of noise impacted residential properties

Construction phase	Approximate number of properties* where ‘Highly Noise Affected’ maximum levels are exceeded	
	Worst-case	Average-case
Demolition & Preparation works	24	8
Excavation	31	11
Construction – Structure	31	11
Construction – Finishes	24	8

Note: *Includes residential and commercial

5.5 Assessment Discussion

The results of the construction noise assessment in Table 12 and Table 13 for a worst-case scenario shows that the residential and commercial premises up to 60m from the site will be ‘highly affected’ by all construction phases of the construction works.

However, for an average-case scenario residential and commercial premises up to 32m from the site will be ‘highly affected’ by all construction phases of the construction works.

The noise predictions for the worst-case scenario presented in the assessment represent an unrealistic scenario, where all the plant and equipment in each construction phase have been assumed to be operating at the same time and location, directly adjacent to the boundary, although the source noise levels are adjusted for percentage use per day.

The average-case scenario represents a more realistic scenario where plant and equipment are used across the entire site as compared to the boundary only. Plant and equipment are expected to operate at one location for a short period of time and move on the next location. For example, when works are conducted on the eastern boundary of the site, noise sensitive areas located on the western boundary side will be less impacted.

Furthermore, plant and equipment are usually spread out across the site conducting specific tasks. The impact of one plant or equipment will be considerably less as compared to the cumulative impact of all plant and equipment.

Although the construction noise is expected to be audible and there is likely to be some degree of adverse impact, as is typical with construction projects in close proximity to people, by incorporating noise control measures, such as those recommended in Section 5.6 below the noise impact to residents and other NSR's surrounding the site can be significantly reduced. Therefore, construction noise can be managed through a Construction Noise and Vibration Management Plan (CNVMP) to minimise the adverse impact to acceptable levels.

5.6 Noise Control Recommendations

The opportunities for practical physical noise control are few given the transient and constantly moving nature of the construction work. However, it is recommended to use mobile noise barriers/enclosures during certain construction work, such as around stationary work activities and plant. Examples of a mobile enclosure and demountable noise barriers are shown in Figure 3 and Figure 4 respectively.

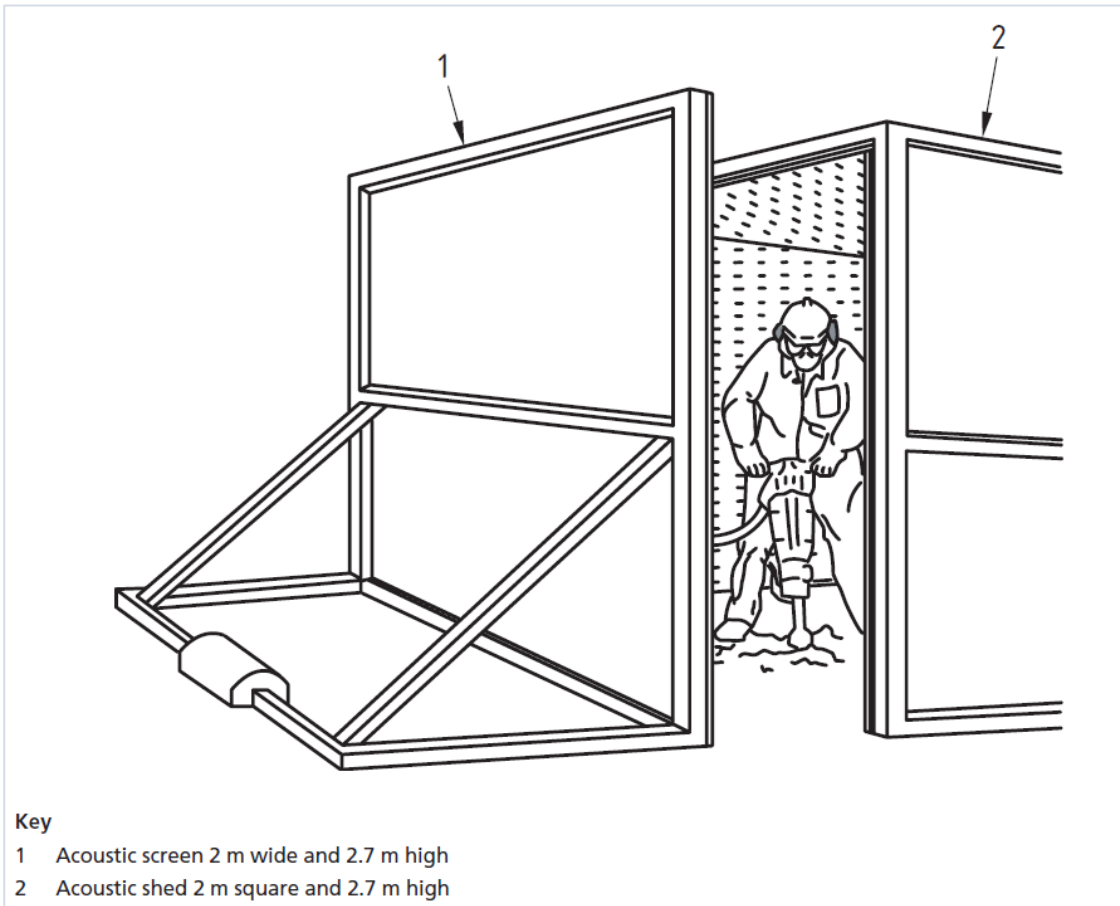


Figure 3: Illustration of a mobile enclosure and barrier



Figure 4: Photos of demountable noise barriers

In addition to physical noise control or in situations where this is not practical, management measures should be employed to minimise the construction noise impact onto residential and commercial premises. These should include all feasible and reasonable measures employed by the builder such as:

- Informing and consulting residents and interested parties, as far as practicable, regarding impending or current events that may cause high levels of noise and how long they are expected to take. This may take the form of letter drops, or community notices
- Provide a complaints telephone number prominently displayed where the works are taking place and on any letter drops or community notices
- Respite hours agreed with residents when noisy works will not take place if necessary
- Investigate complaints when received to establish the cause, and where possible implement a corrective action such as, provide a respite period or other practical measure
- Minimising the operating noise of machinery brought on to the site
- Where appropriate, obtaining acoustic test certificates for machinery brought on to the site
- Undertake noise monitoring at the start of a new noisy activity so noise levels can be investigated should a complaint be received
- If there is excessive noise from any process, that process will be stopped and if possible that noise attenuated to acceptable levels. Where there is no alternative the process will be rescheduled to non-sensitive hours
- Where it is not practical to sufficiently mitigate the noise impact of a particular activity, substitute methods of construction should be considered for example, using a rock saw or stitch drilling to excavate rock instead of a rock breaker, which uses impact as its operating energy
- Ensuring that plant is not left idling when not in use
- Ensuring that plant is well maintained and in good working order and not causing unnecessary noise, such as damaged mufflers on plant
- All access hatches for plant to be kept closed
- Provision of a toolbox talk to personnel on-site so that everyone understands the importance of controlling noise and vibration.

To provide a framework for construction noise management on-site it is recommended that a Construction Noise and Vibration Management Plan (CNVMP) is produced by the contractor. This should include all pertinent information regarding the control and management of noise and vibration, and would be used as a working document on-site by contractors and sub-contractors so that everyone is aware of their responsibilities.

6 Construction Vibration Assessment

As detailed in Section 4.2 of the report, the risk of vibration caused by the construction works onto nearby buildings is considered highly unlikely due to the type of activities taking place and the high levels of vibration required to cause damage.

It is recommended to set a conservative building damage vibration criterion so that in the unlikely event that the criterion is exceeded, the construction works can be stopped and the vibration damage established. If no damage is observed and after the resident's fears have been allayed, the works can resume. The recommended vibration criterion for building damage is set at **5mm/s PPV**.

The greatest risk of vibration causing an adverse impact to the residents is by causing discomfort or fear of damage to their premises.

For reference, the safe working distances for vibration causing plant which may be used during the construction activities have been taken from the *Transport Infrastructure Development Corporation Construction Noise Strategy (Rail Projects) 2007* and are summarised in Table 14.

Table 14: Recommended safe working distances for hydraulic hammer rock breaking attachments

Plant Item	Rating/Description	Safe Working Distance, in metres	
		Cosmetic Damage (BS7385 ⁸)	Human Response (AS2670)
Vibratory Roller	<50kN (1-2t)	5	15 to 20
Vibratory Roller	<100kN (2-4t)	6	20
Vibratory Roller	<200kN (4-6t)	12	40
Vibratory Roller	<300kN (7-13t)	15	100
Small Hydraulic Hammer	300kg – 5 to 12t excavator	2	7
Medium Hydraulic Hammer	900kg – 12 to 18t excavator	7	23

6.1 Potential Exceedance – 10t Vibratory/foot Roller

An exceedance of the human comfort criteria, as given in Table 9, is most likely to be caused when the 10t foot roller is expected to be used to compact the ground during construction works.

The safe working distances for various sizes of vibratory rollers, as shown in Table 14, are expected to be similar for a foot roller. For a proposed 10t vibratory/foot roller, the human comfort criterion may potentially be exceeded when in use at up to 100m away from a residential building. Therefore, where residential dwellings are located less than 100m from construction works and a 10t vibratory/foot roller is expected to

⁸ BS 7385 -2: 1993 Guide to damage levels from ground borne vibration

be used, it is recommended to use a smaller vibratory/foot roller to suit the required buffer distance as given in Table 14.

