Report for:

Motor Fuel Group

Banbury Oil Depot

Noise and Vibration Assessment

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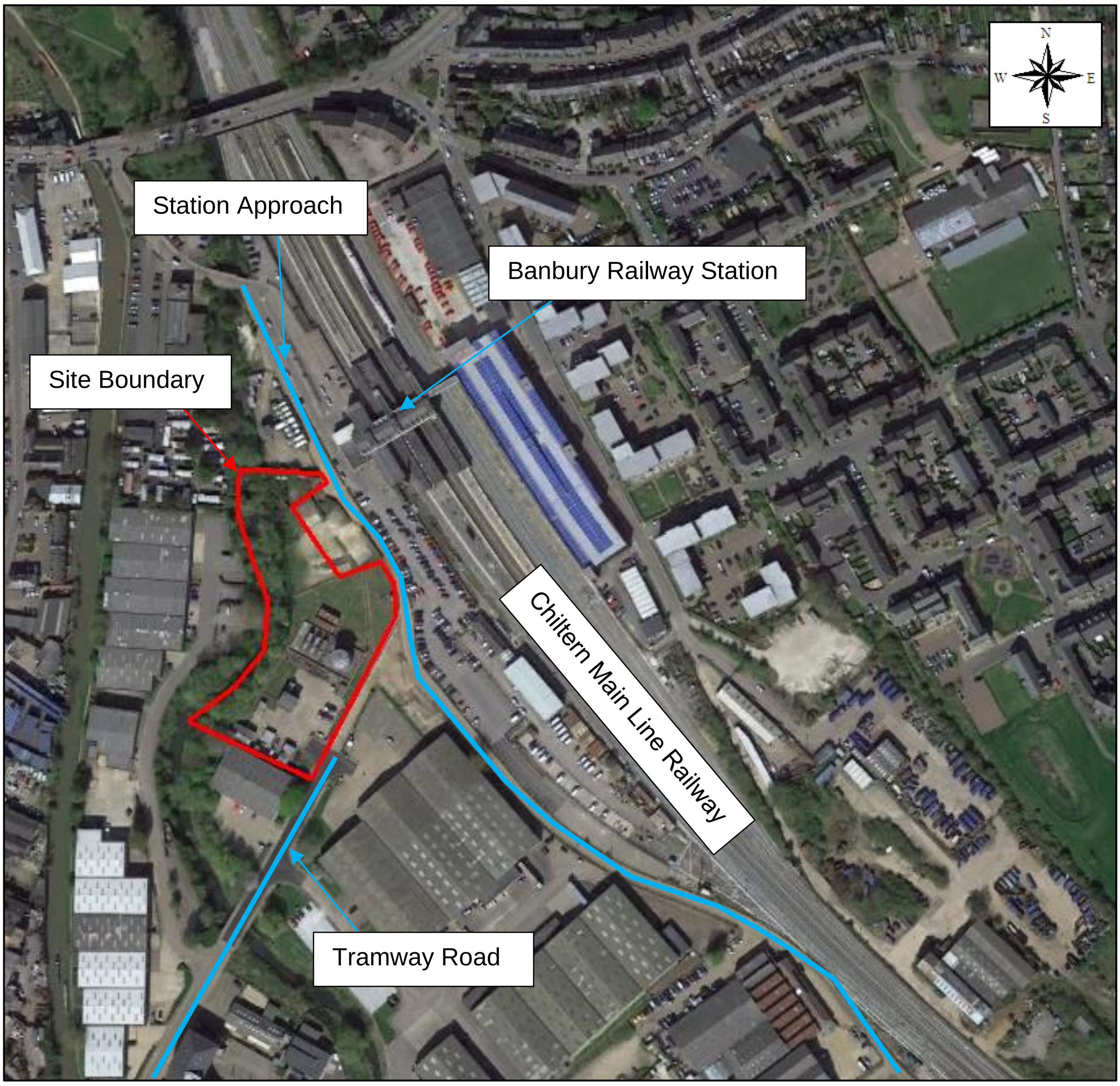
1. INTRODUCTION

ACCON UK Limited (ACCON) has been commissioned by The Motor Fuel Group to carry out a noise and vibration assessment for the proposed residential development on the site of the existing Banbury Oil Depot. The noise and vibration assessment is required to support an outline planning application for a residential development of up to 143 units in buildings of four to six storeys in height with vehicular access from Tramway Road. Part of the development will comprise up to 166 m^2 community, retail and/or commercial uses.

The site is located within the administrative boundary of Cherwell District Council (CDC). A site location plan is presented in **Figure 1.1**.

Figure 1.1: Site Location



The site is located on the edge of Banbury Town Centre and is approximately 30 m to the west of the Banbury Railway Station. The site forms part of the strategic allocation within Planning Policy Banbury 1 Canalside Regeneration (BAN1) of the Cherwell Local Plan 2011-

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2031 (adopted July 2015). Currently the site is located within an existing commercial and industrial area. The site is bounded to the east by Station Approach and to the south-east by Tramway Road. There are proposals to open the link between Tramway Road and Station Approach to reroute current traffic using Station Approach via the new link with Tramway Road. Station Approach is currently used by vehicles accessing commercial units and the Banbury FC football ground approximately 200 m to the south-east of the site. With the opened link between Tramway Road and Station Approach, the section of Station Approach immediately adjacent to the site would only be accessible by buses and taxis serving Banbury Railway Station.

The noise and vibration assessment is required to determine the impact of existing noise and vibration sources on the proposed development.

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2. THE NATURE, MEASUREMENT AND EFFECT OF NOISE

Noise is often defined as sound that is undesired by the recipient. Whilst it is impossible to measure nuisance caused by noise directly, it is possible to characterise the loudness of that noise. 'Loudness' is related to both sound pressure and frequency, both of which can be measured. The human ear is sensitive to a wide range of sound levels. The sound pressure level of the threshold of pain is over a million times that of the quietest audible sound. In order to reduce the relative magnitudes of the numbers involved, a logarithmic scale of decibels (dB) is normally used, based on a reference level of the lowest audible sound.

The response of the human ear is not constant over all frequencies. It is therefore usual to weight the measured frequencies to approximate the human response. The resulting 'A' weighted decibel, dB (A), has been shown to correlate closely to the subjective human response.

When related to changes in noise, a change of ten decibels, for example, from 60 dB(A) to 70 dB(A), would represent a doubling in 'loudness'. Similarly, a decrease in noise, for example, from 70 dB(A) to 60 dB(A), would represent a halving in 'loudness'. A change of 3 dB(A) is generally considered to be just perceptible[1]. **Table 2.1** details typical noise levels.

Table 2.1: Typical Noise Levels

Approximate Noise Level (dB(A))	Example
0	Limit of hearing
30	Rural area at night
40	Library
50	Quiet office
60	Normal conversation at 1 m
70	In car noise without radio
80	Household vacuum cleaner at 1 m
100	Pneumatic drill at 1 m
120	Threshold of pain

A glossary of acoustic terminology is provided in **Appendix 1**.

[1] Institute of Environmental Management and Assessment (2014). Guidelines for environmental noise impact assessment.

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3. NOISE ASSESSMENT CRITERIA

3.1. National Planning Policy Framework

The revised National Planning Policy Framework (NPPF, February 2019 as amended in June 2019) supersedes the 2012 and 2018 versions of the NPPF. The purpose of the planning system is to contribute to the achievement of sustainable development. There are three dimensions to sustainable development: economic, social and environmental. The environmental role is to contribute to protecting and enhancing our natural, built and historic environment; and as part of this, make effective use of land, help to improve biodiversity, use natural resources prudently, minimise waste and pollution, and mitigate to adapt to climate change including moving to a low carbon economy.

One of the core planning principles is to contribute to conserving and enhancing the natural environment and reducing pollution. Allocations of land for development should prefer land of lesser value, where consistent with other policies in the Framework. The planning system should contribute to and enhance the natural and local environment by 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, air, water or noise pollution or land instability.

Paragraph 180 of the NPPF states:

"*Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:*

a) Mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life (see Explanatory Note to the Noise Policy Statement for England (Department for Environment, Food and Rural Affairs, 2010));

b) Identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason."

Additionally, Paragraph 182 states:

"*Planning policies and decisions should ensure that new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on new development (including changes of use) in its vicinity, the applicant (or 'agent of change') should be required to provide suitable mitigation before the development has been completed.*"

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3.2. Noise Policy Statement for England

The Noise Policy Statement for England (NPSE) aims to "*through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:*

- *Avoid significant adverse impacts on health and quality of life;*
- *Mitigate and minimise adverse impacts on health and quality of life; and*
- *Where possible, contribute to the improvement of health and quality of life*".

Based on concepts from toxicology, it introduces three 'Effect Levels' relevant to the assessment of noise. These are:

- NOEL: No Observed Effect Level: This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise;
- LOAEL: Lowest Observed Adverse Effect Level: This is the level above which adverse effects on health and quality of life can be detected; and
- SOAEL: Significant Observed Adverse Effect Level: This is the level above which significant adverse effects on health and quality of life occur.

