Arup**Acoustics**

Barnsley Metropolitan Borough Council

# Elsecar Park and Ride

Noise Assessment

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ArupAcoustics

Barnsley Metropolitan Borough Council

# Elsecar Park and Ride

## Noise Assessment

July 2010

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# Executive Summary

This report considers the potential noise impact resulting from a new park and ride development and the suitability of the site for residential development in Elsecar near Barnsley.

A noise survey has been carried out to determine the existing baseline noise levels around the site during the periods of the day when the park and ride development is expected to be at its busiest. Measurements have also been taken during the day and night to determine the suitability of the site for residential development in accordance with PPG24. The results of the survey and their interpretation are summarised in this report.

**Park and Ride Development**

The daytime assessment of the park and ride concluded that changes in road traffic levels are predicted to be less than 1dB along King Street and Millhouses Street and therefore represents a negligible impact that is not significant.

Changes in road traffic levels for the new site access road are predicted to be 3dB representing a moderate adverse impact that is potentially significant.

A noise barrier has been recommended to protect existing residents from any increase in noise levels due to the new site access road.

The night-time assessment looked at the potential impact of car door slams disturbing nearby residents. The assessment has concluded that with windows closed, the adopted criterion of 45dB $L_{Amax}$ is unlikely to be exceeded.

**Residential Development**

The site is classified as being in NEC C. Mitigation will be required to reduce noise levels to within acceptable limits. A noise barrier along the northern and southern perimeters of the site is required to protect outdoor living space from noise. The exact length and height of the barrier will need to be determined based upon proposed site levels and exact plot locations for the dwellings. This can be determined during the development of the reserved matters submission.

The acoustic design of the building envelope will be required across the majority of the site to reduce internal noise levels to an acceptable standard within proposed new residential dwellings.

**Vibration**

A vibration scoping study has been undertaken. Based on the vibration scoping survey and subsequent predictions, the risk of adverse comment due to perceptible vibration in residential buildings proposed for the north eastern part of the site seems low.

The predicted Vibration Dose Values suggest that perceptible vibration could be an underlying risk if residential properties are developed in the south western areas of the site, where the predicted vibration values suggest probability of adverse comment between ‘possible and ‘probable’.

Geological conditions on the development site may differ from those close to the measurement locations, therefore measured results may not be wholly representative.

If residential buildings are to be developed for any part of this site, it is recommended that more detailed vibration assessment is undertaken.

# 1 Introduction

Arup Acoustics (AAc) has been commissioned by Barnsley Metropolitan Borough Council (BMBC) to provide an environmental noise assessment report in support of a planning application for a new combined park and ride and residential development adjacent to Elsecar railway station, near Barnsley.

King Street (B6097) is located to the north of the development site, railway station buildings are located to the east and to the west is Millhouses Street. To the south lies a railway line with a mix of local stopping commuter trains and non-stopping services between Sheffield and Huddersfield. The M1 motorway is approximately 3.5km south-west of the proposed development. The main park and ride entrance proposed will be via Millhouses Street.

This report details the noise assessment in support of the detailed application for the park and ride development (Section 2 of this report) and support of the outline application for a proposed residential development (Section 3 of this report).

A glossary of acoustic terminology can be found in Appendix A. A noise survey for both areas of the development has been conducted and full results can be found in Appendix B. Noise measurement locations are shown in Figure 1 below.

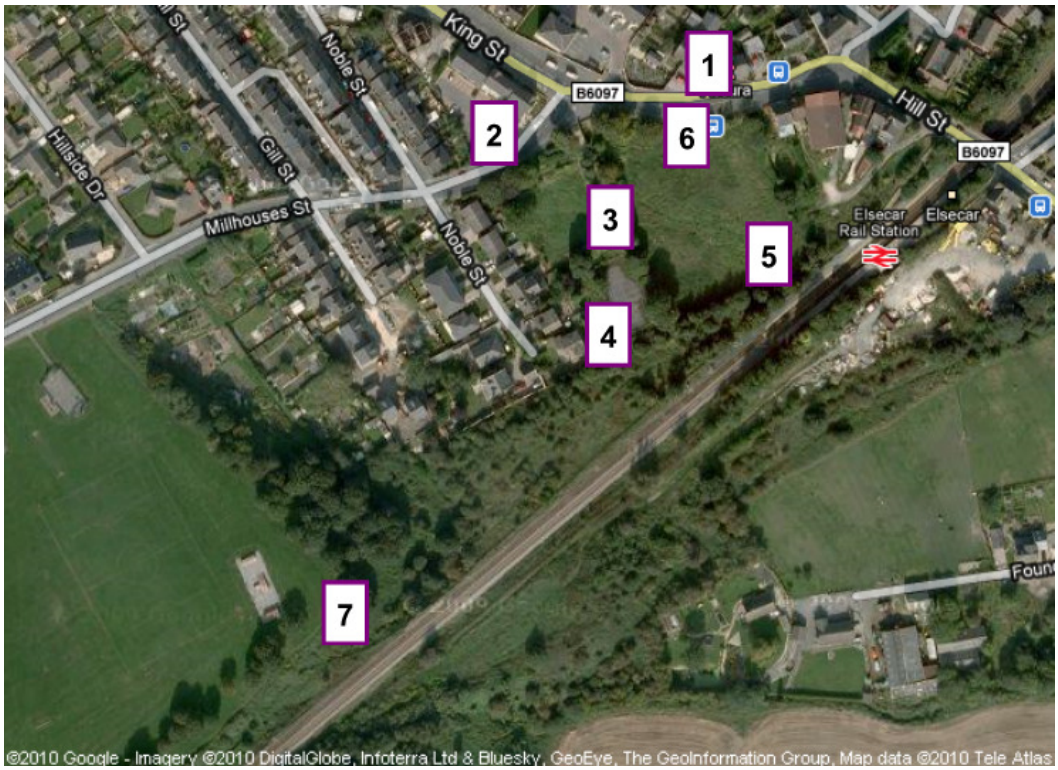



**Figure 1: Noise monitoring location plan**

An indicative vibration survey has also been conducted in areas where housing could be located. Details of the vibration survey and results can be found in Appendix C.

# 2 Park and Ride Development

## 2.1 Assessment Criteria

There is no recognised method in the UK to assess noise from a park and ride facility. An assessment to determine whether suitable noise levels can be achieved within nearby dwellings and outdoor amenity spaces has been conducted by reference to criteria describe in Section 2.1.1 below.