6.2 Potential Exceedance – Other Plant

Exceedances of the human comfort criterion from other plant and activities are unexpected. The next largest vibration generating activities are excavation when hydraulic hammers are expected to be used.

Referring to the safe working distances given in Table 14, by selecting smaller plant when conducting construction work, the risk of cosmetic building damage or human comfort vibration impact, and complaints of vibration from the residents are expected to be low.

6.3 Recommendation – Vibration Monitoring

It is recommended to conduct vibration monitoring when construction work is being undertaken inside or close to the safe working distances, in order to provide measurement records to residents should a complaint be received.

7 Operational Noise Impact Assessment

This section of the report assesses noise emissions from the development to the local community and noise intrusion from existing noise sources onto the development, as follows:

1. Noise emission from future mechanical plant in accordance with the NSW Noise Policy for Industry (NPI) 2017 and Kiama DCP 2012, and
2. Noise intrusion inside the units in accordance with the requirements detailed in Section 2.3 of the report (Kiama DCP 2012).

7.1 Mechanical Plant Noise

Kiama DCP 2012 recommends that any mechanical equipment, such as pumps, lifts, air conditioners, exhaust shafts and mechanisms, should not be located adjacent to bedrooms or living rooms of dwellings on adjoining properties.

Future mechanical plant may also have an adverse effect onto nearby noise sensitive receivers and is required to meet the criteria defined in the NSW NPI.

7.1.1 Evaluated Noise Criteria – NSW NPI 2017

Based on the measured unattended noise levels on site, the applicable criteria using the lowest measured noise levels, have been evaluated for future mechanical plant and are summarised in Table 15.

Table 15: NSW NPI Evaluated criteria

Assessment period	Intrusiveness Criterion, $L_{Aeq,15min}$ in dBA	Amenity Criterion L_{Aeq} in dBA	Project Noise Trigger Levels (PNTLs) $L_{Aeq,15min}$ in dBA
Day	47	55	47
Evening	44	45	44
Night	37	40	37
Note: - Day-time period is from 0700 to 1800 (Monday to Saturday) and 0800 to 1800 (Sundays and Public Holidays) - Evening period is from 1800 to 2200 - Night-time period is from 2200 to 0700 (Monday to Saturday) and 2200 to 0800h (Sundays and Public Holidays)			

Table 15 shows that the intrusiveness criterion is the most stringent for all time periods and are therefore the PNTL's.

By meeting the PNTL's at the identified NSRs, all other residential properties located further away from the development site are expected to comply with NPI noise requirements.

7.1.2 Assessment and Discussion

Individual air conditioning units have been proposed to be installed on the balcony of each unit of the development.

Based on the floor plans of the development, mechanical plant noise from each balcony was predicted to the NSRs. The closest NSRs are located on the north eastern boundary of the site where the balconies of the units from all three floors overlook the adjoining residential properties. The closest noise sensitive residential building is approximately 17 metres from the closest balcony and the mechanical plant is expected to run at any time period.

The cumulative impact of all air conditioning units located on each individual balcony for the three floors have been predicted to ensure compliance with the night-time PNTL of **37dB(A) $L_{Aeq,15min}$** is achieved.

Based on a worst-case scenario assessment where all the mechanical plant is running simultaneously, each mechanical plant must not exceed **51dB(A)** measured at one metre from the source to achieve compliance.

The compliance level of 51dB(A) is very low without noise mitigation measures. It is therefore, recommended to install the mechanical plant away from the noise sensitive buildings, and in an area where noise shielding from the proposed development itself may be provided. Noise barriers, attenuators, an enclosed plantroom with acoustic louvres, attenuated and angled duct inlets and exhausts may also be considered to provide additional noise attenuation.

A detailed noise assessment of the mechanical plant noise during design stage is recommended. The noise assessment should include noise source levels of plant, location and adjustments for mechanical plant noise characteristics to verify compliance with the PNTL derived in this report. However, providing this assessment is completed, it is expected that the PNTL can be met without onerous noise control.

8 Road Traffic and Rail Noise Intrusion

The proposed development is subject to noise intrusion from:

- Road traffic noise from Terralong Street, located at approximately 120 metres from the south-western boundary of the site
- Rail noise from the South Coast railway line is located to the east of the development, and
- Noise from adjacent commercial buildings, including car parks, located south and east of the site.

8.1 Noise Criteria

As detailed in Section 2.3 of the report in accordance with Kiama DCP 2012, all units located in close proximity to: commercial centres, arterial roads, sub arterial major collector roads, railway lines, and highways must meet the following threshold noise transmission standards as measured in the dwelling of 42dB(A) for night and 55dB(A) during the day time. The noise levels have been assumed to represent the L_{Aeq} parameter.

Moreover, reference has been made to the SEPP (Infrastructure) 2007, as detailed in Section 2.4 of this report for road traffic and rail noise intrusion criteria.

8.2 Road Traffic Noise Assessment

8.2.1 Kiama DCP 2012

Data has been acquired from the RMS AADT report⁹ for traffic volumes for Terralong Street, Kiama. The report suggests in 2012, an AADT of approximately 2,400 was counted. The reported AADT is considerably less than the required 40,000 AADT (Refer to Section 2.4) to consider a road traffic noise impact assessment.

It is concluded that the criteria contained in Kiama DCP 2012 is not applicable for road traffic noise from Terralong Street.

8.2.2 NSW Road Noise Policy

The measured road traffic noise and the criteria detailed in Section 2.5 of this report have been compared and have been summarised in Table 16.

⁹ <http://www.rms.nsw.gov.au/documents/about/corporatepublications/statistics/nsw-traffic-volumes-2012.pdf>

Table 16: Road traffic noise – Compliance check

Period (T)	Measured road traffic noise levels in dB(A) ($L_{Aeq,T}$)	NSW Road Noise Policy Criteria in dB(A) ($L_{Aeq,T}$)
Day (7am - 10pm)	49 - 50	60
Night (10pm - 7am)	43 - 45	55

Table 16 shows that compliance is achieved for both the day-time and night-time criteria. The proposed development is not expected to be impacted by road traffic noise.

8.3 Rail Noise Assessment

The current acoustic environment as measured at both ends of the site are given in Table 4. The lowest night-time and day-time measured noise levels on site are 43dB L_{Aeq} (Location 2) and 50dB L_{Aeq} (Location 1) respectively.

Indoor noise levels through an open window are generally expected to be a minimum of 10 dB lower than outdoor noise levels, which equates to 33dB(A) L_{Aeq} during the night-time and 40dB(A) L_{Aeq} during the day-time.

Therefore, the threshold noise transmission standards as measured in the dwelling and defined in the Kiama DCP 2012 are expected to be achieved. The SEPP criteria are also expected to be met for the proposed development as shown in Table 17.

Table 17: Summary of rail noise intrusion assessment

Area in dwelling	Measured noise levels (Most stringent) in dB(A)	Expected noise levels inside dwelling in dB(A)	Noise criteria in dB(A)	
			Kiama DCP 2012	SEPP (Infrastructure) 2007
Bedroom – Sleeping areas	43 (Night-time)	33	42	35
Living areas	50 (Day-time)	40	55	40

Note: All parameters have been represented as L_{Aeq} levels.

9 Conclusion

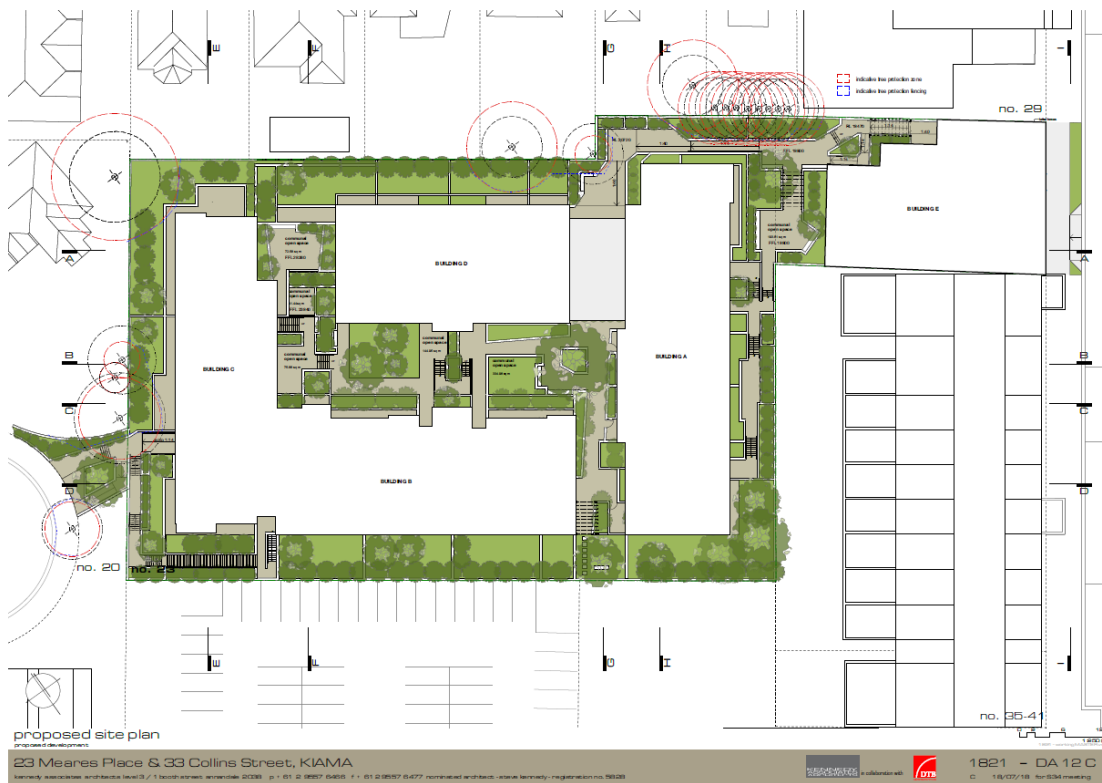
The construction and operational noise impact assessment report for the proposed development at 23 Meares Place & 33 Collins Street, Kiama NSW 2533 yielded the following conclusions:

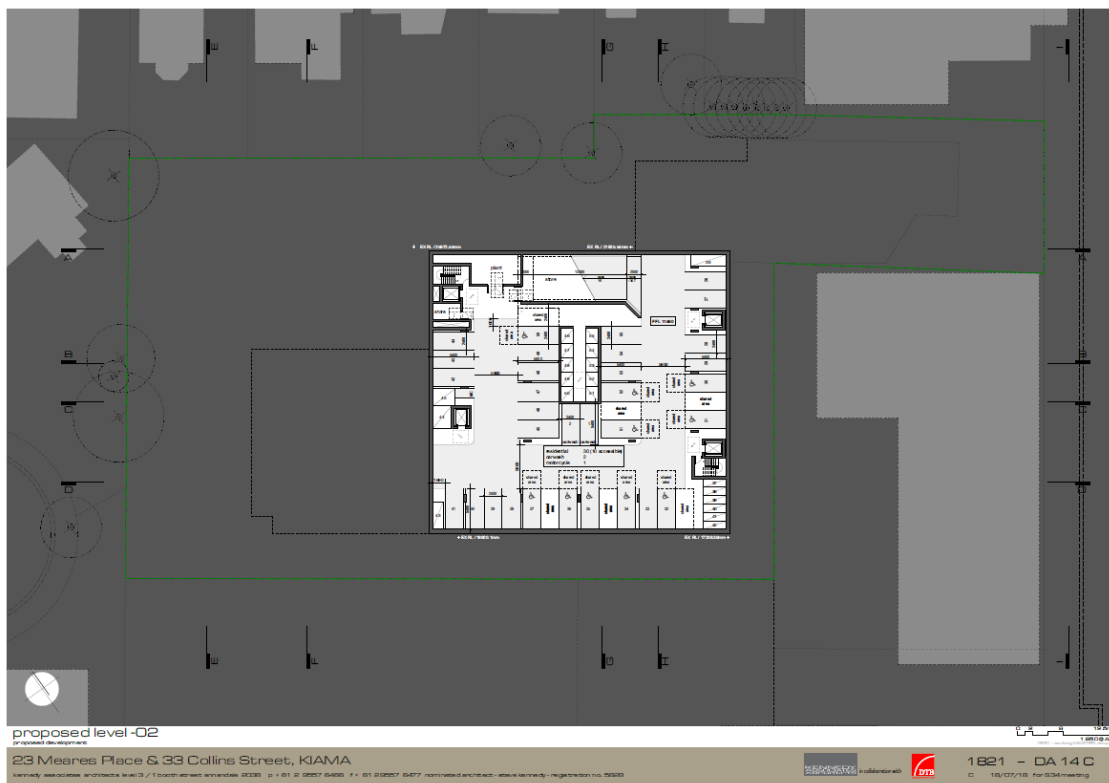
- The construction noise assessment demonstrates for a realistic average-case scenario, eight to eleven residential and commercial premises surrounding the site will be 'highly affected' by all phases of the construction works.
- The impact of construction noise will generally be of short duration for a specific property due to the regular movement of plant and equipment on site.
- The impact of construction noise will generally be less significant since plant and equipment will be used at different locations on the site and not all at the same time, resulting in a lower cumulative impact.
- The opportunities for practical physical noise control are few given the transient and constantly moving nature of the construction work. Therefore, it is recommended to use mobile noise barriers/enclosures to mitigate construction noise during certain activities, such as around stationary work activities and plant.
- In other circumstances, management measures should be employed to minimise the construction noise impact onto residential and commercial premises.
- A conservative building damage vibration criterion is recommended to be set so that in the unlikely event that the criterion is exceeded, the construction works can be stopped and the vibration damage established. If no damage is observed and after the resident's fears have been allayed, the works can resume. The recommended vibration criterion for building damage is recommended to be set at 5mm/s PPV.
- An exceedance of the human comfort criteria is most likely to be caused if a large 10t or greater roller is expected to be used to compact the ground during construction works. For a proposed 10t vibratory/foot roller, the human comfort criterion may potentially be exceeded when in use at up to 100m away from a residential building. Therefore, where residential dwellings are located less than 100m from construction works and a greater than 10t vibratory/foot roller is proposed to be used, it is recommended to use a smaller vibratory/foot roller to suit the required buffer distance.
- Exceedances of the human comfort criterion from other plant and activities are unexpected. The next largest vibration generating activities are excavation when hydraulic hammers are expected to be used.
- Selecting smaller plant when conducting construction work may potentially reduce the risk of cosmetic building damage or human comfort vibration impact, and complaints of vibration from the residents.
- It is recommended to conduct vibration monitoring when construction work is being undertaken inside or close to the safe working distances, in order to provide measurement records to residents should a complaint be received.

- A Construction Noise and Vibration Management Plan is recommended to be written.
- The noise emissions of each quantity of mechanical plant must not exceed 51dB(A) when measured at one metre from the source. It is recommended to install the mechanical plant away from the noise sensitive areas and in an area where noise shielding by the building itself may be used to allow an increase in noise emission levels of the plant.
- A detailed noise assessment of the mechanical plant noise during the design stage is highly recommended. The noise assessment should include noise source levels of plant, location and adjustments for mechanical plant noise characteristics to verify compliance with the PSNL derived in this report.
- Road traffic noise intrusion from Terralong Street is not expected to adversely impact the development due to its low traffic volume and in accordance with NSW Road Noise Policy.
- The threshold noise transmission standards, from road traffic noise, rail noise and noise from adjacent car parks, as measured in the dwelling as defined in the Kiama DCP 2012 are expected to be achieved.
- Rail noise intrusion from the South Coast railway is not expected to adversely impact the development based on the measured noise levels on the development site.

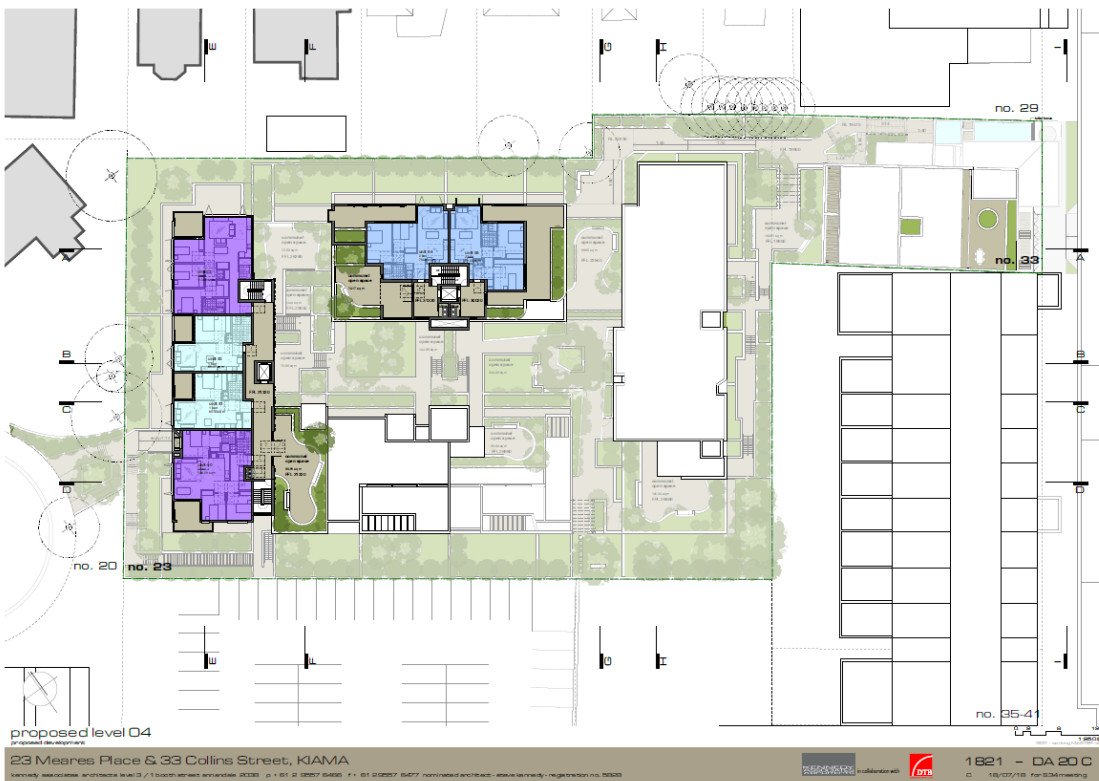
Providing the recommendations described above are incorporated into the proposed development, the relevant noise criteria are expected to be met.