3.3. Planning Practice Guidance

The Planning Practice Guidance for Noise (PPG-N) was published in March 2014 and most recently updated in July 2019. The PPG-N suggests that the most appropriate and cost-effective solutions to potential noise issues are best identified when good acoustic design is considered early in the planning process.

The PPG-N provides the following advice on how to determine the noise impact on development:

"*Plan-making and decision making need to take account of the acoustic environment and in doing so consider:*

- *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.*

In line with the Explanatory Note of the Noise Policy Statement for England, this would include identifying whether the overall effect of the noise exposure (including the impact during the construction phase wherever applicable) is, or would be, above or below the significant observed adverse effect level and the lowest observed adverse effect level for the given situation. As noise is a complex technical issue, it may be appropriate to seek experienced specialist assistance when applying this policy." (Paragraph 003 Reference ID 30-003-20190722)

The document goes on to acknowledge the levels of noise exposure at which an effect may occur as provided in the NPSE and introduces a fourth effect level:

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- UAE: Unacceptable Adverse Effect: Extensive and regular changes in behaviour and/or an inability to mitigate the effect of noise lead to psychological stress or physical effects.

It is important to understand that as the PPG-N does not specifically provide any advice with respect to noise levels/limits for different sources of noise, it is appropriate to consider other sources of advice and guidance documents when considering whether new developments would be sensitive to the prevailing acoustic environment and the PPG-N signposts a number of appropriate guidance documents.

3.4. Cherwell District Council

ACCON contacted the Environmental Health and Licensing Department at CDC to discuss the proposed noise and vibration assessment methodology. The proposed assessment methodology included:

- A detailed noise and vibration measurement survey over a minimum period of 24-hours;
- A review of working timetables and actual train movements in order to address any significant reduction in train services as a result of the Covid-19 pandemic;
- The use of a CadnaA noise model and the *Professional Practice Guidance on Planning and Noise: New Residential Development* to assess railway noise;
- An assessment of train-induced vibration on the proposed development site using British Standard 6472-1:2008.

In addition, it was noted that the site is located within an existing commercial area and whilst the wider aim for the area is regeneration, it may be some time before immediately adjacent commercial and industrial sites are redeveloped. Therefore, a review of noise generating activities in the immediate area was proposed and, where necessary, assessment carried out in line with British Standard 4142:2014+A1:2019.

Neil Whitton, Environmental Health Officer, responded via email on 10th August 2020 in general agreement of the proposed methodology. The following additional items were noted and have been considered in the assessment where information is available:

- Plans to open up Tramway Road for buses and taxis which may impact road traffic noise levels at the site;
- The large number of freight services on the railway line overnight.

3.5. Noise Guidance

3.5.1. Professional Practice Guidance on Planning and Noise: New Residential Development

The Professional Practice Guidance (ProPG) on Planning and Noise for New Residential Development was published in May 2017 and was produced to provide practitioners with guidance on a recommended approach to the management of noise within the planning system in England.

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The recommended approach detailed in the ProPG includes a framework to enable situations where noise is not an issue to be clearly determined, and to help identify the extent of risk at noisier sites. The recommended approach provides opportunities to incorporate effective design interventions that will enable residential development to proceed in areas that might otherwise have been considered unsuitable.

The ProPG provides advice for Local Planning Authorities and developers, and their respective professional advisers. It aims to complement Government planning and noise policy and guidance. In particular, it strives to:

- Advocate full consideration of the acoustic environment from the earliest possible stage of the development control process;
- Encourage the process of good acoustic design in and around new residential developments;
- Outline what should be taken into account in deciding planning applications for new noise-sensitive developments;
- Improve understanding of how to determine the extent of potential noise impact and effect; and
- Assist the delivery of sustainable development.

The two sequential stages of the recommended approach are:

- Stage 1: an initial noise risk assessment of the proposed development site; and
- Stage 2: a systematic consideration of four key elements.

The four key elements to be undertaken in parallel during Stage 2 of the recommended approach are:

- Element 1: demonstrating a “Good Acoustic Design Process”;
- Element 2: observing internal “Noise Level Guidelines”;
- Element 3: undertaking an “External Amenity Noise Assessment”; and
- Element 4: consideration of “Other Relevant Issues”.

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Figure 3.1 below identifies the guidance given in the ProPG when undertaking the risk assessment stage for a site.

Figure 3.1: Phase 1 – Noise Risk Assessment

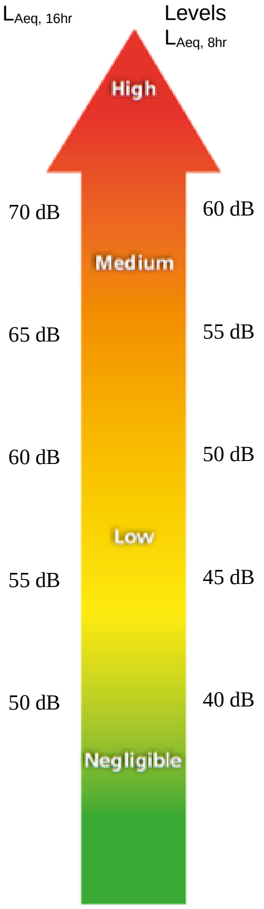
<table>
<tr><th>Noise Risk Assessment</th><th>Potential Effect Without Noise Mitigation</th><th>Pre-Planning Application Advice</th></tr>
<tr><td rowspan="4">Indicative Daytime Noise Levels $L_{Aeq, 16hr}$
Indicative Night-time Noise Levels $L_{Aeq, 8hr}$

</td><td rowspan="3">Increasing risk of adverse effect</td><td>High noise levels indicate that there is an increased risk that development may be refused on noise grounds. This risk may be reduced by following a good acoustic design process that is demonstrated in a detailed ADS. Applicants are strongly advised to seek expert advice.</td></tr>
<tr><td>As noise levels increase, the site is likely to be less suitable from a noise perspective and any subsequent application may be refused unless a good acoustic design process is followed and is demonstrated in an ADS which confirms how the adverse impacts of noise will be mitigated and minimised, and which clearly demonstrates that a significant adverse noise impact will be avoided in the finished development.</td></tr>
<tr><td>At low noise levels, the site is likely to be acceptable from a noise perspective provided that a good acoustic design process is followed and is demonstrated in an ADS which confirms how the adverse impacts of noise will be mitigated and minimised in the finished development.</td></tr>
<tr><td>No adverse effect</td><td>These noise levels indicate that the development site is likely to be acceptable from a noise perspective, and the application need not normally be delayed on noise grounds.</td></tr>
<tr><td colspan="3">Notes:
1. Indicative noise levels should be assessed without inclusion of the acoustic effect of any scheme specific noise mitigation measures.
2. Indicative noise levels are the combined free-field noise levels from all sources of transport noise and may also include industrial/commercial noise where this is present but is “not dominant”.
3. $L_{Aeq, 16hr}$ is for daytime 0700 - 2300, $L_{Aeq, 8hr}$ is for night-time 2300 - 0700.
4. An indication that there may be more than 10 noise events at night (2300 - 0700) with L_{AFmax} > 60 dB means the site should not be regarded as negligible risk.</td></tr>
</table>

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Table 3.1 below identifies the internal noise level criteria provided in the ProPG.

Table 3.1: ProPG Noise Levels

Activity	Location	0700-2300 Hours	2300-0700 Hours
Resting	Living room	35 dB $L_{Aeq,16hr}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16hr}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hr}$	30 dB $L_{Aeq,8hr}$ 45 dB L_{AFmax} Note 4

Notes:

1. The Table provides recommended internal L_{Aeq} target levels for overall noise in the design of a building. These are the sum total of structure-borne and airborne noise sources. Ground-borne noise is assessed separately and is not included as part of these targets, as human response to ground-borne noise varies with many factors such as level, character, timing, occupant expectation and sensitivity.
2. The internal L_{Aeq} target levels shown in the Table are based on the existing guidelines issued by the WHO and assume normal diurnal fluctuations in external noise. In cases where local conditions do not follow a typical diurnal pattern, for example on a road serving a port with high levels of traffic at certain times of the night, an appropriate alternative period, e.g. 1 hour, may be used, but the level should be selected to ensure consistency with the internal L_{Aeq} target levels recommended in the Table.
3. These internal L_{Aeq} target levels are based on annual average data and do not have to be achieved in all circumstances. For example, it is normal to exclude occasional events, such as fireworks night or New Year's Eve.
4. Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or L_{AFmax}, depending on the character and number of events per night. Sporadic noise events could require separate values. In most circumstances in noise sensitive rooms at night (e.g. bedrooms) good acoustic design can be used so that individual noise events do not normally exceed 45dB L_{AFmax} more than 10 times a night. However, where it is not reasonably practicable to achieve this guideline then the judgement of acceptability will depend not only on the maximum noise levels but also on factors such as the source, number, distribution, predictability and regularity of noise events (see Appendix A).
5. Designing the site layout and the dwellings so that the internal target levels can be achieved with open windows in as many properties as possible demonstrates good acoustic design. Where it is not possible to meet internal target levels with windows open, internal noise levels can be assessed with windows closed, however any façade openings used to provide whole dwelling ventilation (e.g. trickle ventilators) should be assessed in the "open" position and, in this scenario, the internal L_{Aeq} target levels should not normally be exceeded, subject to the further advice in Note 7.
6. Attention is drawn to the requirements of the Building Regulations.
7. Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal L_{Aeq} target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved. The more often internal L_{Aeq} levels start to exceed the internal L_{Aeq} target levels by more than 5 dB, the more that most people are likely to regard them as "unreasonable". Where such exceedances are predicted, applicants should be required to show how the relevant number of rooms affected has been kept to a minimum. Once internal L_{Aeq} levels exceed the target levels by more than 10 dB, they are highly likely to be regarded as "unacceptable" by most people, particularly if such levels occur more than occasionally. Every effort should be made to avoid relevant rooms experiencing "unacceptable" noise levels at all and where such levels are likely to occur frequently, the development should be prevented in its proposed form (**see Section 3.D**).

