34-40 Rickmansworth Road
Noise Impact Assessment
(for Planning)

Client:	Howarth Homes plc 54 Oxford Road Uxbridge Middlesex UB9 4DN
Project:	34-40 Rickmansworth Road London
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1.0 Introduction

A new residential development is proposed at 34-40 Rickmansworth road in London. The dominant source of noise at the site is road traffic from moving vehicles along Rickmansworth Road (the A404). During the pre-application discussions, the local authority (London Borough of Hillingdon) requested a noise impact assessment in order to assist the planning department.

NSL (Noise Solutions Ltd) have been appointed to establish the existing incident noise levels at the facades of the proposed building and undertake a noise impact assessment to determine the suitability of the development for residential use.

This report presents the results of the environmental noise survey, the applicable policy and guidance and the conceptual measures required to ensure adverse effects due to noise are minimised.

To assist with the understanding of this report an introduction to acoustics and a glossary of acoustic terms can be found in Appendix A.

2.0 Site Description

The site is bounded to the north, east and west by residential dwellings. Rickmansworth Road is located a few metres from the site to the south. Railtracks are located around 180m to the northeast of the site.

The proposed development comprises three detached multi-storey block of flats comprising around 24 apartments with a partial basement parking and access from Rickmansworth Road.

The development will not provide any private outdoor amenity space. A communal grass area will be located at the rear of the building (and the buildings will provide partial road traffic noise screening). A series of small balconies (mostly for drying clothes/shoes) will also be located along the south and north elevations. Highfield Crescent Open Space is located to the south of the development across Rickmansworth road.

An aerial photograph is contained in Appendix B alongside architectural plans, illustrating the plans for the proposed development.

3.0 Policy Context

3.1 Noise Policy Statement for England

The Noise Policy Statement for England (NPSE[1]), published in March 2010, sets out the long-term vision of Government noise policy. The Noise Policy aims, as presented in this document, are: "*Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:*

- *avoid significant adverse effects on health and quality of life;*
- *mitigate and minimise adverse effects on health and quality of life; and*

[1] Noise Policy Statement for England, Defra, March 2010

- *where possible, contribute to the improvement of health and quality of life."*

The NPSE makes reference to the concepts of NOEL (No Observed Effect Level) and LOAEL (Lowest Observed Adverse Effect Level) as used in toxicology but applied to noise impacts. It also introduces the concept of SOAEL (Significant Observed Adverse Effect Level) which is described as the level above which significant adverse effects on health and quality of life occur.

The first aim of the NPSE is to avoid significant adverse effects, taking into account the guiding principles of sustainable development (as referenced in Section 1.8 of the NPSE). The second aim seeks to provide guidance on the situation that exists when the potential noise impact falls between the LOAEL and the SOAEL, in which case: *"…all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development."*

Importantly, the NPSE goes on to state: *"This does not mean that such adverse effects cannot occur."*

The NPSE does not provide a noise-based measure to define SOAEL, acknowledging that the SOAEL is likely to vary depending on the noise source, the receptor and the time in question. NPSE advises that: *"Not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available."*

It is therefore likely that other guidance will need to be referenced when applying objective standards for the assessment of noise, particularly in reference to the SOAEL, whilst also taking into account the specific circumstances of a proposed development.

3.2 National Planning Policy Framework

The National Planning Policy Framework (NPPF[2]) was published in March 2012. One of the documents that the NPPF replaces is Planning Policy Guidance Note 24 (PPG 24[3]) "Planning and Noise."

Paragraph 109 of the NPPF states that the planning system should contribute to and enhance the natural and local environment by, (amongst others) *"preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, water or noise pollution or land stability."*

The NPPF goes on to state in Paragraph 123 *"planning policies and decisions should aim to:*

- *Avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;*

- *Mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including thorough use of conditions;*

[2] National Planning Policy Framework, DCLG, March 2012
[3] Planning Policy Guidance 24: Planning and Noise, DCLG, September 1994

- *Recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land use since they were established, and*

- *Identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value."*

The NPPF document does not refer to any other documents regarding noise other than the NPSE.

Paragraph 11 of the NPPF states that *"planning law requires that applications for planning permission must be determined in accordance with the development plan unless material considerations indicate otherwise."*

Paragraph 13 of the NPPF states that *"the National Planning Policy Framework constitutes guidance for local planning authorities and decision-takers both in drawing up plans and as a material consideration in determining applications."*

Therefore, if a development/local plan does not align closely with the NPPF, planning decisions should be based on assessments which align with the NPPF. So for instance if a development is refused permission due to conflicts with the local plan, this decision can be overturned (i.e. via the appeal process) if the local plan did not closely align with the aims in the NPPF.

Paragraph 17 of the NPPF states that one of the 12 principles of planning is that it should *"not simply be about scrutiny, but instead be a creative exercise in finding ways to enhance and improve the places in which people live their lives."*

3.3 Planning Practice Guidance – Noise

As of March 2014, a Planning Practice Guidance (PPG[4]) for noise was issued which provides additional guidance and elaboration on the NPPF. It advises that when plan-making and decision-taking, the Local Planning Authority should consider the acoustic environment in relation to:

- *Whether or not a significant adverse effect is occurring or likely to occur;*
- *Whether or not an adverse effect is occurring or likely to occur; and*
- *Whether or not a good standard of amenity can be achieved.*

This guidance introduced the concepts of NOAEL (No Observed Adverse Effect Level), and UAEL (Unacceptable Adverse Effect Level). NOAEL differs from NOEL in that it represents a situation where the acoustic character of an area can be slightly affected (but not such that there is a perceived change in the quality of life). UAEL represents a situation where noise is 'noticeable', 'very disruptive' and should be 'prevented' (as opposed to SOAEL, which represents a situation where noise is 'noticeable' and 'disruptive', and should be 'avoided').

[4] Planning Practice Guidance – Noise, http://planningguidance.planningportal.gov.uk/blog/guidance/noise/, 06 March 2014

As exposure increases above the LOAEL, the noise begins to have an adverse effect and consideration needs to be given to mitigating and minimising those effects, taking account of the economic and social benefits being derived from the activity causing the noise. As the noise exposure increases, it will then at some point cross the SOAEL boundary.