Appendix A Site and Elevation Plans



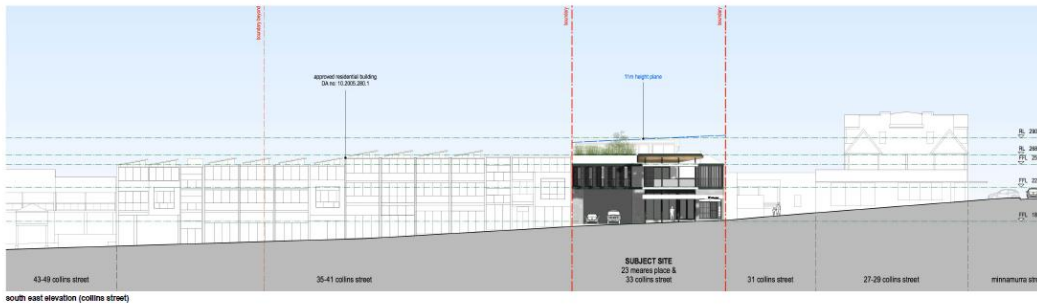








23 Meares Place & 33 Collins Street, KIAMA
 Kennedy Associates Architects Level 3 / 1 South Street, Armadale VIC 3163 P + 61 3 2257 5455 F + 61 3 2257 5477 Kennedy Architects - www.kennedy-architects.com.au registration no. 02203
 1821 - DA 21 C
 C 15/07/18 For S24 meeting



south east elevation (collins street)



south west elevation

elevations 01
 Kennedy Associates Architects Level 3 / 1 South Street, Armadale VIC 3163 P + 61 3 2257 5455 F + 61 3 2257 5477 Kennedy Architects - www.kennedy-architects.com.au registration no. 02203
 1821 - DA 22 C
 C 15/07/18 For S24 meeting



elevations 02

proposed development

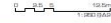
23 Meares Place & 33 Collins Street, KIAMA

kennedy associates architectural 304/3 / 1 booth street, armidale 2320 p + 61 2 3257 5490 f + 61 2 3257 5477 notional architect - anna kennedy - registration no. 2253



1821 - DA 23 C

C 15/12/18 by G24-meeting



elevations 03

proposed development

23 Meares Place & 33 Collins Street, KIAMA

kennedy associates architectural 304/3 / 1 booth street, armidale 2320 p + 61 2 3257 5490 f + 61 2 3257 5477 notional architect - anna kennedy - registration no. 2253



1821 - DA 24 C

C 15/12/18 by G24-meeting





sections 3

23 Meares Place & 33 Collins Street, KIAMA

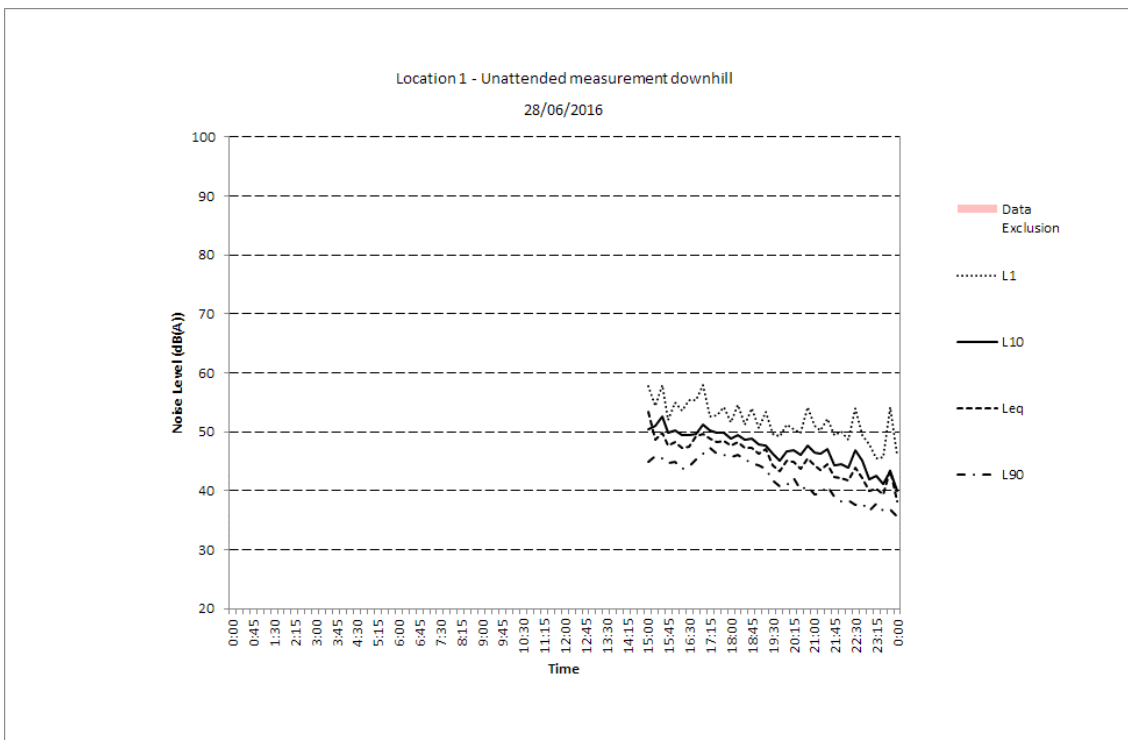
proposed development
 Kennedy Associates Architects Level 3 / 1 Booth Street, Armidale NSW
 p + 61 6 9207 6400 f + 61 6 9207 6477 nominated architect - steve kennedy registration no. 0899

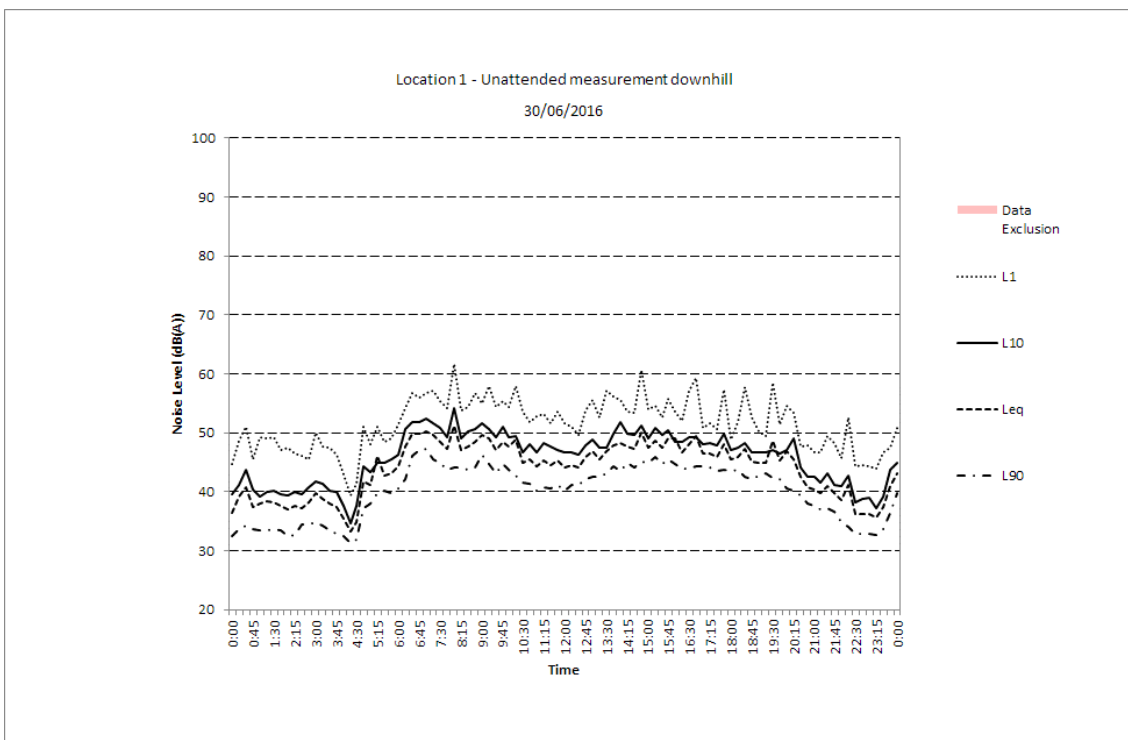
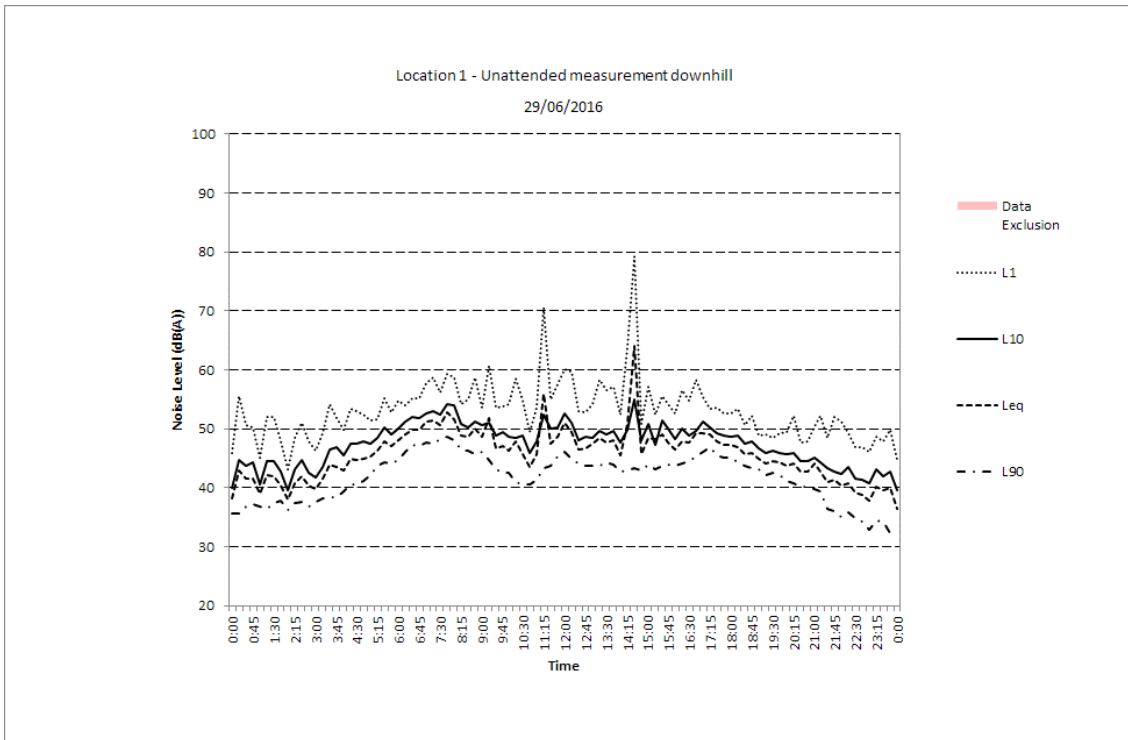