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3.5.2. British Standard BS 8233:2014

BS 8233 *Guidance on sound insulation and noise reduction for buildings* has a number of design criteria for intrusive external noise without a specific character. The guidelines are designed to achieve reasonable resting/sleeping conditions in bedrooms and good listening conditions in other rooms. The most appropriate noise levels (Table 4 of the BS) for the residential environment are reproduced in **Table 3.2**.

Table 3.2: Indoor Ambient Noise Levels for Dwellings

Activity	Location	Daytime 0700 hrs to 2300 hrs	Night-time 2300 hrs to 0700 hrs
Resting	Living room	35 dB $L_{Aeq,16hr}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16hr}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hr}$	30 dB $L_{Aeq,8hr}$

Although there are no limits set for external noise levels in BS 8233 the following guidance is provided at paragraph 7.7.3.2:

"*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.*"

3.6. Vibration Guidance

3.6.1. British Standard 6472-1:2008

BS 6472 Part 1:2008 *Guide to evaluation of human exposure to vibration in buildings Part 1 Vibration sources other than blasting* is the British Standard methodology used for measuring and evaluating human exposure to vibration from sources such as railways. **Table 3.3** below summarises the levels of vibration dose values (VDV) and the corresponding probability of adverse comments arising in respect of human exposure within buildings.

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Table 3.3: BS 6472-1 Vibration dose values which might result in various probabilities of adverse comment within residential buildings

Place and Time	Low probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Residential buildings – 16 hour day	0.2 – 0.4	0.4 – 0.8	0.8 – 1.6
Residential buildings – 8 hour night	0.1 – 0.2	0.2 – 0.4	0.4 – 0.8

3.7. Target Noise and Vibration Levels

3.7.1. External Noise Levels

External amenity areas should ideally achieve noise levels not exceeding the upper guideline noise level (BS 8233) of 55 dB $L_{Aeq, 16hr}$. Where noise levels exceed this upper guideline noise level, appropriate noise mitigation measures will be incorporated into the design to reduce the noise levels as far as reasonably practicable.

3.7.2. Internal Noise Levels

The target internal period noise levels in habitable rooms are 35 dB $L_{Aeq, 16hr}$ during the daytime and 30 dB $L_{Aeq, 8hr}$ during the night-time. Additionally, maximum noise levels should not normally exceed 45 dB L_{AFmax} more than ten times a night within bedrooms.

3.7.3. Internal Vibration Levels

In accordance with the guidance in BS 6472-1, the design aim is to minimise the possibility of adverse comment such that the probability is low (0.2 to 0.4 $m/s^{1.75}$ or less during the daytime and 0.1 to 0.2 $m/s^{1.75}$ or less during the night-time).

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4. NOISE AND VIBRATION MEASUREMENT SURVERYS

4.1. Noise Measurement Survey

A detailed noise measurement survey was carried out at the site in order to determine the extent to which the site is currently affected by noise from road traffic, railway movements and existing commercial uses. Measurements were carried out in order to characterise the existing noise climate over a 24-hour period. The noise measurements were carried out between 0930 hrs on Tuesday 22nd September 2020 and 1230 hrs Wednesday 23rd September 2020 at two semi-permanent noise monitoring positions.

The weather conditions recorded during the daytime on Tuesday 22nd September 2020 were dry with no cloud cover. There was a north easterly wind with speeds of less than 1 m/s and a temperature of 21°C was recorded. The weather conditions recorded on Wednesday 23rd September 2020 included 100% cloud cover and the site was wet underfoot due to light drizzle in the morning. There was a north easterly wind with speeds of up to 2 m/s and a temperature of 17°C was recorded. The light drizzle was not sufficient to result in a noticeable change in noise level when compared against those periods of time prior to the commencement of these wet weather conditions and there was also no noticeable change in recorded vibration levels. These weather conditions were considered suitable for the noise survey.

4.1.1. Semi-Permanent Noise Measurements

The semi-permanent noise measurements utilised two Class 1 Sound Level Meters: a Svantek 971 and a Rion NL-52. Both of these meters hold current certificates of calibration, which are available upon request. The equipment was field calibrated before and after the measurement period to ensure that it had remained within reasonable calibration limits (±0.5 dB).

Measurement Position 1 (MP1) was located at a height of approximately 1.5 m in a free-field position on the eastern boundary of the site, 3 m south-west of Station Approach. This position was dominated by railway noise and delivery vehicles (light good vehicles) on Station Approach. Distant aircraft was also audible.

Measurement Position 2 (MP2) was located at a height of approximately 1.5 m in a free-field position near the western boundary of the proposed development site. The position was approximately 52 m south-west of Station Approach and was dominated by delivery vehicles on Station Approach, however, railway noise and aircraft was also audible.

The locations of the noise measurement positions can be identified in **Figure F.1**.

The daytime and night-time free-field noise levels measured at MP1 and MP2 are summarised in **Table 4.1**. The detailed noise measurement results are presented in **Appendix 2**.

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Table 4.1: Summary of Free-Field Noise Levels from Semi-Permanent Noise Monitoring

Measurement Position	Period (hours)	$L_{Aeq,T}$ (dB)	L_{AFmax} (dB)	Average $L_{A10,5min}$ (dB)	Average $L_{A90,5min}$ (dB)
MP1	Daytime (0700 hrs – 2300 hrs)	54	80	54	45
	Night-time (2300 hrs – 0700 hrs)	55	74[1]	49	39
MP2	Daytime (0700 hrs – 2300 hrs)	49	72	49	43
	Night-time (2300 hrs – 0700 hrs)	48	67	46	37

Note: The noise measurements were carried out over consecutive five-minute periods. The $L_{Aeq,5min}$ was subsequently logarithmically averaged over the time periods indicated in **Table 4.1**, the Average $L_{A10,5min}$, and Average $L_{A90,5min}$ were arithmetically averaged and the L_{AFmax} is the tenth highest measured noise level in each time period.
Note 1: Bird song events have been removed from night-time L_{AFmax} noise levels measured at MP1

It can be identified in **Table 4.1** that the daytime and night-time $L_{Aeq,T}$ noise levels are similar with the night-time noise levels marginally higher than the daytime. During the period of 2230 to 2330 hrs there was a diesel train engine idling at Banbury Railway Station. Additionally, whilst passenger train services reduce during the night-time, there are an increased number of freight services which pass through Banbury Railway Station at night and there is also likely to be some level of maintenance activities (i.e. internal cleaning, warming up engines and systems checks) if trains end or start their period of service at Banbury Station.

After 2130 hrs road traffic noise levels along Tramway Road increased along with speech from pedestrians. This coincides with the end of a football match which took place at the Banbury United Football Club from 1945 hrs. Football matches/training sessions are likely to take place 1-2 evenings a week plus events on both Saturday and Sunday between approximately 1000 hrs and 1700 hrs[2].

ACCON carried out a review of noise generated by adjacent commercial units with no significant noise sources noted and therefore no further assessment of commercial and industrial noise has been carried out.

4.2. Vibration Measurement Survey

A detailed vibration measurement survey has also been carried out at the site in order to determine the extent to which the site is currently affected by vibration from railway movements. The vibration measurements were carried out between 1010 hrs on Tuesday

[2] https://www.banburyunitedfc.co.uk/calendar Accessed 28th October 2020

22nd September 2020 and 1225 hrs on Wednesday 23rd September 2020 at one semi-permanent vibration monitoring position and two satellite vibration monitoring positions.

4.2.1. Semi-Permanent Vibration Measurements

Semi-permanent vibration measurements were carried out between 1225 hrs on Tuesday 22nd September 2020 and 1225 hrs on Wednesday 23rd September 2020. A Svantek SV106 vibration meter was utilised with a PCB tri-axial accelerometer. The meter was set to measure for consecutive one-minute periods over the 24-hour period.