The LOAEL is described in PPG as the level above which *"noise starts to cause small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life."*

PPG identifies the SOAEL as the level above which *"noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area."*

In line with the Explanatory Note of the NPSE, the PPG goes on to reference the LOAEL and SOAEL in relation to noise impact. It also provides examples of outcomes that could be expected for a given perception level of noise, plus actions that may be required to bring about a desired outcome. However, in line with the NPSE, no objective noise levels are provided for LOAEL or SOAEL although the PPG acknowledges that: *"…the subjective nature of noise means that there is not a simple relationship between noise levels and the impact on those affected. This will depend on how various factors combine in any particular situation."*

The relevant guidance in the PPG in relation to the adverse effect levels is summarized below:

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not Noticeable	No Effect	No Observed Effect	No specific measures required
Noticeable and not Intrusive	Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Noticeable and Intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Noticeable and Disruptive	The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Noticeable and very Disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	Prevent

The Planning Practice Guidance states the following in relation to mitigation measures:

> *"For noise sensitive developments mitigation measures can include avoiding noisy locations; designing the development to reduce the impact of noise from the local environment; including noise barriers; and, optimising the sound insulation provided by the building envelope. Care should be taken when considering mitigation to ensure the envisaged measures do not make for an unsatisfactory development."*

The Planning Practice Guidance provides further advice as it states that:

> *"the noise impact may be partially off-set if the residents of those dwellings have access to:*

- *a relatively quiet facade (containing windows to habitable rooms) as part of their dwelling, and/or;*

- *a relatively quiet external amenity space for their sole use, (e.g. a garden or balcony). Although the existence of a garden or balcony is generally desirable, the intended benefits will be reduced with increasing noise exposure and could be such that significant adverse effects occur, and/or;*

- *a relatively quiet, protected, nearby external amenity space for sole use by a limited group of residents as part of the amenity of their dwellings, and/or;*

- *a relatively quiet, protected, external publically accessible amenity space (e.g. a public park or a local green space designated because of its tranquillity) that is nearby (e.g. within a 5 minutes walking distance)."*

In addition:

"consideration should also be given to whether adverse internal effects can be completely removed by closing windows and, in the case of new residential development, if the proposed mitigation relies on windows being kept closed most of the time. In both cases a suitable alternative means of ventilation is likely to be necessary. Further information on ventilation can be found in the Building Regulations".

3.4 Local Policy

The London borough of Hillingdon does not have an up to date local plan. The environmental health department at the council has advised of the following:

"We're in the process of updating our current spd and will upload it on our website when it is ready. In the meantime ,our policy is as per the current spd. Our policy regarding industrial noise is a rating level of 5dB below B.G. and where relevant you may make reference to the new BS4142 and BS8233 and any other British Standards that have been updated. Any reference in the spd to PPG24 should be ignored."

4.0 Acoustic Standards and Guidance

4.1 BS 8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings.

This Standard provides recommended guideline values for internal noise levels within dwellings which are similar in scope to guideline values contained within the World Health Organisation (WHO) document, Guidelines for Community Noise (1999[5]). These guideline noise levels are shown in Table 1, below.

Table 1: BS 8233 Desirable Internal Ambient Noise Levels for Dwellings

Activity	Location	07:00 to 23:00 hours	23:00 to 07:00 hours
Resting	Living room	35 dB LAeq,16h	-
Dining	Dining room/area	40 dB LAeq,16h	-

[5] World Health Organisation Guidelines for Community Noise, 1999

Sleeping (daytime resting)	Bedroom	35 dB LAeq,16h	30 dB LAeq,8h

BS 8233:2014 advises that: *"regular individual noise events…can cause sleep disturbance. A guideline value may be set in terms of SEL or LAmax,F depending on the character and number of events per night. Sporadic noise events could require separate values."*

The standard also provides advice in relation to design criteria for external noise. It states that:

> *"for traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable.*
>
> *In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited.*
>
> *Other locations, such as balconies, roof gardens and terraces, are also important in residential buildings where normal external amenity space might be limited or not available, i.e. in flats, apartment blocks, etc. In these locations, specification of noise limits is not necessarily appropriate.*
>
> *Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses. However, the general guidance on noise in amenity space is still appropriate for larger balconies, roof gardens and terraces, which might be intended to be used for relaxation.*
>
> *In high-noise areas, consideration should be given to protecting these areas by screening or building design to achieve the lowest practicable levels. Achieving levels of 55 dB $L_{Aeq,T}$ or less might not be possible at the outer edge of these areas, but should be achievable in some areas of the space."*

4.2 World Health Organization, Guidelines for Community Noise, 1999 (WHO)

The World Health Organisation (WHO) *Guidelines for Community Noise* (1999) recommends suitable internal and external noise levels based on dose response research. The levels recommend in this guidance could be correlated to the LOAEL. Relevant guidance from this document is presented below.

Sleep Disturbance (Night-time internal LOAEL)

If negative effects on sleep are to be avoided, the equivalent sound pressure level should not exceed **30 dBA** indoors for continuous noise.

Interference with Communication (Daytime internal LOAEL)

Noise tends to interfere with auditory communication, in which speech is a most important signal. However, it is also vital to be able to hear alarming and informative signals such as door bells, telephone signals, alarm clocks, fire alarms etc., as well as sounds and signals involved in occupational tasks. The effects of noise on speech discrimination have been studied extensively and deal with this problem in lexical terms (mostly words but also sentences). For communication distances beyond a few metres, speech interference starts at sound pressure levels below 50 dB for octave bands centred on the main speech frequencies at 500, 1 000 and 2 000 Hz. It is usually possible to express the relationship between noise levels and speech intelligibility in a single diagram, based on the following assumptions and empirical observations, and for speaker-to-listener distance of about 1 metre:

a. Speech in relaxed conversation is 100% intelligible in background noise levels of about **35 dBA**, and can be understood fairly well in background levels of 45 dBA.

b. Speech with more vocal effort can be understood when the background sound pressure level is about 65 dBA.