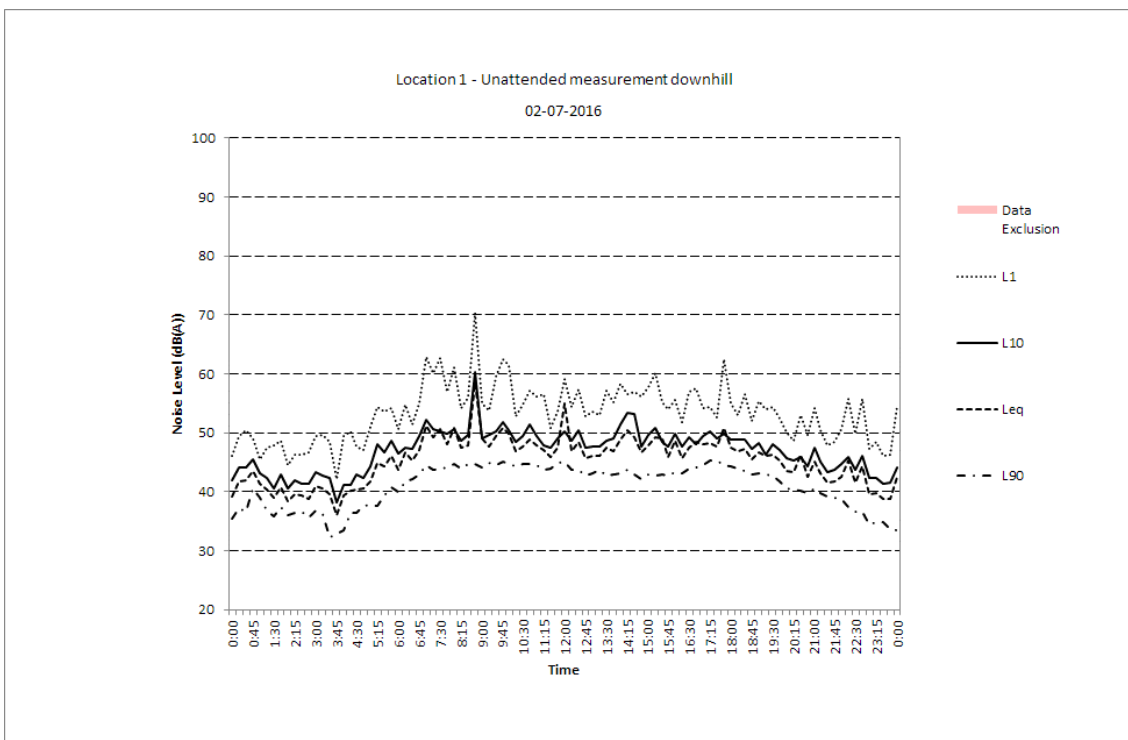
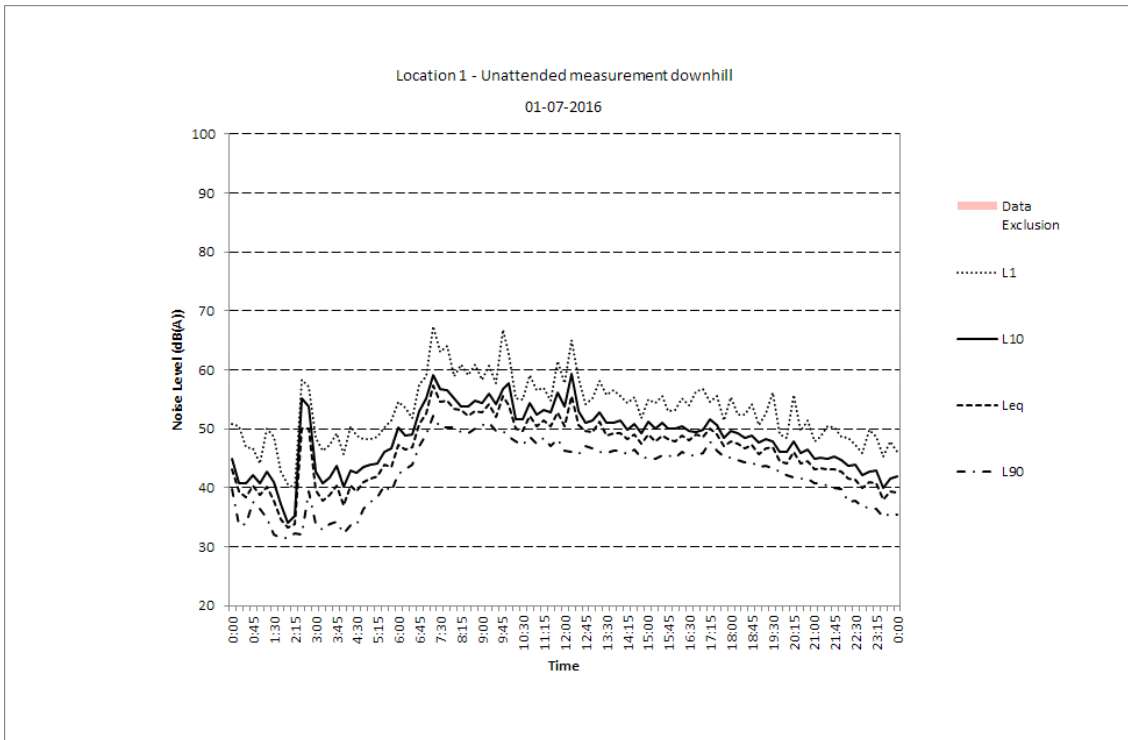
1821 - DA 27 C