The semi-permanent vibration measurement position was located at MP1, approximately 38 m from the nearest railway track. The accelerometer was mounted on a metal plate on the ground in accordance with ISO 14837-1:2005 *Mechanical vibration – Ground-borne noise and vibration arising from rail systems – Part 1 General guidance*. The mounting plate (DIN plate) meets the requirements identified in the DIN Standard 45669-2:2005. The x-axis was horizontal and parallel to the railway line and the y-axis of the accelerometer was positioned horizontally and perpendicular to the railway line. The z-axis of the accelerometer measured the vertical vibration levels.

The total VDV levels for each direction of motion (x, y and z) during the daytime and night-time periods are presented in **Table 4.2**. The total VDV levels have been calculated utilising Equation 3 of BS 6472-1 where the fourth root is taken of the sum of the fourth power of each one-minute measurement to obtain the total VDV.

Table 4.2: Total VDV in Each Direction for Daytime and Night-time Periods at MP1

Period (Hours)	Total Calculated Vibration Dose Value (VDV, $m/s^{1.75}$) in each Axis		
	x	y	z
Daytime (0700 hrs – 2300 hrs)	0.09	0.25	0.08
Night-time (2300 hrs – 0700 hrs)	0.03	0.04	0.05

Vibration levels in the y-axis measured during the daytime are higher than all other directions and periods. The higher recorded level is due to existing vehicle movements over a speed bump close to the measurement position on Station Approach.

4.2.2. Short-term Attended Vibration Measurements

Satellite vibration measurements were obtained at MP3 and MP4 on Tuesday 22nd September 2020. MP3 was positioned 10 m east of MP1 and MP4 was positioned 20 m East of MP1. The locations of the noise measurement positions can be identified in **Figure F.1**.

For all satellite vibration measurements, the x-axis was horizontal and parallel to the railway line and the y-axis of the accelerometer was positioned horizontally and perpendicular to the railway line. The z-axis of the accelerometer recorded the vertical vibration levels.

Table 4.4 presents the measured VDVs at MP3 and MP4 in all three directions.

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Table 4.3: Total VDV in Each Direction at Satellite Vibration Measurement Positions

Measurement Position	Period (Hours)	Total Measured Vibration Dose Value (VDV, $m/s^{1.75}$) in each Axis		
		x	y	z
MP3	1000 hrs – 1100 hrs	0.03	0.08	0.02
MP4	1100 hrs – 1200 hrs	0.05	0.13	0.03

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5. NOISE IMPACT ASSESSMENT

5.1. Noise Modelling

The CadnaA noise modelling software has been utilised to calculate the external noise levels from road traffic and railway movements at the proposed development site. CadnaA is a three-dimensional noise model developed by DataKustik and has been extensively used by ACCON and others to develop noise models for a wide variety of situations and noise sources. CadnaA utilises the methodology in the Department of Transport's Technical Memorandum *'Calculation of Road Traffic Noise'* (CRTN) to predict the noise levels from road traffic and the Technical Memorandum *'Calculation of Railway Noise'* (CRN) to predict the noise levels from railway lines.

The results of the noise measurement survey detailed in **Section 4** have been utilised to calibrate the noise model predictions of the existing site. A review of the Network Rail working timetable against the timetable in place at the time of the noise measurement survey did not identify a significant reduction in train services such that the noise generated by movements on the railway line would result in a noticeable reduction in noise levels at the site.

5.1.1. Road Traffic Data for Tramway Road

Traffic data has been received from David Tucker Associates for Tramway Road for the year 2025 with and without the proposed development. The 2025 'with development' traffic data has been included within the noise model. Detailed road traffic data for the new junction between Tramway Road and Station Approach has not been provided.

5.2. ProPG Stage 1: Initial Site Noise Risk Assessment

Figure F.2 presents the daytime and night-time ($L_{Aeq, T}$) noise contours for the site at ground floor level (a height of 1.5 m). **Figure F.3** presents the daytime and night-time ($L_{Aeq, T}$) noise contours at third floor level (a height of approximately 10.5 m). **Figure F.4** presents the daytime and night-time ($L_{Aeq, T}$) noise contours at fifth floor level (a height of approximately 16.5 m).

For the purpose of the initial site noise risk assessment, it has been assumed that the site topography will not be significantly altered from the current topography. Existing and proposed buildings on the site are excluded from the initial site noise risk assessment.

Figure F.2 indicates that the site, at ground floor level, is generally of a negligible to low risk of adverse noise effect during the daytime period. During the night-time, the site is generally of a low to medium risk of adverse noise effect with the areas of greatest risk closest to the railway line and Tramway Road.

Figure F.3 indicates that the site, at third-floor level, is generally of a low risk of adverse noise effect during the daytime period. During the night-time, the site is generally of a low to medium risk of adverse noise effect with the areas of greatest risk closest to the railway line.

Figure F.4 indicates that the site, at fifth-floor level, is generally of a low risk of adverse noise effect during the daytime period. During the night-time, the site is generally of a low to medium risk of adverse noise effect with the areas of greatest risk closest to the railway line.

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The maximum noise levels measured at MP1, overlooking the railway line, are noted to exceed 60 dB L_{AFmax} more than ten times during the night-time period. Based on the measured railway noise levels and typical frequency of night-time trains (established from Real Time Trains[3]), the risk of a noise effect due to train movements on the railway line during the night-time is increased to *high* for those areas of the site which are closest to the railway line.

5.3. ProPG Stage 2: Noise Assessment

The assessment is based on the Illustrative Masterplan, drawing number P03 (March 2021) prepared by Edge Urban Design (**Figure F.5**).

5.3.1. External Noise Levels

The daytime external noise levels ($L_{Aeq, 16hr}$) predicted using the CadnaA noise model have been compared against the target external noise level range of 50 dB to 55 dB $L_{Aeq, 16hr}$ within amenity areas. Amenity areas could include communal garden areas, play areas, private balconies and terraces, however, only .

Table 5.1 below, identifies the daytime external noise levels for amenity spaces. The amenity space receptors are identified in **Figure F.5** to represent private balconies for each façade of the proposed development.

Table 5.1 External Amenity Area Noise Levels

Receptor	Block	Façade	External Noise Level $L_{Aeq,16hr}$ (dB)	Within or Below Target Noise Level Range?
R1	A	East	57 - 58	X
R2	A	South	47 – 48	✓
R3	A	West	42 – 46	✓
R4	A	North	42 – 47	✓
R5	B	West	43 – 45	✓
R6	B	North	52 – 53	✓
R7	B	East	60 – 61	X
R8	B	South	56 -57	X
R9	C	South	51 – 52	✓
R10 – R11	C/D	West	42 - 46	✓

[3] https://www.realtimetrains.co.uk/search/advanced Accessed 29th September 2020

Receptor	Block	Façade	External Noise Level $L_{Aeq,16hr}$ (dB)	Within or Below Target Noise Level Range?
R12 – R13	C/D	East	56 - 59	X
R14	C	North	46 - 49	✓
R15	D	West	39 – 44	✓
R16	D	North	50 - 51	✓
R17 – R18	D	East	55	✓
R19	D	East	55 - 56	X
R20	D	South	41 - 44	✓
R21	E	West	43 - 47	✓
R22	E	North	50 - 52	✓
R23	E	East	53	✓
R24	E	South	48 - 49	✓
Green Amenity Space	Rear of Block E	-	47	✓
Riverside Walkway Platform	Rear of Block A	-	42	✓

It can be identified in **Table 5.1** that balconies and terraces which have direct line of sight to the railway track or Tramway Road are unlikely to be within the target noise level range. Balconies on other facades should experience noise levels below 55 dB $L_{Aeq,\ 16hr}$.

A 1-2 dB noise reduction may be achievable by providing solid balustrades to the worst-affected balconies. It is also recommended, where possible, that acoustically absorptive materials are provided to the soffit of balconies to reduce reflections of noise within balconies below. However, noise levels in the worst-affected balconies (generally any which overlook Tramway Road) are likely to remain above the upper target noise level of 55 dB $L_{Aeq,\ 16hr}$ without being fully enclosed.

It should be noted that the residents of flats with balconies on noisier facades also have access to quieter communal areas of the site, such as the green amenity space located immediately to the rear (west) of the Block E as well as the proposed Riverside Walkway and associated platforms. Noise levels to the west of the proposed buildings should readily achieve the target of 50 dB to 55 dB $L_{Aeq,16hr}$ or lower, as demonstrated in **Table 5.1**.

It is concluded that, for the relatively few balconies which will exceed the upper target external noise level, these exceedances are not unreasonable as residents will also have access to larger communal spaces for external amenity within a very short walk of their residence.

5.3.2. Internal Noise Levels

BS 8233 states the *“if partially open windows were relied upon for background ventilation, the insulation would be reduced to approximately 15 dB”*. The WHO guidelines also state that *“a slightly open window would result in a [sound] reduction from outside to inside of 15 dB”*.