Annoyance Responses (Daytime external LOAEL for private amenity areas)

During the daytime, few people are seriously annoyed by activities with L_{Aeq} levels below 55 dB; or moderately annoyed with L_{Aeq} levels below **50 dB**.

4.3 The Noise Insulation Regulations 1975

The Noise Insulation Regulations 1975 define the conditions under which dwellings are eligible for noise insulation to control internal noise levels. The conditions relate to the level of traffic noise at the façade, the increase in noise levels as a result of the highway and the contribution of the new or altered scheme to the noise level received at the façade.

Noise insulation qualification criteria must abide by a few tests which include the following two:

- The facade noise threshold of 68dB $L_{A10,18h}$ is met or exceeded;
- That there must be a noise increase of at least 1dB(A) compared to the prevailing noise level immediately before the construction of a highway or an additional carriageway were begun;

4.4 SOAELs for transportation airborne noise

Based on the noise insulation regulations a façade noise level of 69 dB $L_{A10,18h}$ is therefore considered as unacceptable and can trigger the provision of mitigation measures by the government. This level can therefore be used as the SOAEL in relation to transportation noise in England. This level relates to a level of 64 dB $L_{Aeq, 16h}$. Even though this level is predominantly proposed in relation to internal noise levels it can be used in this case as the SOAEL for external private amenity space (i.e. gardens). Based on guidance[6] in

[6] BS8233:2014 states that "If partially open windows were relied upon for background ventilation, the insulation would be reduced to approximately 15 dB"

BS8233:2014, an external noise level of 64 dB $L_{Aeq, 16h}$ would roughly equate to an internal level of 49 dB $L_{Aeq\ 16h}$. As daytime and night-time desirable target levels differ by 5 dB, a night-time SOAEL could be 44 dB $L_{Aeq, 8h}$.

4.5 Proposed LOAEL and SOAELs for transportation airborne noise affecting new residential developments.

A summary of the proposed LOAEL and SOAEL is provided in Table 2.

Table 2: Proposed LOAEL and SOAEL for transportation noise affecting new Dwellings

Level	Daytime (07:00 hours to 23:00 hours)	Night-time (23:00 hours to 07:00 hours)
LOAEL Internal	35 $L_{Aeq,16h}$ (dB)	30 $L_{Aeq,8h}$ (dB)
SOAEL Internal	49 $L_{Aeq,16h}$ (dB)	44 $L_{Aeq,8h}$ (dB)
LOAEL External	50 $L_{Aeq,16h}$ (dB)	Not applicable
SOAEL External	64 $L_{Aeq,16h}$ (dB)	Not applicable

Based on guidance in BS8233:2014 it appears that night-time L_{Amax} events should be associated with transportation noise involving train or aircraft pass by and not busy road traffic. As the dominant noise source around the development is road traffic noise from Rickmansworth Road, LOAEL and SOAEL values for L_{Amax} events during the night-time are not presented as these are not deemed necessary.

It should be highlighted that the Secretary of State approved assessment for the HS2 project includes a SOAEL of 65 dB $L_{Aeq,16h}$. The HS2 project also includes a LOAEL of 50 dB $L_{Aeq,16h.}$ Therefore the difference between the LOAEL and SOAEL for transportation noise in the Secretary of State approved HS2 project is 15 dB.

4.6 Building Regulations

Part L of the Building Regulations mandates that buildings become more airtight, and Part F stipulates ventilation requirements. Even though there appears to be a contradiction in this, Part L limits uncontrollable ventilation, while Part F ensures that ventilation requirements are provided in a controlled manner.

Ventilation requirements for new dwellings

Background ventilation

Three types of ventilation are required under Part F. Whole building ventilation provides nominally continuous air exchange which may be reduced or ceased when the building is not occupied. It can be provided via background ventilators operating alone, or together with:

- passive stack ventilators;
- continuous mechanical extract; or
- continuous mechanical supply and extract with heat recovery.

Extract ventilation is applicable to rooms where most water vapour and/ or pollutants are released (e.g. kitchens and bathrooms). It can be provided by intermittent fans, passive stack or continuous mechanical extract with or without mechanical supply and heat recovery.

The four systems described in Part F do not present solutions which utilise the use of opening windows for background ventilation. Opening windows do not provide a controllable means of ventilation and also pose security risks.

Purge ventilation

Purge ventilation is required throughout the building to aid the removal of high concentrations of pollutants and water vapour. It is commonly provided simply by opening windows and doors.

Even though purge ventilation is recommended via opening windows, the temporary and intermittent occurrence of this does not normally result in an unacceptable increase of internal noise levels.

Part F goes on to say that "*Purge ventilation provisions may also be used to improve thermal comfort, although this is not controlled under the Building Regulations."*

5.0 Environmental Noise Survey

An unattended environmental sound pressure level survey was undertaken from 13:16 hours on Monday 7th March 2016 to 15:16 hours on Tuesday 8th March 2016. The survey was undertaken in order to establish the prevailing typically highest incident environmental noise levels at the proposed development. A short attended survey was also undertaken at four locations during the afternoon of the 8th of March 2016 in order to obtain suitable octave band frequency information and review the spread of road traffic induced noise across the site.

Full details of the survey are provided in Appendix C alongside a time history graph of the long term measurements.

The relevant results of the long term survey have been summarised in Table 3 below.

Table 3 Summary of free field façade incident environmental noise levels

	Position 1	
	$L_{Aeq\ 16\ hours}$	$L_{Aeq\ (8\ hours)}$
Monday/Tuesday	66	58

The results of the survey shows that the daytime levels are 8 dB higher compared to the night-time levels. Since the proposed LOAEL values are only 5dB different between day and night-time, the daytime targets are more onerous. Therefore an assessment of the noise impact during the night-time is superfluous for this site.