### 2.1.1 Internal Noise Criteria

Commonly, design targets for dwellings are determined by reference to BS 8233:1999: *Sound insulation and noise reduction for buildings – Code of practice* or World Health Organization (WHO) *Guidelines for Community Noise* (1999). These target noise criteria are summarised in Table 1 below.

| Source of criteria and Space | Criteria | |
|---|---|---|
| | Good | Reasonable |
| BS8233 - Bedrooms (2300hrs to 0700 hrs) | 30dB$L_{Aeq}$ | 35dB$L_{Aeq}$ |
| BS8233 - Living rooms (0700hrs to 2300 hrs) | 30dB$L_{Aeq}$ | 40dB$L_{Aeq}$ |
| WHO - Bedrooms (2300hrs to 0700 hrs) | 30dB$L_{Aeq}$ | |
| WHO - Living rooms (0700hrs to 2300 hrs) | 35dB$L_{Aeq}$ | |
| WHO - Bedrooms (2300hrs to 0700 hrs) | 45dB$L_{Amax}$* | |
| WHO - Outdoor living areas (0700hrs to 2300 hrs) | 50 - 55 dB$L_{Aeq}$ | |

*Noise events should not exceed the given level more than 10-15 times per night

**Table 1 Residential ambient noise criteria**

WHO criteria are commonly accepted to be aspirational and represent a level below which virtually no adverse health effects have been observed. Noise levels in excess of WHO values can be acceptable and the BS8233 'reasonable' criteria have been employed successfully on many projects.

In addition, advice contained within Planning Policy Guidance Note 24: *Planning and Noise* (1994) (PPG24) has been used. PPG24 advises that the sound insulation afforded by a partially open window is usually taken to be 10 - 15 dB(A) and that a reduction of 13 dB(A) from the facade level is assumed for the purposes of PPG24.

PPG24 summarises the main issues to be considered when specifying adequate sound insulation of windows. Closed windows will naturally provide more sound insulation than an open window. The level of sound insulation afforded by various types of closed windows for road traffic noise contained in Annex 6, Table 1 of PPG24 have been reproduced in Table 2 below.

| Noise Source | Difference between dB(A) Levels Outside and Inside | | |
|---|---|---|---|
| | Single Glazing | Thermal Double Glazing | Secondary Glazing |
| Road Traffic | 28 | 33 | 34 |

**Table 2 Typical noise reduction of a dwelling façade with windows set in a brick / block wall (from PPG24)**

From experience a standard thermal double glazed unit with a ventilation opening not exceeding 8000mm$^2$ would provide at least 26dB(A) sound insulation in relation to road traffic noise. This value has been assumed for the purpose of this report.

### 2.1.2 Road Traffic Impact Assessment

#### 2.1.2.1 Calculation of Road traffic Noise (1988)

In order to establish the relative road traffic noise impact resulting from the proposed development, calculation of the "Basic Noise Level" (BNL) has been conducted for each of the above roads in accordance with the Calculation of Road Traffic Noise (CRTN) - Department of Transport, Technical Memorandum.

The BNL provides an indication of the noise emission from a road by providing a calculated noise level at 10m from the edge of the carriageway. This enables a simple comparison to be made of noise emissions for individual roads and the effect of changes in traffic flows attributable to the development.

#### 2.1.2.2 Design Manual for Roads and Bridges (DMRB), Volume 11, Part 7

Traffic noise, particularly from freely flowing traffic, is a relatively uniform noise source without strong tonal or impulsive characteristics. It is common practice to use the change in noise level brought about by a scheme as the basis for evaluating noise impacts (i.e. the impact of the scheme on the pre-existing noise environment and the effects this may have on the receptors in that environment).

The scale or severity of any noise change, positive or negative, requires description to indicate the degree of impact where possible. This leads to the common practice of defining noise change impact categories with an associated semantic scale.

Guidance documents relating to traffic noise assessment note that a long term change of less than 3dB(A) is not generally perceptible and it would follow that a significant effect is unlikely to occur if the change is not perceptible. The fact that a change is perceptible does not necessarily mean that it is sufficient to give rise to a significant effect. Nevertheless, a change threshold of 3dB(A) has commonly been used in traffic noise assessments in the UK to approximate the threshold of significance.

DMRB 2008 guidance on Noise and Vibration Assessment (DMRB, Vol 11, Section 3, Part 7 HA213/08) provides the clearest guidance to date, where clause 3.42 of HA 213/08 notes that:

*"A change of 1dB(A) in the short-term (eg when a project is opened) is the smallest that is considered perceptible. In the long-term a 3dB(A) change is considered perceptible, and such an increase should be mitigated if possible."*

A semantic scale is proposed to assess noise impacts and effects arising from the operation of the proposed park and ride development and is shown in Table 3.

| Change In Noise Level | Impact Category | Initial Indicator of Significance |
|---|---|---|
| ≥5 | Major adverse | Potentially significant increase |
| ≥3 to <5 | Moderate adverse | |
| ≥1 to <3 | Minor adverse | Unlikely to be significant |
| <1 to >-1 | Negligible | |
| ≤-1 to >-3 | Minor beneficial | |
| ≤-3 to >-5 | Moderate beneficial | Potentially significant decrease |
| ≤-5 | Major beneficial | |

**Table 3: Proposed scale for assessment of noise from the park and ride scheme**

## 2.2 Park and Ride Operation

It is understood that the park and ride development will be accessed 24 hours a day as there will be no barrier controls. However, it is anticipated that the facility will be mainly used for commuting and will therefore be used during peak hours with very low levels of traffic expected during off-peak hours.

### 2.2.1 Inventory of On-Site Noise Sources

The main on site noise sources will be cars parking (including manoeuvring vehicles and car door slams).

### 2.2.2 Inventory of Off Site Noise Sources

The main off site noise sources will be noise from increased traffic flows due to park and ride users on the wider road network.

## 2.3 Noise Survey

Noise measurements were taken at Locations 1, 2, 3 and 4 as shown on Figure 1 to determine the ambient noise climate for assessing the impact of the park and ride.