The receivers of the proposed buildings have been labelled R1 to R24 for ease of description: this naming convention can be identified in **Figure F.5**.

The highest predicted noise levels will occur at façades of the proposed development which overlook the railway line and Tramway Road. Where possible, single aspect units which only have windows to habitable rooms on a façade overlooking the railway line or Tramway Road should be avoided.

The highest predicted noise levels will be as a result of maximum noise levels (L_{AFmax}), the tenth highest measured L_{AFMax} noise level at MP1 was 74 dB. Accounting for marginal differences in distance from the railway line using a point source correction, the maximum noise levels predicted at R17, R18 (Block D) and R23 (Block E) are approximately 74 dB. With open windows for ventilation, the target maximum noise level of 45 dB L_{AFmax} would be exceeded. Residential units are likely to require a combined building façade sound insulation of 29 dB(A) to achieve the target internal noise levels.

Applying the same assessment of maximum noise levels to receptors R19 and R24, the predicted maximum noise levels at these facades are 73 dB L_{AFmax}. A combined building façade sound reduction of 28 dB(A) would be required for units with windows in these facades. At R13, the predicted maximum noise levels at this façade is 72 dB L_{AFmax}. A combined building façade sound reduction of 27 dB(A) would be required for units with windows in this façade. At R1, R6, R7, R12 and R14 the predicted maximum noise levels are up to 71 dB L_{AFmax}. A combined building façade sound reduction of up to 26 dB(A) would be required for units with windows in these façades.

All façades which do not overlook or have direct line of sight to the railway line are predicted to experience daytime external noise levels which are unlikely to exceed 50 dB $L_{Aeq,16hr}$, night-time external noise levels which are unlikely to exceed 45 dB $L_{Aeq,8hr}$ externally and maximum external noise levels which are unlikely to exceed 60 dB L_{AFmax}. Therefore, no specific acoustic mitigation measures are likely to be required to habitable rooms with windows in these façades.

Glazing

It is assumed that the external wall construction of the buildings will achieve a sound reduction of at least 50 dB R_w. This level of sound reduction would normally be readily achieved by a brick and block cavity construction, for example. As a result, the glazing and any ventilation openings would be considered to be the weakest acoustic elements of the building façade.

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A sound reduction of up to 28 dB(A) should be achievable through the provision of a typical double-glazed window system (i.e. in a 4 mm glass, 6 mm to 16 mm air gap, 6 mm glass formation).

A sound reduction of up to 29 dB(A) could be achievable with glazing in a 10 mm glass, 6 mm to 16 mm air gap, 4 mm glass formation, or similar.

Figure F.5 identifies the level of sound reduction required to each façade of the buildings identified in the Illustrative Masterplan.

Acoustics, Ventilation and Overheating

Whole dwelling ventilation, which is defined in Approved Document F *Ventilation: F1: Means of ventilation* (ADF) as the dilution and removal of pollutants and water vapour, should be achievable through the provision of acoustic trickle ventilators, acoustically treated through-wall ventilators or mechanical means of whole house ventilation.

Open windows are required by the Building Regulations for purge ventilation and are otherwise a form of overheating mitigation during warmer months of the year.

ADF sets out four ventilation systems which can achieve the relevant rates of whole dwelling and extract ventilation:

- System 1: Trickle/background ventilators and intermittent extract fans
- System 2: Trickle/background ventilators and passive stack ventilation
- System 3: Trickle vents for inlet air, continuous mechanical extract
- System 4: Continuous supply and extract (i.e. mechanical ventilation with heat recovery: MVHR).

Ventilation designed in accordance with Systems 3 and 4 is generally recommended for flats to achieve the relevant whole-dwelling ventilation rates. However, with windows open for additional ventilation or comfort cooling the internal noise conditions are not considered to be unreasonable where habitable rooms do not overlook the railway line or Tramway Road.

For habitable rooms at the majority of façades of the proposed blocks, daytime internal noise levels with open windows for ventilation should not exceed 5 dB greater than the target noise level of 35 dB $L_{Aeq,16hr}$. With reference to **Table 3.1** Note 7, this should not be considered unreasonable for daytime internal noise conditions. A small number of receptors are likely to experience higher noise levels during the daytime: R1 (Block A), R7 and R8 (Block B), R12 (Block C), R13 (Block C/D), and R19 (Block D). In most cases, the exceedance of the target internal noise level is less than 10 dB(A) and, depending on the duration of time that windows may need to be open, should not be considered unreasonable.

During the night-time, noise levels are marginally higher than the daytime due to the frequency of freight train services, train maintenance activities and idling train engines on the railway line. Night-time period noise levels with windows open are likely to exceed the target internal noise level by more than 10 dB(A) in the area closest to the railway line. L_{AFmax} noise levels with windows open are likely to exceed the target internal noise level by up to 14 dB(A) in the area closest to the railway line. This generally applies to façade receptors R1 (Block

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A), R7 (Block B), R12 (Block C), R13, (Block C/D), R17, R18 and R19 (Block D) and R23 (Block E). Residential units with habitable rooms, particularly bedrooms, with windows in these façades may require further assessment of the overheating and acoustic effects to ensure that there will be appropriate means of ventilation provided. All other façades are predicted to experience reasonable internal noise conditions when windows are open for ventilation and overheating mitigation during the night-time.

It is not envisaged that overheating effects will be significant for this site or for the units closest to the railway line, however, the following recommendations are provided and should be incorporated into the detailed design where possible:

- Avoid single aspect flats that overlook the railway line, where practicable;
- Minimise the number of bedrooms, as far as practicable, which overlook the railway line.

Ideally, the development should be designed to ensure that residents have access to at least one relatively quiet façade so that windows on those façades can be opened during the night-time without experiencing unreasonable noise levels. However, for relatively short durations of time or a very small number of nights of the year, the highest predicted night-time internal noise levels (on those façades overlooking the railway line) are not considered to be unreasonable.

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6. VIBRATION ASSESSMENT

Vibration levels were measured externally on the ground approximately 38 m, 48 m and 58 m from the nearest railway tracks. As the vibration levels were measured in a free-field position on the ground, it is necessary to consider how this would translate into vibration within the proposed dwellings.

The Illustrative Masterplan identifies that the nearest proposed dwellings to the railway line could be located approximately 40 m from the railway line. Whilst vibration levels due to railway movements are likely to decrease with increasing distance from the source of vibration, the vibration levels at the foundations of the nearest proposed dwellings to the railway line would be similar to the measured vibration levels at MP1.

As the foundations of the building will resist motion from groundborne vibration, the motion of the building structure at base level will be lower than the measured vibration levels. Conversely, there would be some amplification up the structure of the nearest proposed buildings and potential increases in vibration due to floor resonances. As a result, the overall levels of vibration within the proposed dwellings will be lower than, or as a worst-case, approximately equal to the measured vibration levels[4].

Therefore, in order to assess the worst case, the measured vibration levels have been compared against the criteria in BS 6472-1 (summarised in **Table 3.3**). The results of the comparisons for the daytime and the night-time periods are presented in **Table 6.1**.

Table 6.1: Assessment of Daytime and Night-time Vibration Dose Values

Measurement Position	Period	Calculated/Measured VDV ($m/s^{1.75}$)			BS 6472 Residential Criterion
		x	y	z	
MP1	Daytime	0.09	0.25	0.08	*"Low probability of adverse comment*
	Night-time	0.03	0.04	0.05	Below "*Low probability of adverse comment*"

The higher vibration level measured in the y-direction during the daytime is the result of vehicles travelling along Station Approach and over a speed bump close to the measurement position.

With reference to **Table 6.1**, the assessment of the VDVs against the BS 6472-1 assessment criteria concludes that the vibration levels are within or below the *"low probability of adverse comment"* range. Therefore, vibration from the railway line should not result in a requirement for mitigation. As a result, no further analysis of the results for MP3 and MP4 has been carried out.

[4] The Association of Noise Consultants, ANC Guidelines, Measurement & Assessment of Groundborne Noise & Vibration 3rd Edition, Section 8.2.5 Transfer Functions

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7. ACOUSTIC DESIGN STATEMENT

An environmental noise and vibration measurement survey has been carried out at the site and a detailed noise model has been prepared for the proposed development.

7.1. ProPG Stage 1: Initial Site Noise Risk Assessment

The initial site noise risk assessment has identified that the site is of low risk of adverse noise effect during the daytime. During the night-time, the site is at a low to medium risk of adverse noise effect from railway movements with maximum noise levels placing those areas of the site closest to the railway line at high risk of adverse noise effect.

7.2. External Noise Levels

The assessment of external noise levels identifies that the majority of façades (where balconies may be the located) and the communal amenity spaces would generally experience noise levels within or below the target noise level range of 50 dB to 55 dB $L_{Aeq, 16hr}$.