6.0 Noise impact assessment

6.1 External Amenity Noise Levels

Based on the results of the environmental noise survey, it appears that the proposed outdoor ground level amenity area at the rear of the development will experience incident environmental noise levels which will generally be lower than the proposed daytime LOAEL and therefore no mitigation measures are required. Balconies with a line of sight to Rickmansworth Road will experience incident road traffic noise levels above the LOAEL. However, no mitigation measures are deemed necessary to reduce this impact as these small balconies are unlikely to be used for relaxation or similar. In accordance with the advice in BS8233:2014 "*Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses."*

6.2 Internal Noise Levels

The composite acoustic performance required of any portion of the building envelope will depend on its location relative to the principal noise sources around the site and the nature of the spaces behind it (noise criteria, size, room finishes etc.).

The levels of noise incident upon each façade of a building are different. Consequently, each façade and even each window on a façade can have its own unique sound insulation requirement. However, it is not practical to specify a large number of different external building fabric constructions. For the purposes of this assessment, a calculation has been undertaken in order to ascertain the likely internal ambient noise level at the realistically "worst" case habitable room. For the purposes of this assessment, a master bedroom with a fully openable glazed access door to the balcony has been chosen.

The following table presents the various assumptions used in the assessment:

Table 4 Assumptions used in the calculations for the acoustic performance of the composite external building fabric

Assumptions	
Room Volume (m^3)	35
Room Type	Bedroom
Room Furnishings	Curtains, bed, timber finish
Area of window (m^2)	3.5
Area of wall (m^2)	5.5
External incident noise level (dB $L_{Aeq,\ 16\ hours}$) due to road traffic (bedroom overlooking the roads)	66
Target internal noise level (dB L_{Aeq}) due to road traffic noise ingress	35
Effective area of ventilators (mm^2)	8000

The calculations, shown in Appendix D, demonstrate that the proposed target (the LOAEL) should be met if the composite external building fabric comprises typical brick and block wall, 4/16/4 double glazing and hit and miss ventilators. The background ventilation system is System 1 in Approved Document F of the building regulations and therefore a mandatory requirement. Due to the building regulations, the glazing element will be a composite cavity glazed element. A double glazed element comprising 4mm glass, 16mm of airspace and 4mm glass is in fact the thinnest and minimum glazing element to comply with the thermal

requirements of the building regulations. Therefore, if the development is build using the typical elements required to comply with the building regulations, even if elements with the lowest acoustic performance are chosen, suitable internal ambient noise levels will be achieved. Therefore, as compliance with the minimum requirements in the building regulations will ensure that desirable internal ambient noise levels are achieved it would be superfluous to impose a relevant planning condition (as this condition would not comply with at least one of the six tests for planning conditions under the NPPF).

7.0 Conclusions

An environmental noise survey was undertaken in order to establish the ambient noise levels incident at the proposed residential facades for the development at 34-40 Rickmansworth Road.

The assessment of the suitability of the site for residential development was undertaken in full accordance with the aims and requirements within the National Policy Statement for England (NPSE), the National Planning Policy Framework (NPPF) and the Planning Practice Guidance (PPG).

The assessment has demonstrated that the proposals will not give rise to significant adverse effects on health and quality of life and that adverse effects will be reduced and minimized as a result of the requirements in the various building regulations (i.e. Approved Document F and L) and the layout of the proposed development.

The noise impact assessment has demonstrated that incident noise levels at the proposed development should not be viewed as a constraint to the development proposals. The assessment also demonstrated that planning conditions relating to noise are also superfluous for this site.

APPENDIX A – Introduction to acoustics and glossary of terms

Introduction to Noise

Noise is defined as unwanted sound, and the unit of measurement is the decibel (dB(A)). Noise levels range from the threshold of hearing at 0 dB(A) to levels of over 130 dB(A) at which point noise becomes painful.

Sound consists of vibrations transmitted to the ear as rapid variations in air pressure. The more rapid the fluctuation the higher the frequency of the sound. Frequency is the number of pressure fluctuations per second and is expressed in Hertz (Hz).

The sensitivity of the human ear varies with frequency. To allow for this phenomenon, sound level meters are often equipped with a set of filters that modify the response of the sound level meter in a similar way to the human ear; these filters are referred to as the 'A-weighting network'. The 'dB(A)' notation is used to indicate when noise levels have been filtered using the A-weighting network. It has been found that changes in noise level when measured in dB(A) correlate better with changes in subjective reaction than to changes in noise measured without using the A-weighting network.

Noise Descriptors

The subjective response to noise is dependent not only upon the sound pressure level and its frequency but also on its duration and the time of day it occurs. In the environment, noise levels fluctuate in response to events, for instance with aircraft passing overhead or changes in the quantity and speed of road traffic on nearby roads. For this reason environmental noise is often described in terms of an equivalent continuous sound pressure level, which can be thought of as a constant noise level over a time period (T) that contains the same sound energy as the fluctuating noise level.

Decibel Addition

If the sound levels from two or more sources have been measured or predicted separately, and the combined sound level is required, the sound levels must be added together. However, due to the fact the decibel is a logarithmic value they cannot be added together using normal arithmetic. For instance if you add two sound pressure levels of 50 dB, the answer is 53 dB and not 100 dB.

Human Sensitivity to Change

Generally, a change of 3 dB(A) in environmental noise is the minimum change perceptible to a human. However, there is research that suggests with respect to road traffic noise, immediately following a change in traffic flow or road alignment people may find benefits or disbenefits when noise changes are as small as 1 dB(A). A change of 1 dB(A) is equivalent to an increase in traffic flow of 25 per cent or a decrease in traffic flow of 20 per cent. These effects last for a number of years, however, in the longer term, perceived noise nuisance may tend towards the steady state level associated with the new source, which is generally lower.

Free-field and Façade Incident Levels

Due to the effects of reflection, sound pressure levels measured close to large vertical reflecting surfaces such as building façades higher than those that are measured away from reflective surfaces.

Sound pressure levels measured 1 meter from a large solid, reflecting surface are termed 'façade incident' levels, whilst those measured at least 3 meters away from any reflective surfaces (apart from the ground) are termed 'free-field'. Façade incident levels are typically 3 dB higher than free-field levels and therefore it is important to know the conditions under which a noise measurement or prediction has been undertaken.

An indication of the range of sound levels found commonly in the environment is given below.