Measurements were taken during the morning peak period and at other times during the day. Measurements during the night were not taken as the park and ride facility is not expected to generate significant amounts of additional traffic during night-time hours. A summary of the results is contained in Table 4.

| Location (Refer to Figure 1) | Measurement Duration | Noise Level, dB | | | |
|---|---|---|---|---|---|
| | (mm:ss) | $L_{A90}$ | $L_{Aeq}$ | $L_{A10}$ | $L_{Amax,F}$ |
| 1 | 10:00 – 15:00 | 42 - 42 | 62 - 63 | 66 – 68 | 81 – 84 |
| 2 | 10:00 – 15:00 | 38 - 42 | 54 - 60 | 54 – 64 | 73 – 76 |
| 3 | 10:00 – 15:00 | 39 - 41 | 45 – 50 | 48 – 50 | 59 - 70 |
| 4 | 10:00 – 15:00 | 36 - 38 | 48 - 50 | 47 – 49 | 72 - 73 |

**Table 4: Summary of baseline noise results**

### 2.3.1 Summary of Noise Climate

Location 1 was dominated by road traffic travelling along King Street. A bus stop was situated close to this location and buses stopping and accelerating were audible from time to time. Rail noise was also audible at this location and was more noticeable during lulls in road traffic. Other noise sources included occasional birdsong and occasional aeroplanes.

The noise climate at location 2 was similar to location 1 however there was much less road traffic on Millhouses Street than on King Street. A refuse wagon collecting waste was audible during one of the measurements made at location 2.

At locations 3 and 4, the noise climate was dominated by distant road traffic noise from Millhouses Street and King Street. Noise from occasional stopping trains was also measured at these locations. Occasional barking dogs from nearby dwellings were audible together with occasional birdsong and aeroplanes.

## 2.4 Assessment

The impact of additional road traffic on local roads has been assessed by calculating basic noise levels and comparisons made between do minimum and do something traffic flows to determine the level of impact.

The number of car park users during night-time hours is expected to be low due to the nature of the proposed park and ride facility. It is therefore considered that night-time $L_{Amax}$ noise levels will be the limiting case and night-time $L_{Amax}$ noise levels have therefore been predicted for typical car park activity.

### 2.4.1 Road Traffic Assessment

Traffic data for 18-hour (06:00 – 00:00) flows has been provided by Arup Transport Planning and BMBC for the new access road, King Street and Millhouses Street. This has been provided for the year 2010, both with and without the development.

In order to establish the relative road traffic noise impact resulting from the proposed development, calculation of the “Basic Noise Level” (BNL) has been conducted for each of the above roads in accordance with the Calculation of Road Traffic Noise (CRTN).

The BNL provides an indication of the noise emission from a road by providing a calculated noise level at 10m from the edge of the carriageway. For the purposes of the comparative assessment it has been assumed that the road surface is “Impervious bitumen” and that there is no gradient on the road. There is anticipated to be no change in percentage HGVs due to the development. The following percentages have been used in this assessment:

- King Street – 5% HGVs
- Millhouses Street – 0% HGVs
- Park and ride access road – 0% HGVs

The following mean traffic speeds for each road link have been used:

- King Street – 48km/h
- Millhouses Street – 48km/h
- Park and ride access road – 24km/h

Based upon the above assumptions, Table 5 provides a summary of the anticipated road traffic noise impact.

| Road Link | 2010 18 Hour Do Minimum (DM) | 2010 Do Minimum BNL $L_{A10}$ (18 hour) (dB) | 2010 18 Hour Do Something (DS) | 2010 Do Something BNL $L_{A10,18hr}$ (dB) | Change in Noise Level (dB) (DS – DM) |
|---|---|---|---|---|---|
| Millhouses Street | 1458 | 56.2 | 1653 | 56.9 | +0.7 |
| King Street | 4789 | 63.7 | 4885 | 63.8 | +0.1 |
| Site Access | - | 48.4[1] | 389 | 51.6[2] | +3.2 |

[1]Based upon average $L_{A10}$ noise levels measured during the baseline noise survey at locations 3 and 4 because the site access road does not exist.

[2]Includes the effect of existing baseline noise levels (BNL from access road in isolation is 48.8dB)

**Table 5: Summary of 18 hour traffic data and change in BNL**

The results in Table 5 demonstrate that changes in road traffic levels are less that 1dB for Millhouses Street and King Street. Road traffic noise therefore represents a negligible impact that is unlikely to be significant.

Changes in road traffic noise levels for the site access road are greater than 3dB when compared to measured baseline noise levels. A section of the site access road runs parallel to the rear gardens of Noble Street at a distance of between 15 to 20m. Road traffic noise along this section represents a moderate adverse noise impact that is potentially significant. However, it should be noted that absolute level of 51.6dB $L_{A10}$ (approximately 50dB $L_{Aeq}$) are modest in absolute terms.

### 2.4.2 Night-time $L_{Amax}$ Assessment

Calculations of noise levels within dwellings have been conducted for a car door slam in the nearest parking bay to existing and proposed residential receivers. This calculation has been based upon windows being closed but without any other mitigation. The results are summarised in Table 6 below.

| Scenario | Car Door Slam $L_{Amax}$ Noise level (dB) (measured at 6m) | Approximate Distance to Nearest dwelling (m) | Predicted External $L_{Amax}$ Noise Level (free field) (dB) | Predicted Internal $L_{Amax}$ Noise Level (dB) |
|---|---|---|---|---|
| Existing dwellings | 75 | 20 | 65 | 42 |
| Proposed new dwellings | 75 | 15 | 67 | 44 |

**Table 6: Night-time $L_{Amax}$ noise level calculation summary for a car door slam**

The results in Table 6 demonstrate that with windows closed and based upon worst case distances to nearby dwellings, $L_{Amax}$ noise levels from car doors slams are predicted to be below the adopted criterion of 45dB $L_{Amax}$ at existing dwellings.

## 2.5 Mitigation

A noise barrier is recommended to protect the back gardens of nearby dwellings from experiencing any increase in noise levels due to the park and ride access road. Figure 2 shows recommended locations for noise barriers to the perimeter of the park and ride. A

1.8m high barrier has been recommended with the precise location of these barriers to be further refined during detailed design. Any such barrier would need to be solid (i.e. no gaps between panels or at the base) and have surface mass in excess of 10kgm$^{-2}$. The provision of such barriers could be secured by a suitable worded planning condition.