Any proposed balconies which overlook Tramway Road and the railway line are predicted to exceed the upper target noise level. Solid balustrades and acoustic absorption to the underside of balconies would assist in reducing the noise levels in these amenity areas, however, the noise levels are likely to remain above 55 dB $L_{Aeq, 16hr}$ in the worst-affected areas which have a direct line of sight to the railway track. Residents will have access to communal amenity spaces to the west of the proposed buildings (Green Amenity Space and Riverside Walkway platforms) which are predicted to experience noise levels within or below the target noise level range. Therefore, it is considered that the noise levels on such balconies are acceptable when all other factors are considered.

7.3. Internal Noise Levels

It has been identified that the target internal noise levels would not be achieved in habitable rooms with open windows for ventilation where residential units overlook the railway lines or Tramway Road. With regards to Good Acoustic Design, it is recommended that single aspect flats which overlook the railway line are avoided and, where possible, the number of bedrooms which overlook the railway line are kept to a minimum.

Based on the Illustrative Masterplan, windows for habitable rooms which overlook the railway line and Tramway Road are likely to require a minimum sound reduction of 29 dB(A). Using open windows for overheating mitigation during the daytime and for relatively few numbers of nights should not be considered unreasonable. An alternative means of ventilation or other overheating mitigation may need to be considered to avoid the need to leave windows open for extended periods of time in the case of prolonged overheating effects. The level of sound reduction required reduces with increasing distance and screening from the railway line and Tramway Road and the suitability of open windows for ventilation increases.

Habitable rooms which do not have a line of sight to the railway line or Tramway Road are likely to achieve the target internal noise levels with open windows for ventilation and therefore are unlikely to require any specific acoustic mitigation measures.

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7.4. Vibration Levels

An assessment of the measured vibration levels identifies that vibration levels within a building in the area closest to the railway line are likely to fall within or below the BS 6472-1 *"low probably of adverse comment"* range. It is concluded that vibration mitigation measures are not required for this development.

7.5. Recommendations to the Decision Maker

On the basis of the above, it is recommended that there should be no objection to granting outline planning consent for the proposed development on noise and vibration grounds.

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ADDITIONAL FIGURES

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Figure F.1: Noise Measurement Positions

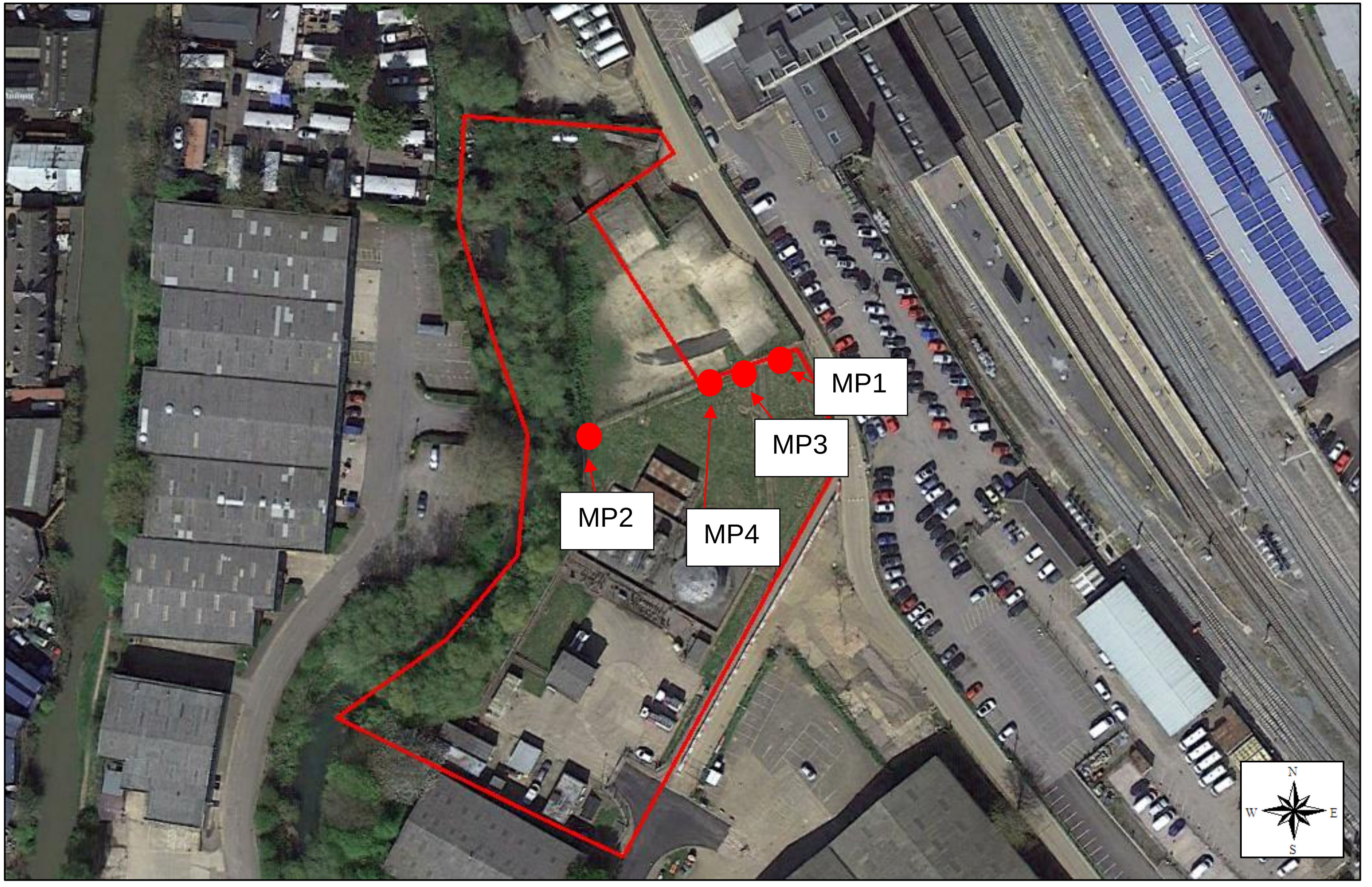

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Figure F.2: ProPG Initial Site Noise Risk Assessment for Ground Floor (Height 1.5 m)

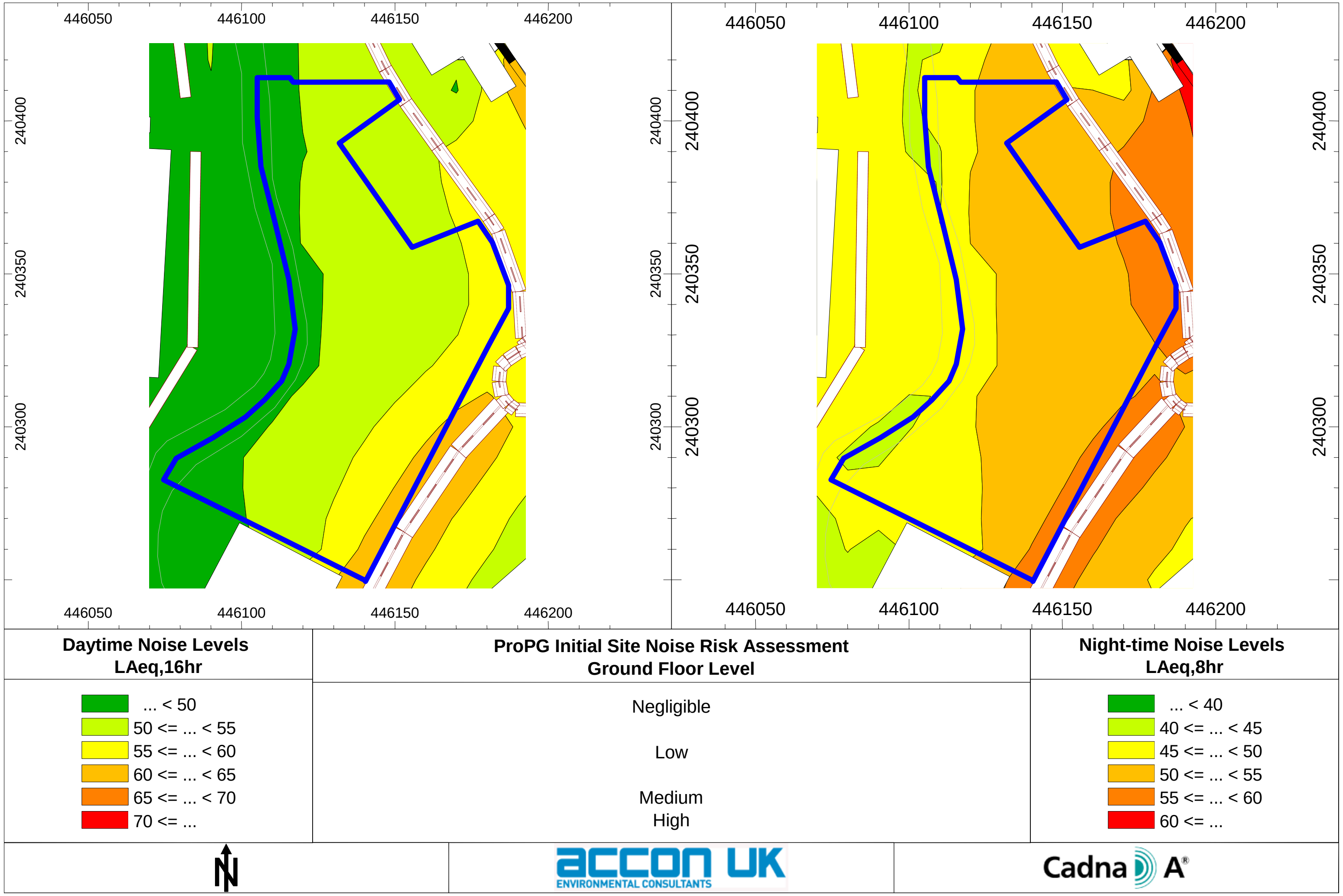

Figure F.3: ProPG Initial Site Noise Risk Assessment for Third Floor (Height 10.5 m)