Sound Pressure Level, dB(A)	**Environmental Condition**
0	Threshold of hearing
10	Breathing
20	Background in broadcasting studio
30	Quiet bedroom at night
40	Quiet library
50	Average home
60	Conversational speech at 1m
70	Vacuum cleaner at 1m
80	Kerbside of busy road at 5m
90	Diesel truck at 10m
100	Disco, 1m from speaker
110	Chain saw at 1m
120	Threshold of discomfort
130	Around 50m from a jet aircraft at take off
140	Threshold of pain

The subjective response to a noise is dependent not only upon the sound pressure level and its frequency, but also its intermittency. Various statistical indices have been developed to try and correlate annoyances with the noise level and its fluctuations in a changing noise environment. The indices and parameters used in this report are defined below.

$L_{Aeq,T}$ - a noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound under investigation. It is in effect the energy average level over the specified measurement period (T) and is the most widely used indicator for environmental noise.

L_{AFmax} - The maximum A-weighted noise level over the time period T, and unless described otherwise, it is measured using the 'fast' sound level meter response. The L_{AFmax} is

sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{Aeq} noise level but will still affect the noise environment.

L_{AN} - If non-steady noise is to be described, it is necessary to know both its level and degree of fluctuation. The L_{AN} indices are used for this purpose. The terms refers to the A-weighted level (in decibels) exceeded for n% of the time specified.

$L_{A10,T}$ is the level exceeded for 10% of the time and as such gives an indication of the upper limit of fluctuating noise. $L_{A10,T}$ is commonly used to describe traffic noise.

$L_{A90,T}$ is the noise level that is exceeded for 90% of the measurement time interval, T. It gives an indication of the lower levels of fluctuating noise. It is often used to describe the background noise level and can be considered to be the "average minimum" noise level and is a term used to describe the level to which non-specific noise falls during quiet spells, when there is lull in passing traffic for example.

L_{A1} is the level exceeded for 1% of the time and as such gives an indication of the maximum noise level that discounts one-off atypical events.

Ambient sound : The total sound at a given place, usually a composite of sounds from many sources near and far. Should not be confused with "background sound." 17.4 Residual sound

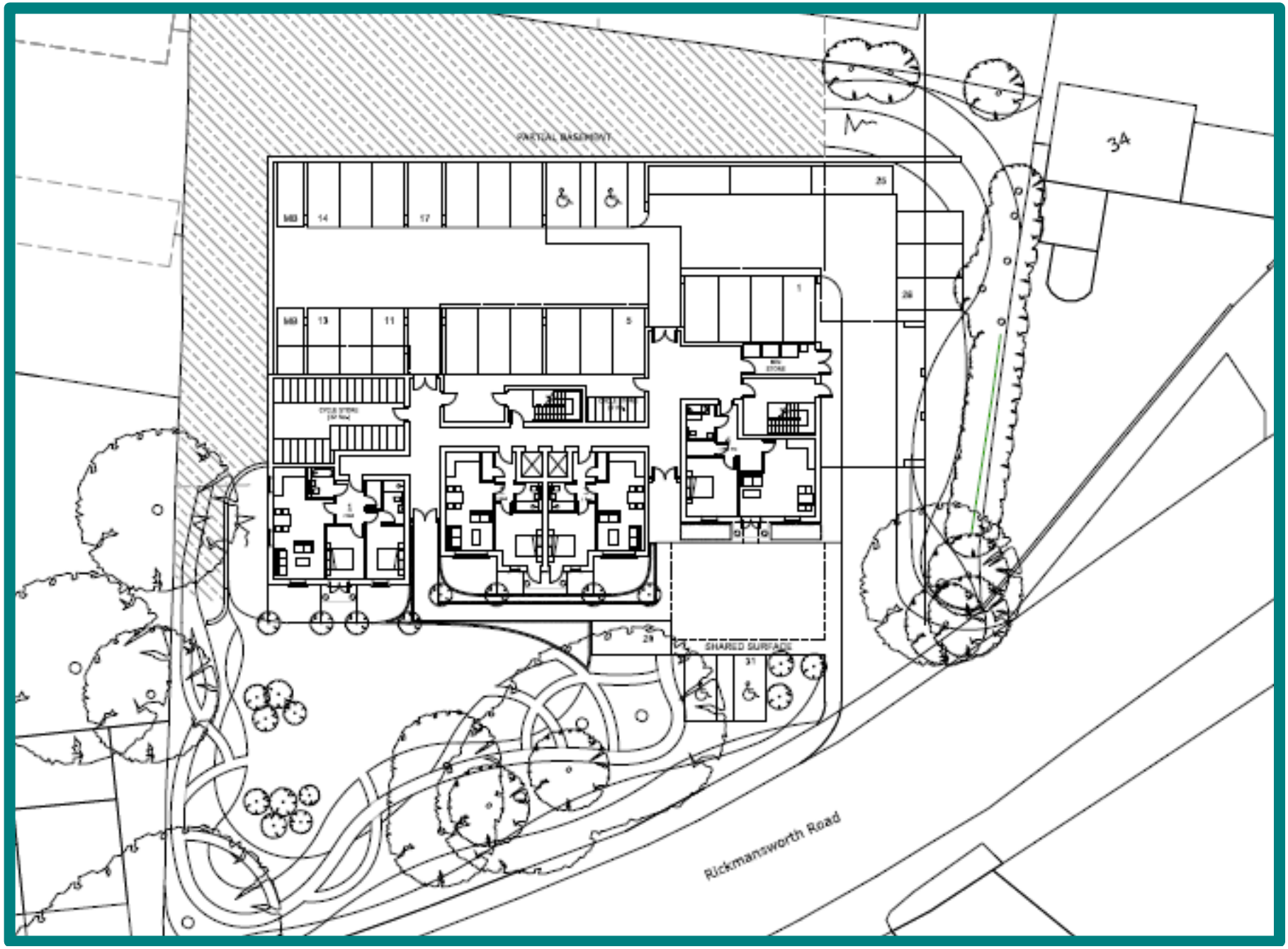
The ambient sound remaining at a given position in a given situation when the specific sound source is suppressed to a degree such that it does not contribute to the ambient sound.