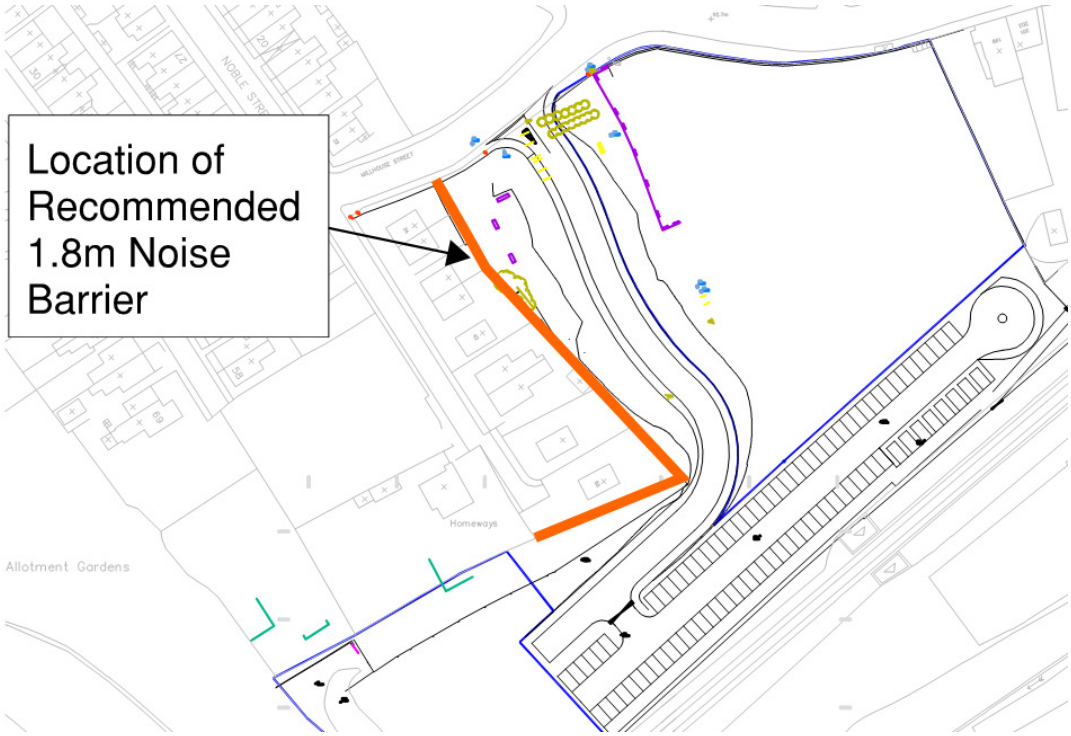



**Figure 2: Location of recommended noise barrier**

# 3 Residential Development

## 3.1 Assessment Criteria

### 3.1.1 PPG24 Planning and Noise

Planning Policy Guidance Note 24: *Planning and Noise* (1994) (PPG24) sets out the Government's policies relating to noise as it affects development control. PPG24 outlines the considerations to be taken into account in determining planning applications for noise sensitive uses and activities that generate noise.

PPG24 introduces Noise Exposure Categories (NECs) for proposed residential development affected by transportation noise or mixed sources (those where no one source is considered dominant), and recommends appropriate levels for exposure to different sources of noise. The guidance advises on the use of planning conditions to minimise the impact of noise.

The Noise Exposure Categories given in PPG24 for road traffic, rail and mixed sources are shown in Table 7. The associated advice provided in PPG24 relating to the granting of planning permissions for residential use is reproduced in Table 8.

| Noise Source and Time of Day | Noise Levels Corresponding to the Noise Exposure Categories for New Dwellings $L_{Aeq,T}$ dB | | | |
|---|---|---|---|---|
| | Noise Exposure Category | | | |
| | A | B | C | D |
| Road traffic | | | | |
| 07:00 – 23:00 | <55 | 55 – 63 | 63 – 72 | >72 |
| 23:00 – 07:00* | <45 | 45 – 57 | 57 – 66 | >66 |
| Rail | | | | |
| 07:00 – 23:00 | <55 | 55 – 66 | 66 – 74 | >74 |
| 23:00 – 07:00* | <45 | 45 – 59 | 59 – 66 | >66 |
| Mixed sources | | | | |
| 07:00 – 23:00 | <55 | 55 – 63 | 63 – 72 | >72 |
| 23:00 – 07:00* | <45 | 45 – 57 | 57 – 66 | >66 |

Notes: * Night-time noise levels (23:00 – 07:00): sites where individual noise events regularly exceed 82 dB $L_{Amax}$ (S time weighting) several times in any hour should be treated as being in NEC C regardless of the $L_{Aeq,8hr}$ (except where the $L_{Aeq,8hr}$ already puts the site in NEC D).

**Table 7 Noise Exposure Categories for new dwellings near road traffic or mixed sources**

| NEC | Description |
|---|---|
| A | Noise need not be considered as a determining factor in granting planning permission, although the noise level at the high end of the category should not be regarded as a desirable level. |
| B | Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate level of protection against noise. |
| C | Planning permission should not normally be granted. Where it is considered that permission should be given, for example because there is no alternative quieter site available, conditions should be imposed to ensure a commensurate level of protection against noise. |
| D | Planning permission should normally be refused. |

**Table 8 Definitions of Noise Exposure Categories for new dwellings near existing noise sources**

## 3.2 Noise Survey

An environmental noise survey has been carried out to quantify the existing baseline ambient and background noise levels around the site of the proposed buildings. Table 9 describes the measurements undertaken and the purpose of these measurements.

| Measurements | Time (hrs) | Location (refer to Figure 1) | Purpose |
|---|---|---|---|
| Daytime | 09:45 – 16:35 | 5, 6 and 7 | To determine site wide ambient noise levels |
| Daytime | 09:45 – 16:35 | 5 and 7 | To establish sound exposure levels (SEL) from passing trains. |
| Noisiest night-time | 23:00 - 02:00 | 5, 6 and 7 | To determine noisiest night-time noise levels around the site. |

**Table 9: Summary of environmental noise measurements**

### 3.2.1 Summary of Results

Measurements were conducted on the 16 and 17 June 2010 and full noise survey methodology is contained in Appendix B of this report. Table 10 and Table 11 summarises the results of the noise survey.