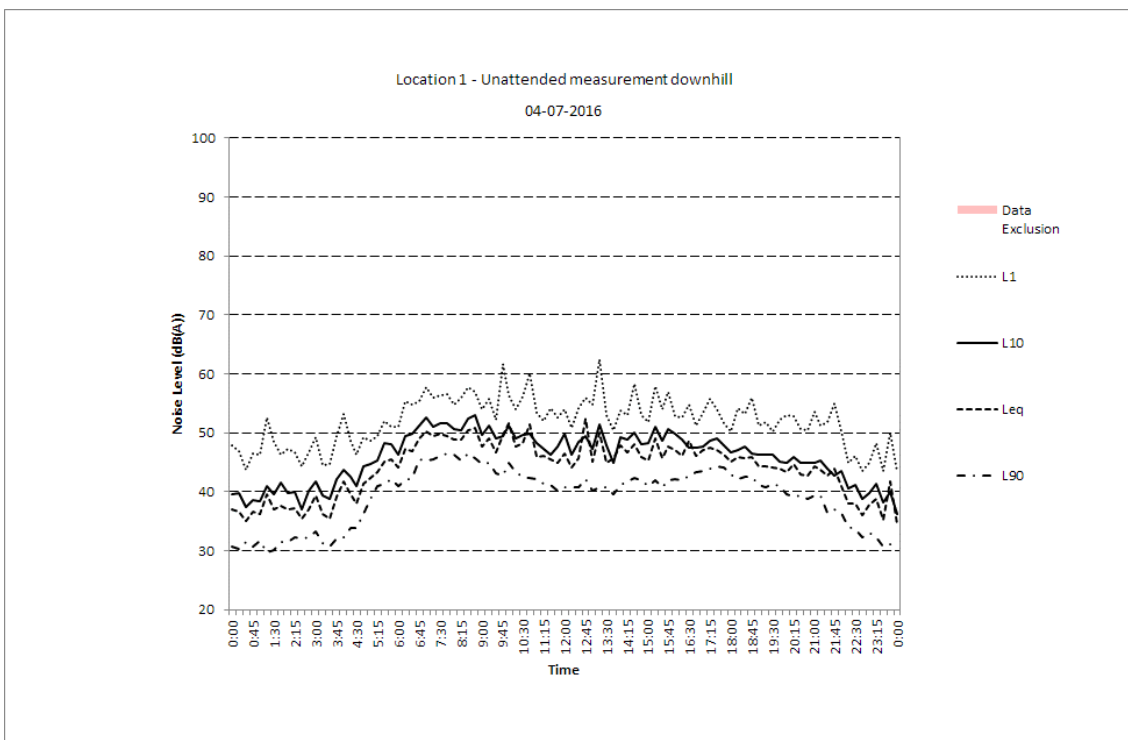
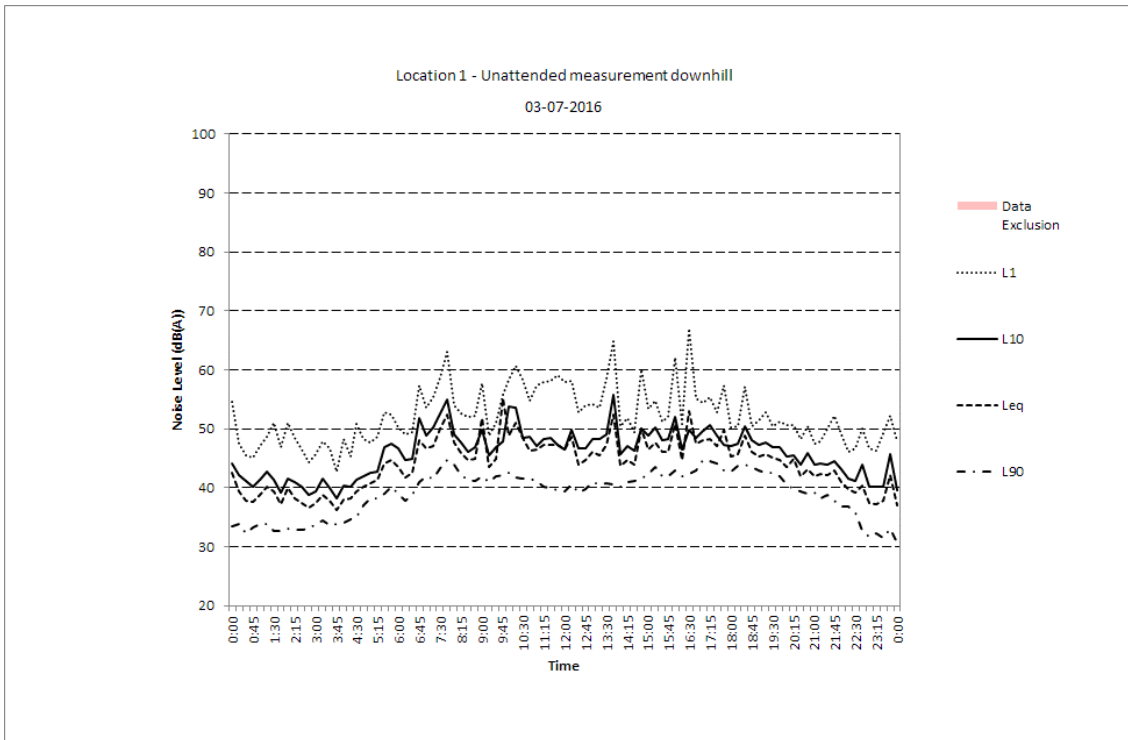
C 16/07/16 for 034 meeting

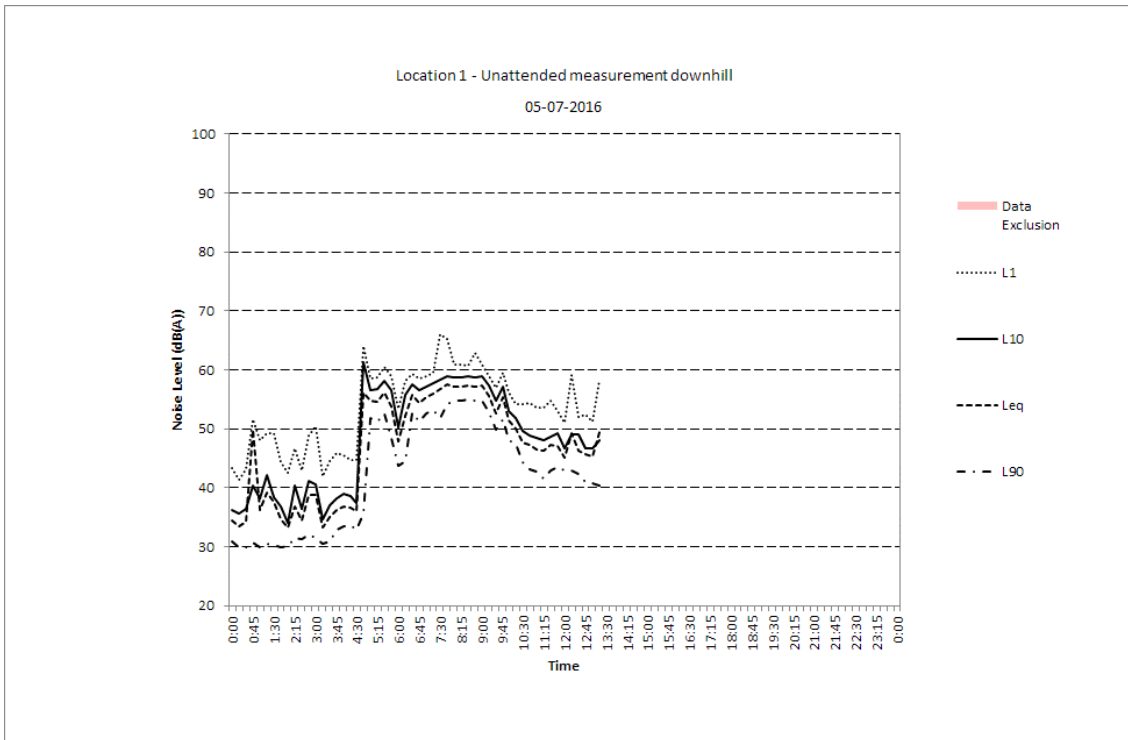
Appendix B Graphical Monitoring Results Location 1