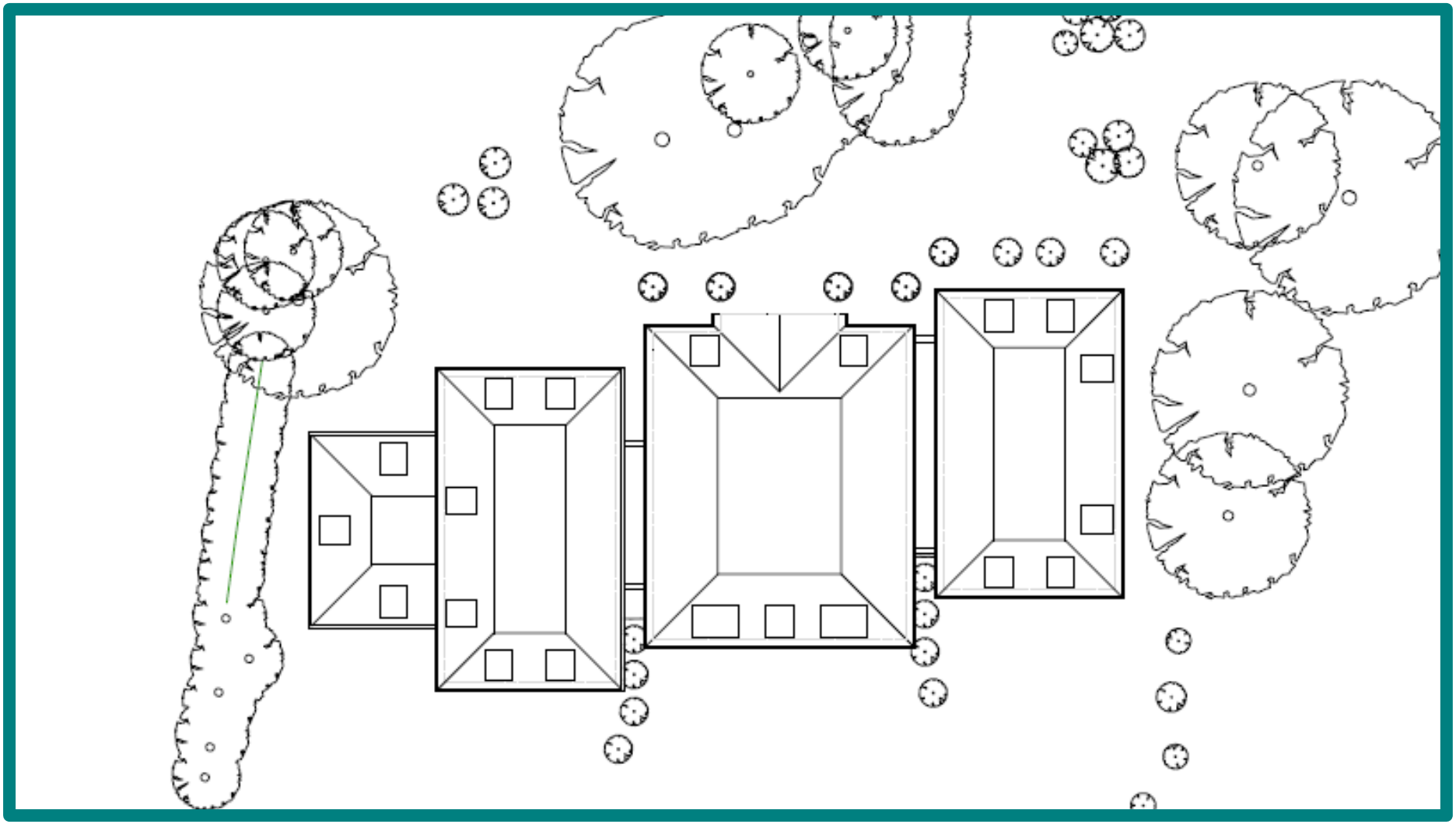
Background sound level, LA90,T : The A-weighted sound pressure level of the residual sound at the assessment position that is exceeded for 90% of a given time interval, T, measured using Fast time weighting, and quoted to the nearest whole number of decibels.