| Location (Refer to Figure 1) | Measurement Duration (mm:ss) | Noise Level, dB | | | |
|---|---|---|---|---|---|
| | | $L_{A90}$ | $L_{Aeq}$ | $L_{A10}$ | $L_{Amax,F}$ |
| 5 | 05:00 | 36 - 38 | 41 - 43 | 44 - 45 | 54 – 63 |
| 6 | 15:00 | 40 – 44 | 63 - 64 | 67 - 68 | 80 – 82 |
| 7 | 05:00 | 35 - 37 | 39 - 46 | 41 - 43 | 52 - 65 |

**Table 10: Summary of measured daytime noise levels for PPG24 assessment**

| Location (Refer to Figure 1) | Measurement Duration (mm:ss) | Noise Level, dB | | | |
|---|---|---|---|---|---|
| | | $L_{A90}$ | $L_{Aeq}$ | $L_{A10}$ | $L_{Amax,S}$ |
| 5 | 05:00 | 26 - 33 | 29 - 40 | 29 - 45 | 40 – 50 |
| 6 | 05:00 | 27 - 33 | 35 - 63 | 34 - 65 | 48 – 79 |
| 7 | 05:00 | 25 - 29 | 28 - 38 | 28 - 39 | 33 – 58 |

**Table 11: Summary of measured night-time noise levels for PPG24 assessment**

### 3.2.2 Summary of Noise Climate

Location 5 was situated approximately 10m from the edge of the railway line. A solid brick wall approximately 1m high runs parallel with the train line along the edge of the platform which provided some screening of the railway at this location. Excluding train noise, the general noise climate comprised of road traffic from Millhouses Street and King Street and more distant traffic noise from the M1. Other noise sources included birdsong and occasional aeroplanes. Noise from residents along Noble Street was occasionally audible. During the night, distant road traffic noise and occasional vehicles along King Street and Millhouses Street were audible. A distant mechanical extract was just audible.

Location 6 was situated approximately 3m from the kerb of King Street. The site dips away from the road and measurements taken therefore represent a worst case noise level. This is due to the shielding effect and reduced angle of view to the road, however if site levels change, this effect would be reduced. The dominant noise source during day and night-time monitoring was road traffic along King Street with some contribution from Millhouses Street. Occasional buses stopping and accelerating away were audible at the nearby bus stop during the day. Passing trains were occasionally audible during the daytime only, no trains passed during measurements conducted at night. Birdsong and occasional aircraft noise was also audible.

Location 7 was positioned along an embankment with a full view of the railway track. The south-western area of the site was overgrown and access to the proposed housing area was not possible. Location 7 is an equivalent distance from the railway track (approximately 8m) and is considered to be a suitable alternative. Excluding train noise, the noise climate comprised of distant sources including road traffic, birdsong and aeroplanes. During the daytime, noise from a nearby allotment was occasionally audible.

## 3.3 Assessment

### 3.3.1 Road Traffic Noise

At location 6, the noise climate is dominated by road traffic. The day time noise levels have been calculated from 3 individual noise measurements, based upon the principles of the 'Shortened measurement procedure' described at Section 43 of CRTN. This method has been used to calculate a noise level in terms of $L_{10,18hr}$. A further correction has been applied in accordance with Section 9 of Annex 1 of PPG24 to convert the noise levels to $L_{Aeq,16h}$. This process is summarised below.

- $L_{10(18\text{-hour})} = L_{10(3\text{-hour})} – 1dB(A)$ (CRTN)
- $L_{Aeq,16h} \approx L_{10(18\text{-hour})} – 2dB(A)$ (PPG24)
- $L_{Aeq,16h} \approx L_{10(3\text{-hour})} – 3dB(A)$

This method has been used to establish the 16 hour day time noise levels for location 6. The 8 hour night-time noise level has been calculated by a logarithmic average of measured $L_{Aeq}$ levels including a late evening measurement between 22:53 and 22:58hrs. The noise

levels have then been compared to the road traffic NECs in Table 7. The results are summarised in Table 12.

| Daytime $L_{Aeq\ 16\ hr}$ (dB) | Daytime NEC | Night-time $L_{Aeq\ 8hr}$ (dB) | Night-time $L_{Amax,S}$ (dB) | Night-time NEC | Overall NEC at Location 6 |
|---|---|---|---|---|---|
| 65 | C | 56 | 48 – 79 | B | C |

**Table 12: Summary of day and night-time noise levels at Location 6**

### 3.3.2 Rail Noise

Daytime and night-time sound exposure levels ($L_{AE}$) of passing trains were measured at Location 5 and 7. Trains have been divided into stopping services and fast through trains, which each have a different characteristic. A summary of these levels is shown in Table 13.

| Location | Period | Noise Level, dB | | | | |
|---|---|---|---|---|---|---|
| | | Stopping Trains | | Fast Through Trains | | Stopping and through train $L_{Amax,S}$ |
| | | $L_{AE}$ | Average $L_{AE}$ | $L_{AE}$ | Average $L_{AE}$ | |
| 5 | Day | 62 – 77 | **72.3** | 73 – 80 | **78.3** | 55 – 76 |
| | Night | 69 | **74.8** | - | **-** | 65 |
| | Total | | **73.1** | - | **-** | |
| 7 | Day | 87 – 88 | **87.2** | 88 – 97 | **94.3** | 80 - 93 |
| | Night | 52 - 85 | **81.2** | - | **-** | 43 – 78 |
| | Total | | **85.5** | - | **-** | - |

**Table 13: Train noise levels**

Passenger train movement numbers have been estimated from train timetables and information provided by SYPTE, which is summarised in Table 14 below.

| Train Movement Description | Train movements | |
|---|---|---|
| | Day | Night |
| Fast Through Trains | 70 | 9 |
| Local Stopping Trains | 47 | 8 |

**Table 14: Estimated train movements**

These movements have been used to calculate long term average noise levels for locations 5 and 7. The noise levels have then been compared to the rail traffic NECs in Table 7. The results are summarised in Table 15.

| Location | Daytime $L_{Aeq\ 16\ hr}$ (dB) | Daytime NEC | Night-time $L_{Aeq\ 8hr}$ (dB) | Night-time NEC | Overall NEC at Location 5 | Overall NEC at Location 7 |
|---|---|---|---|---|---|---|
| 5 | 49.9 | A | 44.3 | A | A | C |
| 7 | 65.5 | B | 59.7 | C | | |

**Table 15**: **$L_{Aeq}$ Rail Noise Levels Calculated from Measured Levels**

$L_{Amax,S}$ noise levels are all below 82dB except at location 7 where daytime maximum noise levels exceed 82dB $L_{Amax,S}$. During the night, $L_{Amax,S}$ noise levels are unlikely to regularly exceed 82dB $L_{Amax,S}$. At location 7, the site is already classified as being in NEC C.