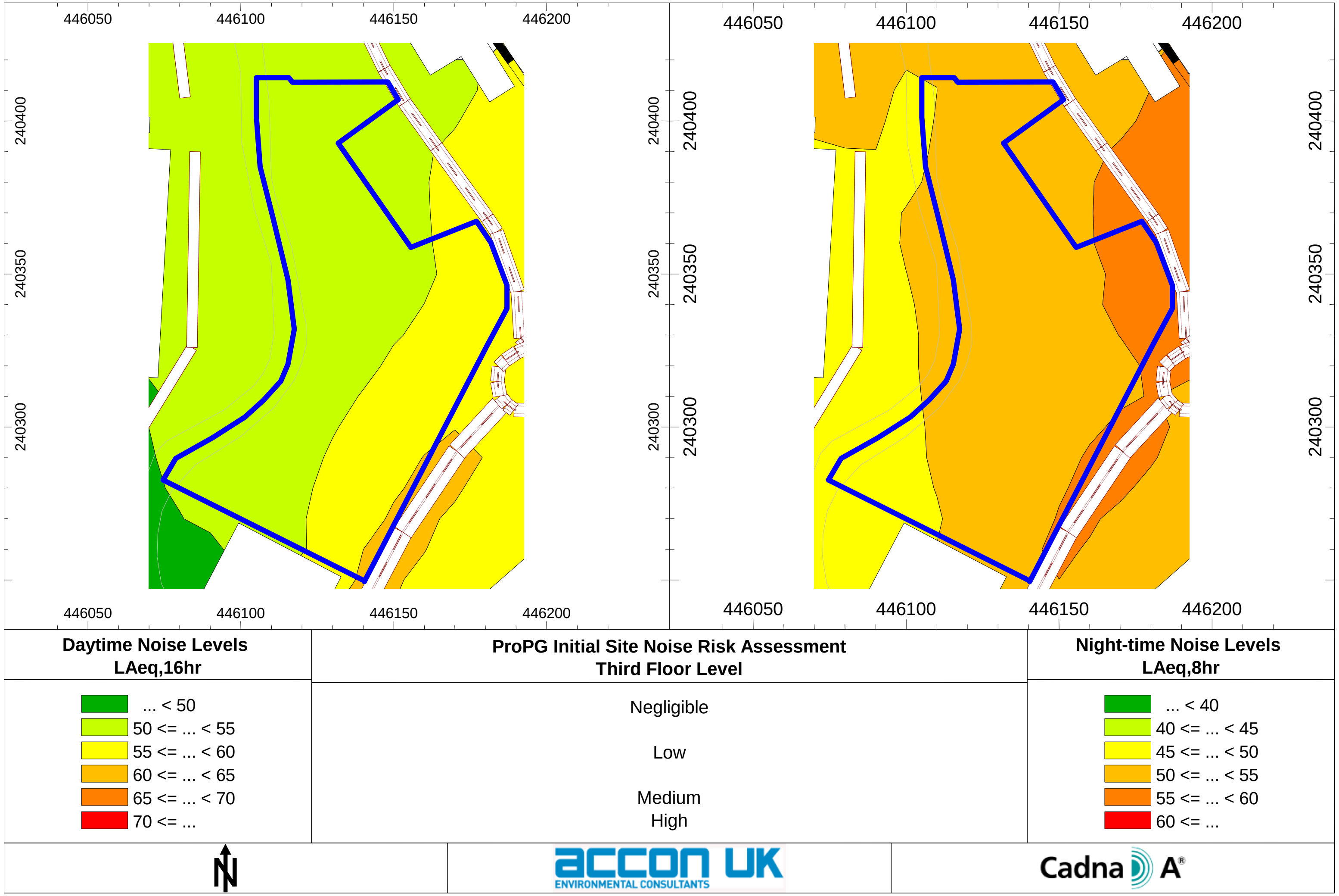

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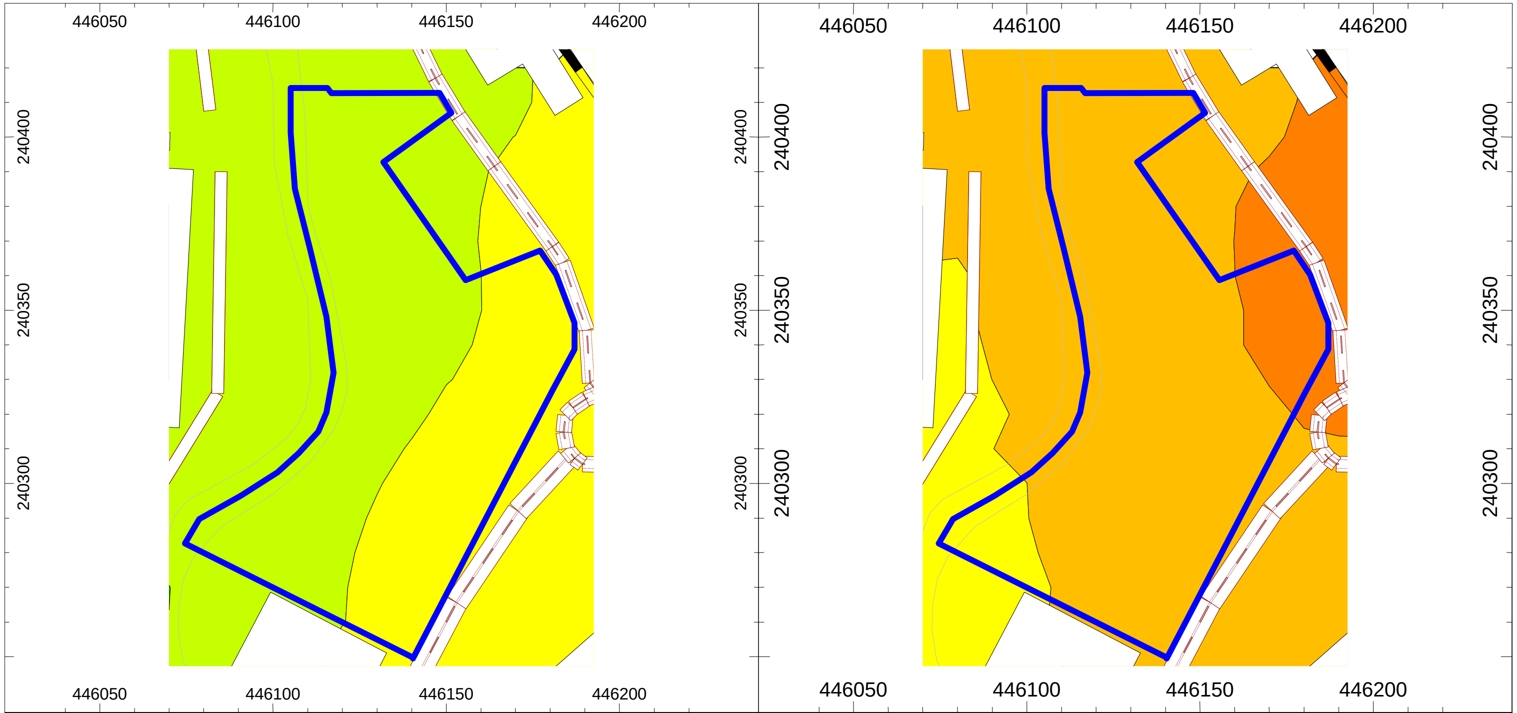
Figure F.4: ProPG Initial Site Noise Risk Assessment for Fifth Floor (Height 16.5 m)



Daytime Noise Levels LAeq,16hr	ProPG Initial Site Noise Risk Assessment Fifth Floor Level	Night-time Noise Levels LAeq,8hr
... < 50	Negligible	... < 40
50 <= ... < 55		40 <= ... < 45
55 <= ... < 60	Low	45 <= ... < 50
60 <= ... < 65		50 <= ... < 55
65 <= ... < 70	Medium	55 <= ... < 60
70 <= ...	High	60 <= ...