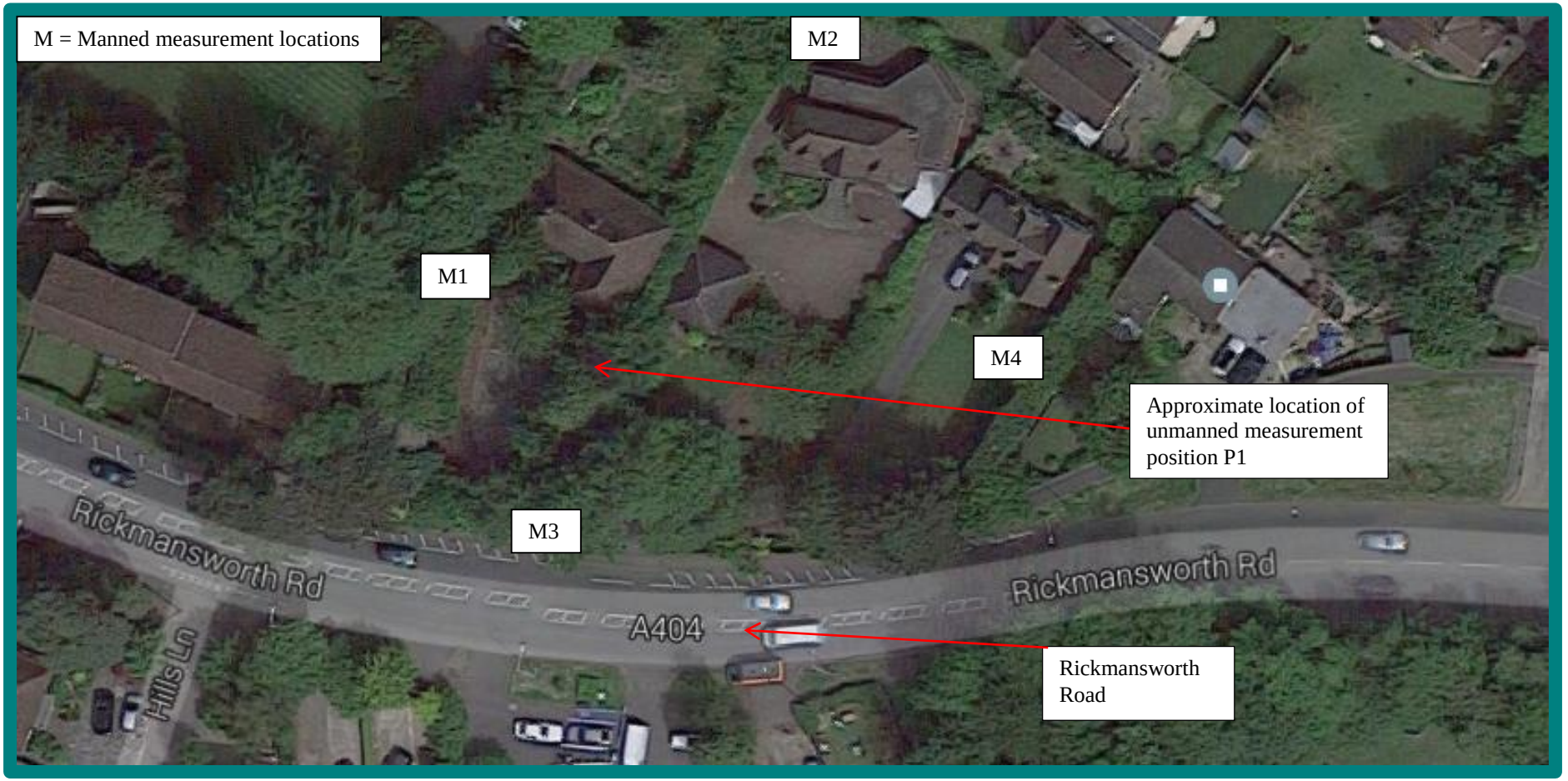
Specific sound level, LAeq, T : The equivalent continuous A-weighted sound pressure level at the assessment position produced by the specific sound source over a given reference time interval.

Rating level, LAeq, T : The specific sound level plus any adjustment for the characteristic features of the sound.

APPENDIX B – Drawings, elevations and aerial photograph showing the site, the surrounding area and measurement positions


PARTIAL BASEMENT
34
SHARED SURFACE
Rickmansworth Road




M = Manned measurement locations
M2
M1
M4
Approximate location of unmanned measurement position P1
M3
Rickmansworth Rd
A404
Rickmansworth Rd
Hills Ln
Rickmansworth Road

APPENDIX C – Details of noise survey

C.1. Measurement period

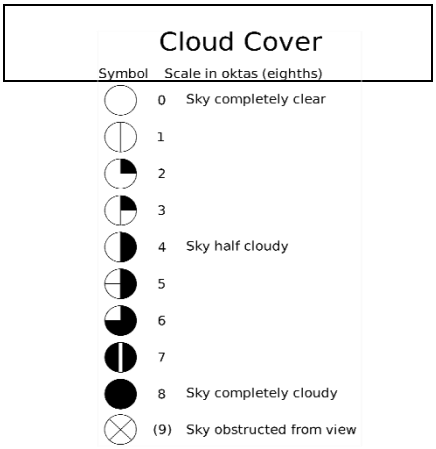
An unattended environmental sound pressure level survey was undertaken from 13:16 hours on Monday 7th March 2016 to 15:16 hours on Tuesday 8th March 2016. The survey was undertaken in order to establish the prevailing typically highest incident environmental noise levels at the proposed development. A short attended survey was also undertaken at four locations during the afternoon of the 8th of March 2016 in order to obtain suitable octave band frequency information and review the spread of road traffic induced noise across the site.

C.2. Measurement positions

The approximate locations of the measurement positions are indicated on the aerial photograph in the previous page. At all positions the microphones were located at free field locations (i.e. at least 1m above ground level and at least 3.5m away from a horizontal reflective surface).

C.3. Weather Conditions

Weather conditions were determined both at the start and on completion of the survey. It is considered that meteorological conditions were appropriate for environmental noise measurements.

			Weather Conditions	
Measurement Location	**Date/Time**	**Description**	**Beginning of Survey**	**Completion of Survey**
All	14:00 - 7/03/2016- 15:15 - 8/03/2016	Temperature (°C)	10	10
		Precipitation:	Dry	Dry
		Cloud cover (oktas - see guide)	7	5
		Presence of fog/snow/ice	No	No
		Presence of damp roads/wet ground	No	No
		Wind Speed (m/s)	3.1	4.2
		Wind Direction	Westerly	Westerly
		Conditions that may cause temperature inversion (i.e. calm nights with no cloud)	No	No

C.3. Noise measurement equipment

Details of the equipment used during the course of the noise surveys have been provided in the table below. The sound level meters were calibrated before and after the surveys; no significant change (±0.2 dB) in the calibration levels was noted.