In accordance with PPG24, the site is classified as being in NEC C.

## 3.4 Mitigation

Where the noise exposure falls within NEC C, PPG24 advises that "*Planning permission should not normally be granted. Where it is considered that permission should be given, for example because there is no alternative quieter site available, conditions should be imposed to ensure a commensurate level of protection against noise*". However, planning permission is routinely granted for NEC C and NEC D sites, provided that adequate noise mitigation measures are provided.

Target internal noise criteria for dwellings are presented in Section 2.1.1 (Table 1).

Mitigation for properties could be achieved by a number of means;

- Increased sound insulation from glazing and provision of ventilation (e.g. sound attenuated mechanical ventilation or cross ventilation to the quieter façades) for bedrooms and living rooms facing King Street and the railway line; and
- Revised internal space planning of individual buildings, moving bedrooms and living rooms away from road and rail sources.

From experience even a basic combination of thermal double glazing and ventilation can deliver a 26 dB(A) reduction in noise levels from outside to inside. This site is sufficient to achieve the 'reasonable' criteria proposed in BS8233. By inspection it can be seen that enhanced glazing is likely to be required to deliver internal noise levels consistent with BS8233 and WHO guidelines at location 7.

For dwellings situated close to location 5, standard glazing should deliver suitable internal noise levels. Further enhancements could be developed in order to achieve the 'good' criteria if necessary, potentially requiring higher specification glazing and acoustically treated ventilation.

It is recommended that a noise barrier be erected along the southern perimeter and the northern perimeter of the site to protect the gardens of new dwellings. The size and length of the barrier would be determined at a later stage of design once the layout and number of dwellings is known.

Further barriers may need to be erected in order to protect gardens from park and ride car park noise. Designs for these can be brought forward during the development of the reserved matters submission for the residential element of the scheme. In summary it is considered that the mitigation of road and rail traffic noise ingress to proposed new dwellings can be developed during the development of the reserved matters submission of the properties and secured by suitably worded planning conditions to control internal noise levels.

# 4 Conclusions

## 4.1 Park and Ride Development

Road traffic impacts have been assessed by comparing do minimum and do something traffic data and by comparison of measured baseline noise levels. It has been established that noise levels change by less than 1dB along King Street and Millhouses Street and there is therefore a negligible impact.

For the new site access road, a 3dB increase has been predicted, representing a moderate adverse impact. A 1.8m high noise barrier has been recommended to protect existing dwellings in order to ensure that there is no significant increase in noise levels as a result of the scheme (see Figure 2).

The provision of such barriers could be secured by a suitable worded planning condition.

Any noise barrier requirements for the proposed new residential areas of the development will fall within the development of the reserved matters submission for the residential scheme.

## 4.2 Residential Development

The site has been assessed in accordance with PPG24. Noise levels on the site are predicted to range between 50 and 66dB $L_{Aeq,T}$ during the day. During the night, noise levels range between 44 and 61dB $L_{Aeq,T}$. The site is classified as being in NEC C overall, the single highest classification on the site.

Mitigation will be required to reduce noise levels to within acceptable limits. A noise barrier along the northern and southern perimeters of the site is required. The exact length and height of the barrier will need to be determined based upon proposed site levels and exact plot locations for the dwellings. This can be determined in detail during the development of the reserved matters submission.

The acoustic design of the building envelope for some plots will be required to reduce internal noise levels to an acceptable level within proposed new residential dwellings.

The assessment of noise barriers and glazing could be secured by a suitable worded reserved matters planning condition.

## 4.3 Vibration

Based on the vibration scoping survey (refer to Appendix C) and subsequent predictions, the risk of adverse comment due to perceptible vibration in residential buildings proposed for the north eastern part of the site is low.

However, there is a risk that perceptible vibration could be problematic if residential properties are developed within the south western area of the site. The predicted vibration suggests a probability of adverse comment between ‘possible and ‘probable’ according to BS6472.

The south western area of the development site was overgrown and access to the proposed housing area was not possible. Measurement Location V2 is an equivalent distance from the railway track but some distance along it. Geological conditions on the development site may differ from those close to the measurements locations, therefore measured results may not be representative.

If residential buildings are to be developed within the south western part of this site, it is recommended that more detailed vibration assessment is undertaken.

Appendix A

# Glossary of Acoustic Terminology

# A1 Glossary of Acoustic Terminology

### Decibel, dB

The ratio of sound pressures which we can hear is a ratio of approximately 1:$10^6$ (one: one million). For convenience, therefore, a logarithmic measurement scale is used. The resulting parameter is called the 'sound pressure level' (Lp) and the associated measurement unit is the decibel (dB). As the decibel is a logarithmic ratio, the laws of logarithmic addition and subtraction apply.

### dB(A)

The unit generally used for measuring environmental, traffic or industrial noise is the A-weighted sound pressure level in decibels, denoted dB(A). An A-weighting network can be built into a sound level measuring instrument such that sound levels in dB(A) can be read directly from a meter. The weighting is based on the frequency response of the human ear and has been found to correlate well with human subjective reactions to various sounds. It is worth noting that an increase or decrease of approximately 10dB corresponds to a perceived doubling or halving of the loudness of a noise, and a change of 2 to 3dB is subjectively barely perceptible.

### Equivalent Continuous Sound Level, Leq

Another index for assessment for overall noise exposure is the equivalent continuous sound level, Leq. This is a notional steady level which would, over a given period of time, deliver the same sound energy as the actual time-varying sound over the same period. Hence fluctuating levels can be described in terms of a single figure level.

### Frequency

The number of repetitions per second of a complete waveform. The subjective equivalent in music is pitch. The unit of frequency is the Hertz (Hz), which is identical to cycles per second. A thousand hertz is often denoted kHz, e.g. 2kHz = 2000Hz. Human hearing ranges approximately from 20Hz to 20kHz. For design purposes, the octave bands between 63Hz to 8kHz are generally used. The most commonly used frequency bands are octave bands, in which the mid frequency of each band is twice that of the band below it. For more detailed analysis, each octave band may be split into three one-third octave bands or in some cases, narrow frequency bands.