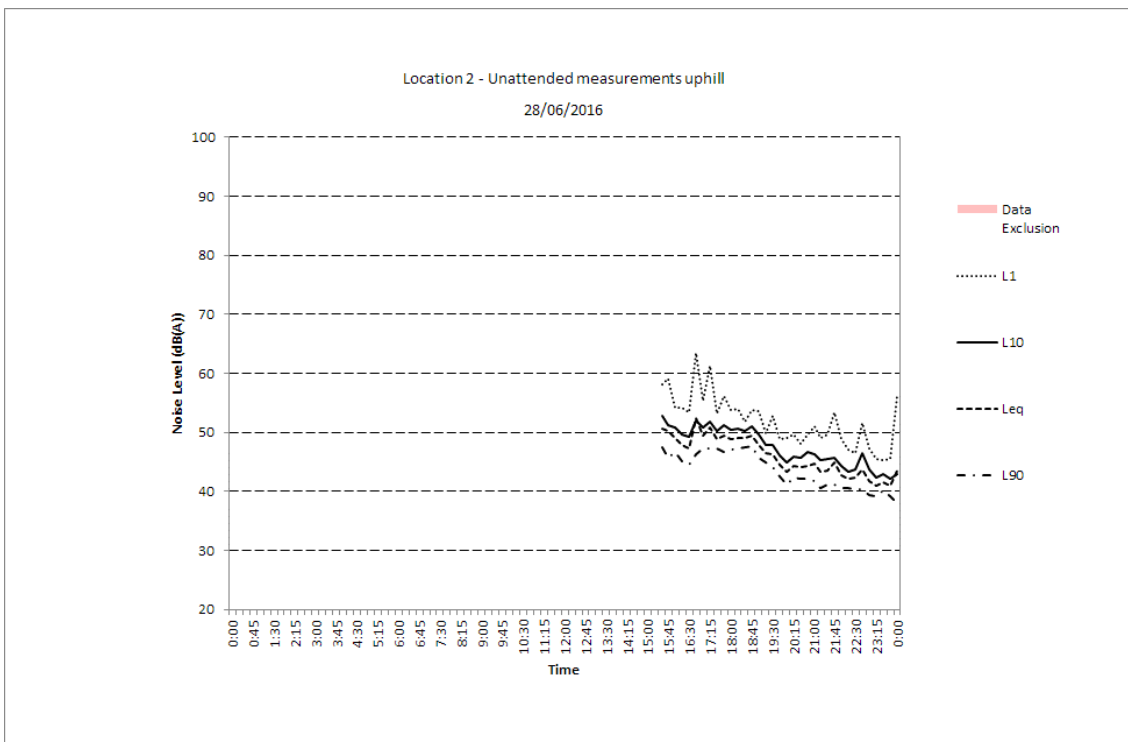


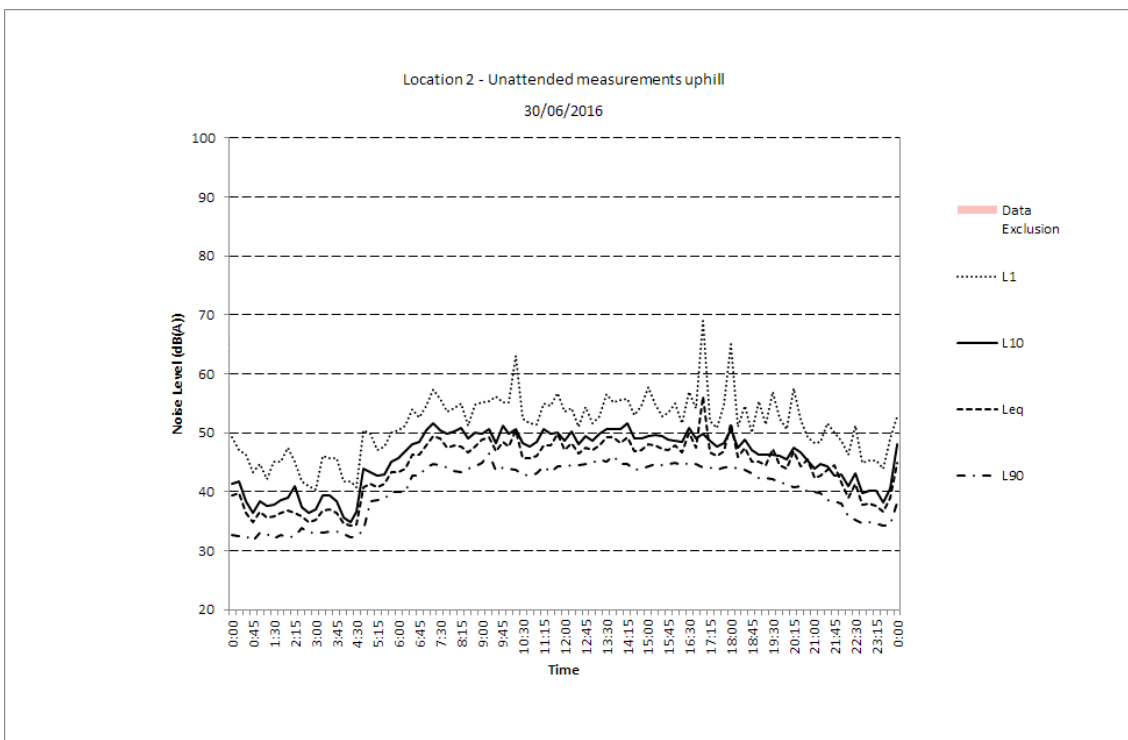
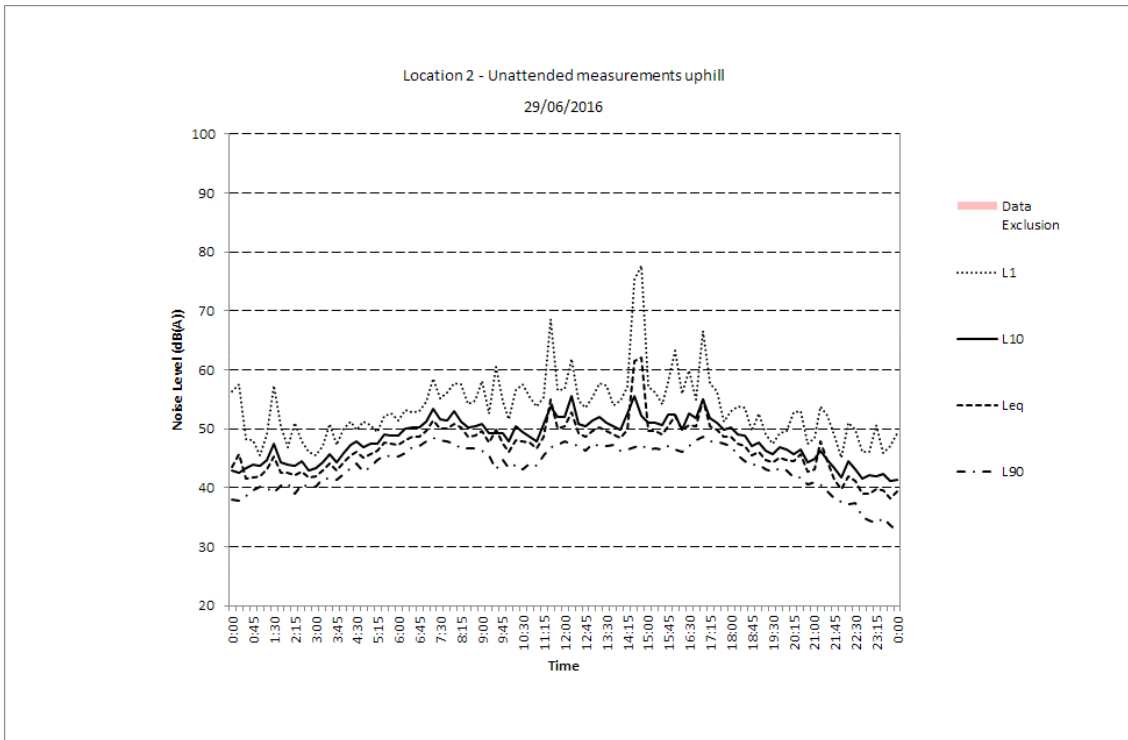


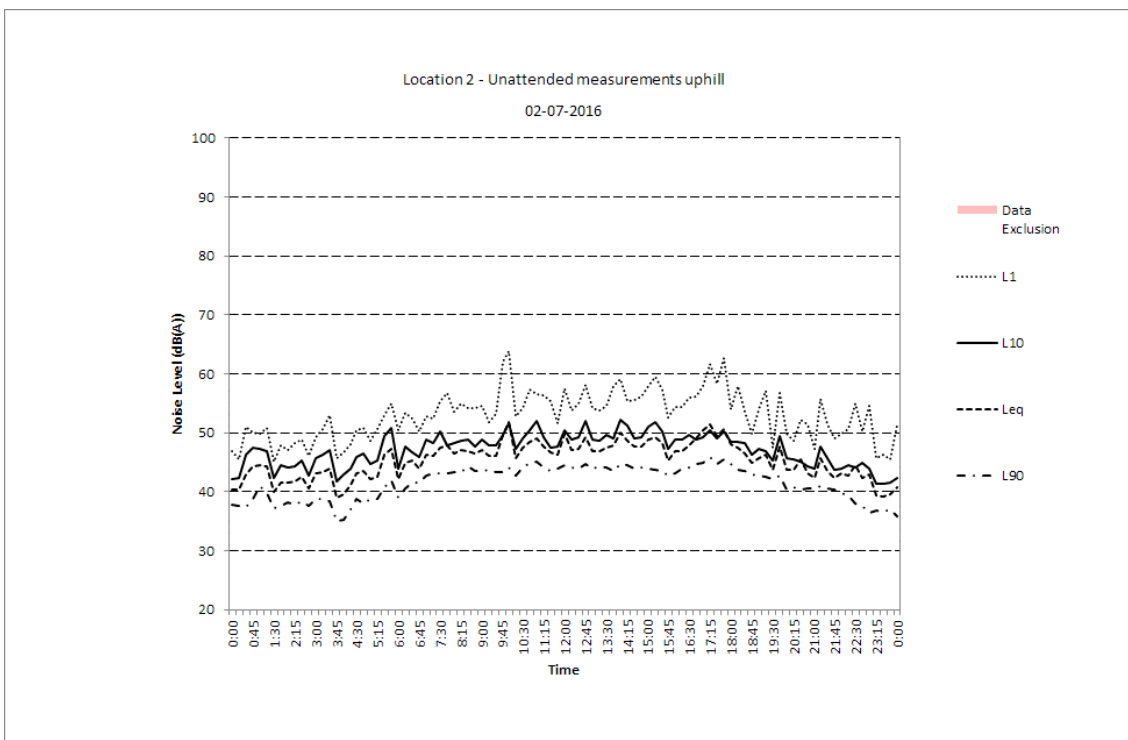
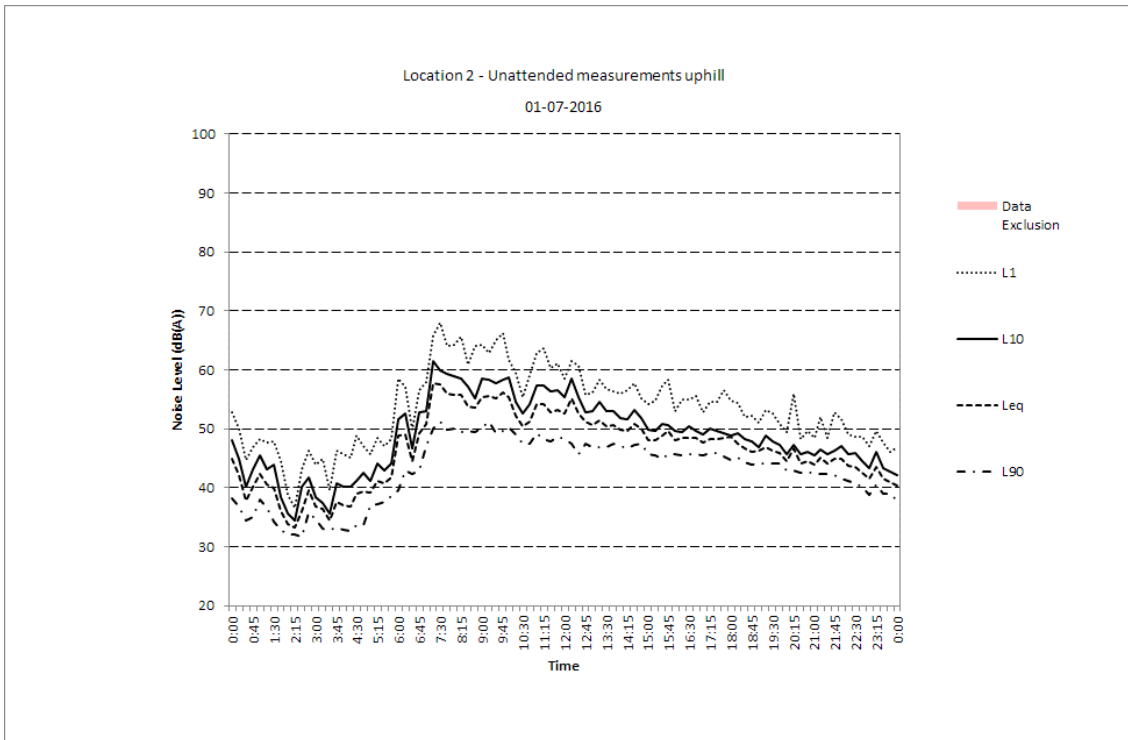