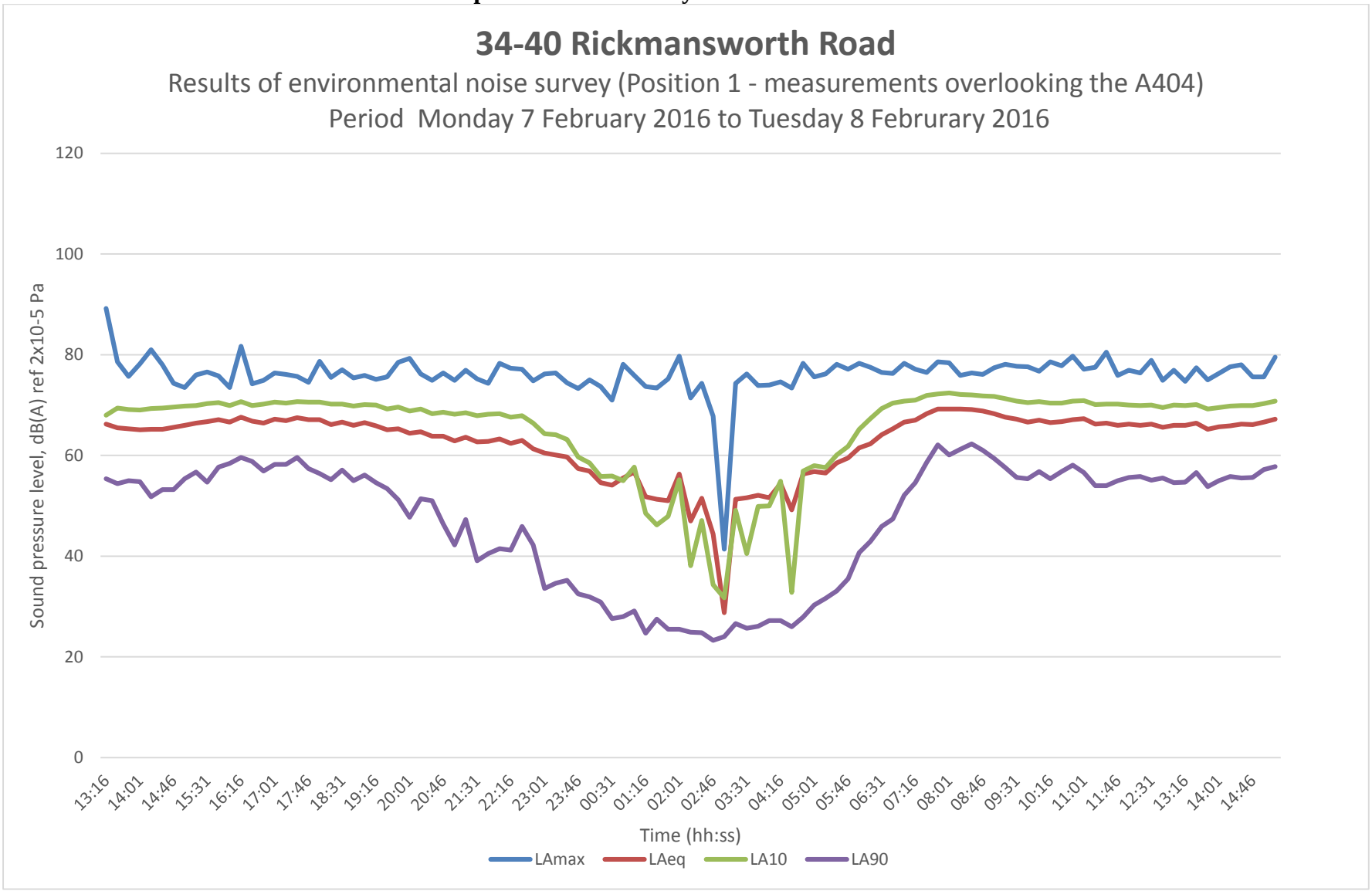
Description	Model / serial no.	Calibration date	Calibration certificate no.
Unmanned Measurements			
Class 1 Sound level meter	Svantek 949 / 12262	20/04/2015	14731
Condenser microphone	SV22 / 4012444		
Preamplifier	Svantek SV12L / 13163		
Calibrator	Svantek SV 40A / 10847	20/04/2015	14730
Manned Measurements			
Class 1 Sound level meter	Svantek 949 / 8195	22/09/2014	7939
Condenser microphone	MCE212/ 22267		
Preamplifier	Svantek SV12L / 7557		
Calibrator	Svantek SV 40A / 10843	15/09/2014	7927

C.4. Results

The results of the long term noise survey are considered to be representative of typical worst case prevailing noise levels at the façades of the proposed residential development. The noise climate was dominated by general road traffic emanating from Rickmansworth road. The full set of results for the short term manned survey are shown in the table below. The time history graph of the measurements during the long term unmanned noise survey are presented in the time history graph overleaf.

		Sound Pressure level measurements (dB $L_{eq, 15min}$) at Octave Band Centre Frequencies (Hz)								
Location	Start Time	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	dBA
M1	14:16:30	66	57	54	55	60	56	43	33	62
M2	14:32:14	59	52	46	47	49	43	35	33	52
M3	14:48:36	70	62	59	60	64	59	47	36	66
M4	15:04:24	66	61	55	53	59	55	41	31	61

APPENDIX C – Details of unmanned sound pressure level survey



Appendix D

External Building Fabric Analysis - Calculation of internal noise levels based on BS8233 methodology

NSL reference number	85905	**Job Title**	34-40 Rickmansworth road		**Room Description**		Bedroom				
	S_{wi}		(Area of windows)=	3.36	m^2		Room Length =	4.1	m		
	S_{ew}		(External wall Area) =	5.28	m^2		Room Width =	3.2	m		
	S_{rr}		(Area of ceiling) =		m^2		Room Height =	2.7	m		
	S		(Total area) =	8.64	m^2		Room Surface Area =	65.66	m^2		
		Octave Band Centre Frequency (Hz)								**dBA**	**Description**
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**		
	L_p out	*70*	62	59	60	64	59	*47*	*36*	66	External Leq (16hour) Noise Level
Insulation of Trickle Ventilator	$D_{n,e}$	*0*	*31*	*24*	*34*	*32*	*55*	*0*	*0*		Hit-and-miss trickle ventilator (8000mm^2)
Sound Reduction of Window	R_{wi}	*19*	*24*	*23*	*30*	*33*	*33*	*30*	*32*		4/16/4 Double Glazing
Sound Reduction of External Wall	R_{ew}	*0*	*41*	*45*	*45*	*54*	*58*	*0*	*0*		Brick/block cavity wall
Equivalent Absorption Area	A	7	12	16	18	20	21	21	23		

	L_p in (Linear)	76	37	37	30	33	21	48	37	
	A weight	-26	-16	-9	-3	0	1	1	-1	
		50.3	21.3	28.2	26.6	32.6	21.7	49.4	36.5	
	L_p in (A-Weighted)	50	21	28	27	33	22	49	36	
		dBA(125-2kHz)	**35.1**							