### Maximum Noise Levels

The maximum noise level identified during a measurement period. Experimented data has shown that the human ear does not generally register the full loudness of transient sound events of less than 125ms. Fast time weighting has an exponential time constant of 125ms which reflects the ear's response. The maximum level measured with fast time weighting is denoted as $L_{AMax, f}$. Slow time weighting (S) with an exponential time constant of 1s is used to allow more accurate estimation of the average sound level on a visual display.

Impulse (I) time weighting has a fast rise (35ms) and a slow decay and is intended to mimic the ear's response to impulsive sounds.

### Statistical Noise Levels

For levels of noise that vary widely with time, for example road traffic noise, it is necessary to employ an index which allows for this variation. The $L_{10}$, the level exceeded for ten per cent of the time period under consideration, has been adopted in this country for the assessment of road traffic noise. The $L_{90}$, the level exceeded for ninety per cent of the time, has been adopted to represent the background noise level. The $L_1$, the level exceeded for one per cent of the time, is representative of the maximum levels recorded during the

sample period. A weighted statistical noise levels are denoted $L_{A10}$, $dBL_{A90}$ etc. The reference time period (T) is normally included, e.g. $dBL_{A10, 5min}$ or $dBL_{A90, 8hr}$.

## Typical Noise Levels

Some typical noise levels are given in Table A1 below;

| Noise Level dB(A) | Example |
|---|---|
| 130 | Threshold of pain |
| 120 | Jet aircraft take-off at 100 m |
| 110 | Chain saw at 1 m |
| 100 | Inside disco |
| 90 | Heavy lorries at 5 m |
| 80 | Kerbside of busy street |
| 70 | Loud radio (in typical domestic room) |
| 60 | Office or restaurant |
| 50 | Domestic fan heater at 1m |
| 40 | Living room |
| 30 | Theatre |
| 20 | Remote countryside on still night |
| 10 | Sound insulated test chamber |
| 0 | Threshold of hearing |

**Table A1: Typical noise levels**

## Vibration

Vibration may be expressed in terms of displacement, velocity and acceleration. Velocity and acceleration are most commonly used when assessing human comfort or structureborne noise issues.

Vibration amplitude may be quantified as a peak value, or as a root mean squared (rms) value. The rms value is of benefit because it takes into account both time history variation and energy content. The rms value is equal to 0.707 times the peak value and experience has shown that the overall rms value of vibration velocity, over the range of 10Hz to 1kHz, gives the best indication of vibration severity.

Vibration amplitude can be expressed as an absolute value eg $1mms^{-1}$ or as a ratio on a logarithmic scale in decibels, ie.

vibration velocity level, $dB = 20 \log (V/V_{ref})$,

where the preferred reference level, $V_{ref}$, for vibration velocity = $1x10^{-9}$ $ms^{-1}$.

For example; $1mms^{-1}$ = 120dB

Note that the reference level for acceleration, $a_{ref}$, is $1x10^{-6}ms^{-2}$.

The decibel approach has advantages for manipulation and comparison of data and the definition of descriptors such as $L_{eq}$ and $L_{max}$ given above will also be applicable.

Generally humans are more sensitive to changes in vibration amplitude than they are to changes in the duration of the exposure to vibration.

### Vibration Dose Value (VDV)

This is a complex metric that has been identified as being the best objective measure of human disturbance from intermittent/transient vibration. The VDV is the fourth root of the time integral of the fourth power of the weighted acceleration. VDV are measured in units of $m/s^{1.75}$. The frequency weightings are defined in BS 6472: 2008 and in BS 6841: 1987.

The VDV doubles in magnitude with a doubling of vibration amplitude. However, a 16-fold increase in the duration of exposure to the vibration is required to double the VDV (without any change in amplitude).

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Appendix B

# Detailed Noise Survey Measurements

# B1 Detailed Noise Survey Measurements

An attended noise survey was conducted by Judith Chan of Arup Acoustics as follows:

- Daytime noise measurements conducted between 08:00 and 16:33; and
- Night-time noise measurements conducted between 22:53 and 02:09.

Measurements were taken at locations 1 to 4 for the assessment of the park and ride development. Measurements were taken at locations 5 to 7 for the assessment of the residential areas of the site.

## B1.1 Survey Methodology

### B1.1.1 Attended Survey

The sound level meter was set to record noise levels over 5, 10 and 15 minute periods during the daytime and 5 minute periods during night time periods. The meter was set to store the $L_{Aeq}$, $L_{A10}$, $L_{A90}$ $L_{Amax,S}$ and $L_{Amax,F}$ indices. Measurements were made with a fast (0.125s) time constant except when measuring $L_{Amax,S}$ which used a slow time constant (1s).

The measurements were made with the measurement microphone mounted using a tripod approximately 1.2m – 1.5m above ground level under acoustically free field conditions (i.e. at least 3.5 metres from any acoustically reflecting surface other than the ground).

## B1.2 Measurement Equipment

The sound level meter and microphone are Type 1 confirming to BS EN 61672-1: 2003. The calibration of the sound level meter and microphone was checked before and after use, to confirm that there was no significant drift in meter response at the calibrator frequency and level. This verification indicated that there was <0.5dB variation between checks. The meter is annually calibrated and this calibration is traceable to international standards.

Measurement instrumentation used is detailed in Table B1.

| Equipment | Manufacturer | Type number | Serial Number |
|---|---|---|---|
| Precision grade sound level meter | Brüel & Kjær | 2260 | 2370442 |
| ½“ diameter pre-polarised condenser microphone | Brüel & Kjær | 4189 | 2143205 |
| Type 1 sound pressure level calibrator | Brüel & Kjær | 4231 | 2402714 |

**Table B1: Measurement instrumentation**

## B1.3 Weather

Meteorological conditions during the noise survey periods were dry, with negligible wind speed (<<5ms$^{-1}$).