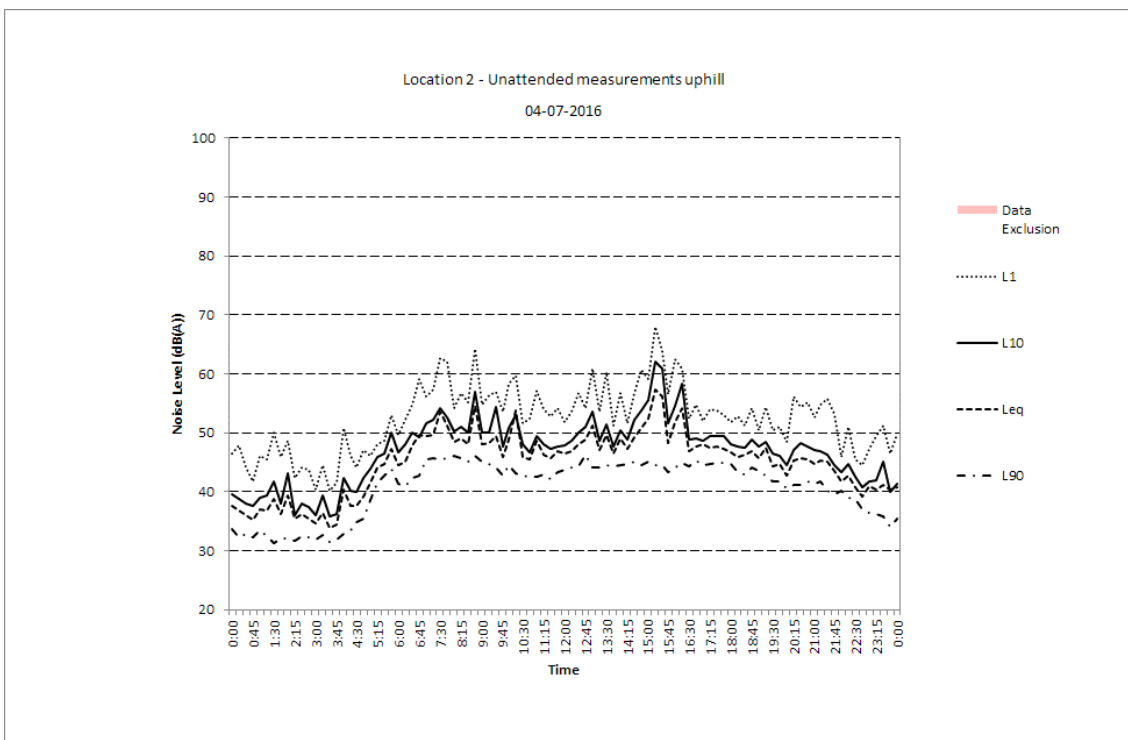
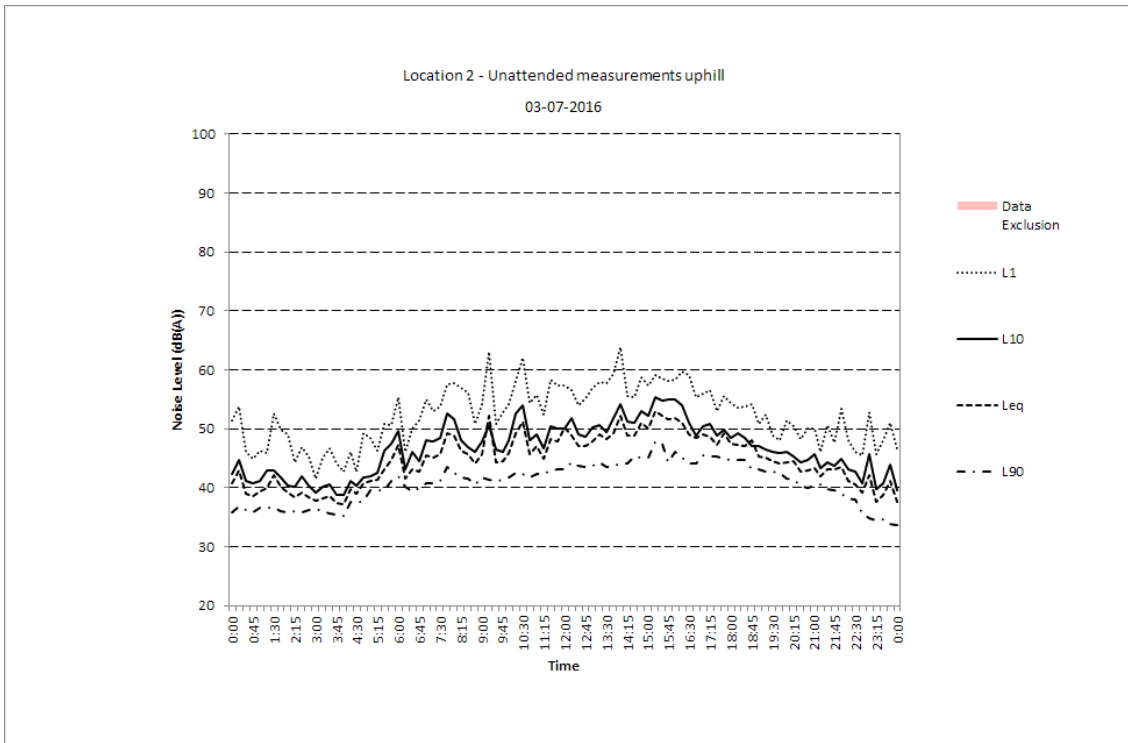


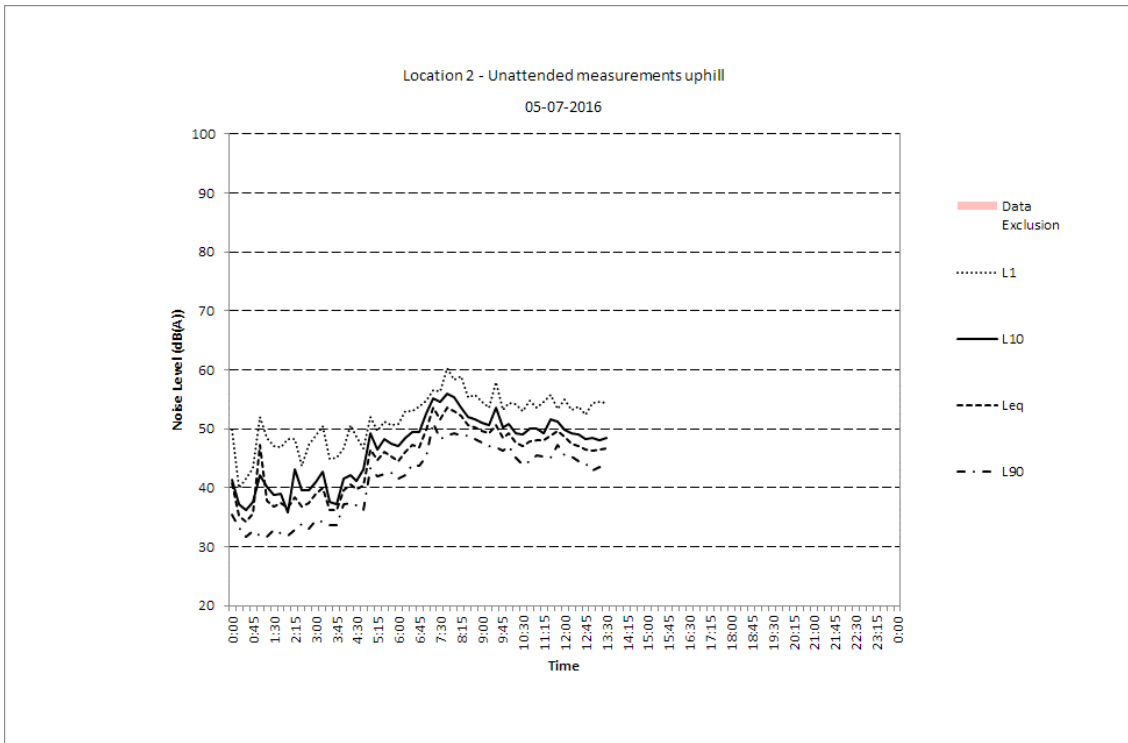
Appendix C Graphical Monitoring Results Location 2











Appendix D Construction Noise Contours – Worst-case Scenario