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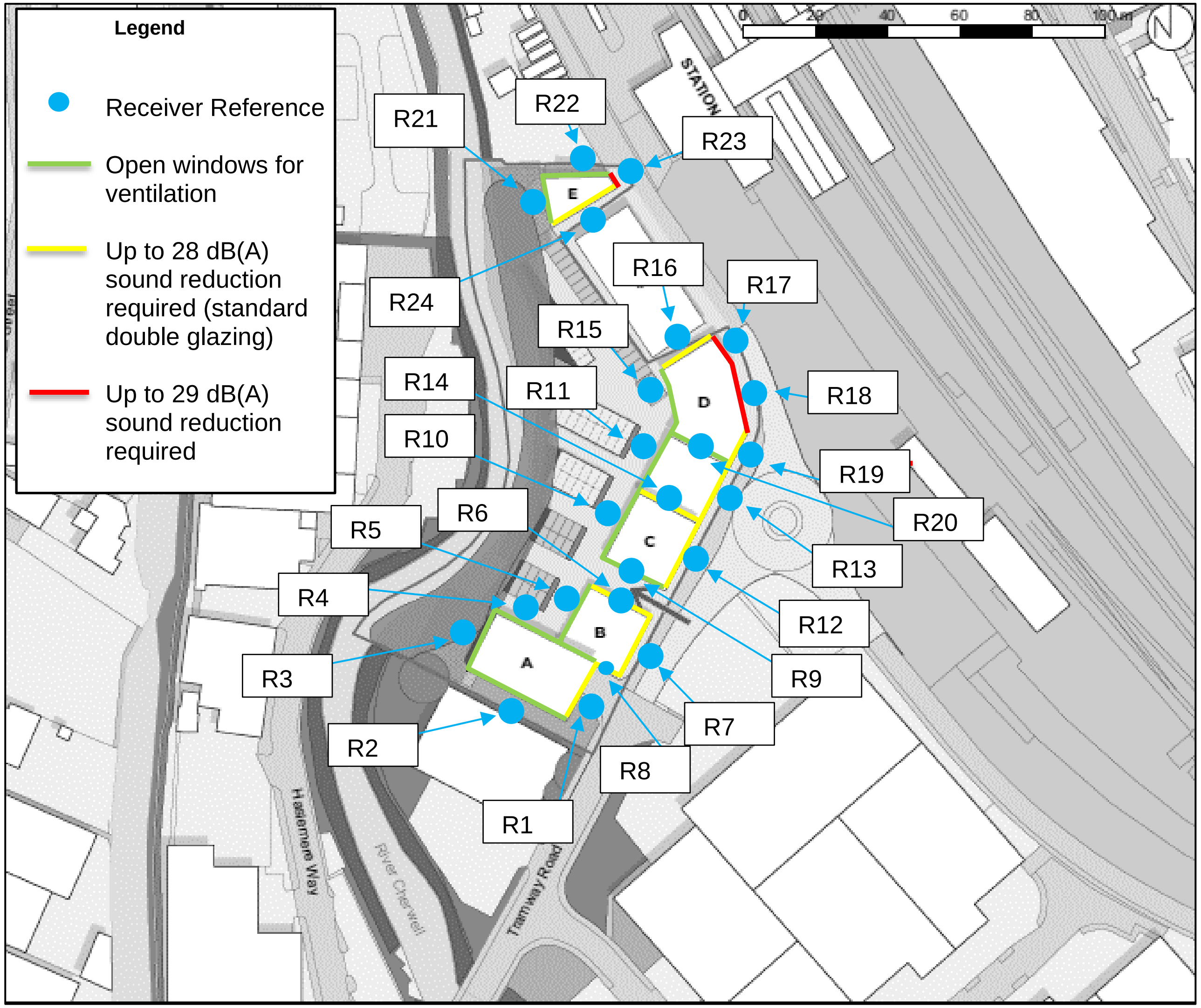
Figure F.5: Illustrative Masterplan with Receivers



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APPENDICES

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Appendix 1

Glossary of Acoustic Terminology

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Term	Description
'A'-Weighting	*This is the main way of adjusting measured sound pressure levels to take into account human hearing, and our uneven frequency response.*
Decibel (dB)	*This is a tenth (deci) of a bel. A decibel can be a measure of the magnitude of sound, changes in sound level and a measure of sound insulation. Decibels are not an absolute unit of measurement but are an expression of ratio between two quantities expressed in logarithmic form.*
Frequency	*Frequency is related to sound pitch; frequency equals the ratio between velocity of sound and wavelength.*
$L_{Aeq,T}$ *(Ambient /Period Sound Level)*	*The equivalent steady sound level in dB containing the same acoustic energy as the actual fluctuating sound level over the given period, T. T may be as short as 1 second when used to describe a single event, or as long as 24 hours when used to describe the noise climate at a specified location.* $L_{Aeq,T}$ *can be measured directly with an integrating sound level meter.*
$L_{A10,T}$ *(Road Traffic Noise Level)*	*The 'A'-weighted sound pressure level of the residual noise in decibels exceeded for 10 per cent of a given time. The* $L_{A10,T}$ *is used to describe road traffic noise levels at a particular location.*
$L_{A90,T}$ *(Background Sound Level)*	*The 'A'-weighted sound pressure level of the residual noise in decibels exceeded for 90 per cent of a given time. The* $L_{A90,T}$ *is used to describe the background noise levels at a particular location.*
L_{Amax}	*The 'A'-weighted maximum sound pressure level measured over a measurement period.*

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Appendix 2
Noise Measurement Results

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NOISE MEASUREMENT RESULTS FOR MP1

Time	$L_{Aeq,T}$ (dB)	L_{Amax} (dB)	$L_{A10,T}$ (dB)	$L_{A90,T}$ (dB)
07:00-08:00	50	75	52	44
08:00-09:00	55	82	55	45
09:00-10:00	56	91	54	45
10:00-11:00	54	86	54	46
11:00-12:00	55	82	55	46
12:00-13:00	52	81	53	45
13:00-14:00	52	73	53	44
14:00-15:00	53	74	53	46
15:00-16:00	54	85	54	47
16:00-17:00	53	80	55	47
17:00-18:00	51	73	54	45
18:00-19:00	54	76	56	47
19:00-20:00	54	77	56	46
20:00-21:00	51	71	52	43
21:00-22:00	54	76	55	46
22:00-23:00	53	72	55	42
23:00-00:00	54	73	53	42
00:00-01:00	51	77	49	37
01:00-02:00	48	76	46	36
02:00-03:00	59	80	44	38
03:00-04:00	56	80	42	34
04:00-05:00	55	77	53	41
05:00-06:00	58	87	55	45
06:00-07:00	51	73	52	43
07:00-23:00	**54**	**79**	**54**	**45**
23:00-07:00	**55**	**78**	**49**	**39**

Note: The noise measurements were carried out over consecutive five minute periods. The $L_{Aeq,5min}$ was subsequently logarithmically averaged over the time periods indicated, the Average $L_{A10,5min}$ and Average $L_{A90,5min}$ were arithmetically averaged and the L_{AFmax} is the highest measured noise level in each hourly period with the average of those highest hourly L_{AFmax} noise levels presented in the period summaries.

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NOISE MEASUREMENT RESULTS FOR MP2

Time	$L_{Aeq,T}$ (dB)	L_{Amax} (dB)	$L_{A10,T}$ (dB)	$L_{A90,T}$ (dB)
07:00-08:00	50	78	50	44
08:00-09:00	50	71	51	44
09:00-10:00	51	84	49	43
10:00-11:00	48	74	49	44
11:00-12:00	49	72	50	44
12:00-13:00	48	71	49	43
13:00-14:00	48	75	49	43
14:00-15:00	50	76	50	44
15:00-16:00	51	73	51	44
16:00-17:00	48	67	51	44
17:00-18:00	47	70	48	43
18:00-19:00	47	70	49	42
19:00-20:00	47	66	48	42
20:00-21:00	45	66	46	39
21:00-22:00	47	70	48	41
22:00-23:00	53	67	50	41
23:00-00:00	54	67	50	39
00:00-01:00	46	72	45	34
01:00-02:00	44	71	42	34
02:00-03:00	44	64	44	37
03:00-04:00	43	69	41	33
04:00-05:00	48	70	47	40
05:00-06:00	50	70	51	44
06:00-07:00	47	69	49	40
07:00-23:00	**49**	**72**	**49**	**43**
23:00-07:00	**48**	**69**	**46**	**37**

Note: The noise measurements were carried out over consecutive five minute periods. The $L_{Aeq,5min}$ was subsequently logarithmically averaged over the time periods indicated, the Average $L_{A10,5min}$ and Average $L_{A90,5min}$ were arithmetically averaged and the L_{AFmax} is the highest measured noise level in each hourly period with the average of those highest hourly L_{AFmax} noise levels presented in the period summaries.

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