# B2 Noise Survey Results

## B2.1 Attended Measurements

Table B2 to Table B5 give the measured results of the attended noise survey. Measurement locations are as shown on Figure 1.

| Start Time (hh:mm) | Elapsed Time (mm:ss) | $L_{A90}$ | $L_{Aeq}$ | $L_{A10}$ | $L_{Amax,F}$ |
|---|---|---|---|---|---|
| 08:00 | 15:00 | 42 | 63 | 68 | 84 |
| 11:57 | 10:00 | 42 | 62 | 66 | 81 |

**Table B2 Measured noise levels at location 1, dB**

| Start Time (hh:mm) | Elapsed Time (mm:ss) | $L_{A90}$ | $L_{Aeq}$ | $L_{A10}$ | $L_{Amax,F}$ |
|---|---|---|---|---|---|
| 08:19 | 15:00 | 40 | 60 | 64 | 76 |
| 11:01 | 10:00 | 42 | 56 | 58 | 73 |
| 15:47 | 10:00 | 38 | 54 | 54 | 73 |

**Table B3 Measured noise levels at location 2, dB**

| Start Time (hh:mm) | Elapsed Time (mm:ss) | $L_{A90}$ | $L_{Aeq}$ | $L_{A10}$ | $L_{Amax,F}$ |
|---|---|---|---|---|---|
| 08:44 | 15:00 | 41 | 50 | 50 | 70 |
| 15:03 | 10:00 | 39 | 45 | 48 | 59 |

**Table B4 Measured noise levels at location 3, dB**

| Start Time (hh:mm) | Elapsed Time (mm:ss) | $L_{A90}$ | $L_{Aeq}$ | $L_{A10}$ | $L_{Amax,F}$ |
|---|---|---|---|---|---|
| 09:20 | 15:00 | 38 | 50 | 49 | 73 |
| 14:50 | 10:00 | 36 | 48 | 47 | 72 |

**Table B5 Measured noise levels at location 4, dB**

| Start Time (hh:mm) | Elapsed Time (mm:ss) | $L_{A90}$ | $L_{Aeq}$ | $L_{A10}$ | $L_{Amax,F}$ | $L_{Amax,S}$ |
|---|---|---|---|---|---|---|
| 10:12 | 05:00 | 38 | 43 | 45 | 54 | |
| 11:16 | 05:00 | 37 | 42 | 44 | 56 | |
| 15:21 | 05:00 | 36 | 41 | 44 | 55 | |
| 15:26 | 05:00 | 38 | 43 | 45 | 57 | |
| 15:33 | 05:00 | 37 | 43 | 44 | 63 | |
| 23:18 | 05:00 | 32 | 36 | 39 | 53 | 46 |
| 23:23 | 05:00 | 32 | 34 | 36 | 51 | 43 |
| 23:28 | 05:00 | 33 | 40 | 45 | 54 | 47 |
| 00:34 | 05:00 | 26 | 32 | 35 | 54 | 46 |
| 00:39 | 04:30 | 27 | 36 | 38 | 56 | 50 |
| 00:48 | 05:00 | 26 | 30 | 31 | 49 | 49 |
| 00:53 | 05:00 | 26 | 29 | 30 | 44 | 42 |
| 01:54 | 05:00 | 26 | 30 | 30 | 46 | 42 |
| 01:59 | 05:00 | 26 | 29 | 29 | 46 | 40 |
| 02:04 | 05:00 | 27 | 30 | 31 | 44 | 42 |

**Table B6 Measured noise levels at location 5, dB**

| Start Time (hh:mm) | Elapsed Time (mm:ss) | $L_{AE}$ | $L_{Aeq}$ | $L_{Amax,S}$ | $L_{AE}$ Details |
|---|---|---|---|---|---|
| 09:48 | 00:07 | 80 | 71 | 76 | Through train not stopping |
| 09:52 | 00:10 | 73 | 63 | 68 | Through train not stopping |
| 10:08 | 00:11 | 77 | 66 | 73 | Through train not stopping |
| 10:10 | 00:07 | 80 | 71 | 75 | Through train not stopping |
| 10:21 | 00:09 | 80 | 70 | 76 | Through train not stopping |
| 10:35 | 00:07 | 62 | 54 | | Stopping Train |
| 10:36 | 00:30 | 76 | 61 | 66 | Departing Train |
| 10:36 | 01:02 | 75 | 57 | 69 | Train stops, idles and then departs |
| 11:22 | 00:08 | 79 | 70 | 74 | Through train not stopping |
| 11:24 | 00:16 | 66 | 54 | 61 | Stopping Train |
| 11:25 | 00:19 | 65 | 52 | 55 | Departing Train |
| 11:32 | 00:09 | 77 | 68 | 73 | Through train not stopping |
| 11:33 | 01:31 | 74 | 54 | 64 | Train stops, idles and then departs |
| 23:16 | 00:25 | 69 | 55 | 65 | Stopping Train |
| 23:17 | 00:36 | 77 | 62 | 67 | Departing Train |

**Table B7 Measured $L_{AE}$ (sound exposure level) noise levels at location 5, dB**

| Start Time (hh:mm) | Elapsed Time (mm:ss) | $L_{A90}$ | $L_{Aeq}$ | $L_{A10}$ | $L_{Amax,F}$ | $L_{Amax,S}$ |
|---|---|---|---|---|---|---|
| 10:44 | 15:00 | 43 | 63 | 68 | 80 | |
| 11:39 | 15:00 | 44 | 64 | 68 | 83 | |
| 12:12 | 15:00 | 40 | 64 | 67 | 82 | |
| 22:53 | 05:00 | 33 | 63 | 65 | 82 | 79 |
| 22:58 | 05:00 | 32 | 56 | 59 | 73 | 70 |
| 23:03 | 05:00 | 32 | 57 | 60 | 75 | 73 |
| 00:12 | 05:00 | 31 | 51 | 48 | 70 | 68 |
| 00:18 | 05:00 | 31 | 44 | 40 | 62 | 62 |
| 00:23 | 05:00 | 31 | 53 | 54 | 71 | 69 |
| 01:33 | 05:00 | 28 | 34 | 34 | 50 | 51 |
| 01:38 | 05:00 | 27 | 47 | 35 | 70 | 67 |
| 01:43 | 05:00 | 28 | 35 | 39 | 54 | 48 |

**Table B8 Measured noise levels at location 6, dB**

| Start Time (hh:mm) | Elapsed Time (mm:ss) | $L_{A90}$ | $L_{Aeq}$ | $L_{A10}$ | $L_{Amax,F}$ | $L_{Amax,S}$ |
|---|---|---|---|---|---|---|
| 13:45 | 05:00 | 35 | 40 | 43 | 53 | |
| 14:01 | 05:00 | 36 | 40 | 42 | 52 | |
| 14:29 | 05:00 | 36 | 72 | 44 | 98 | |
| 16:06 | 05:00 | 36 | 41 | 42 | 65 | |
| 16:12 | 05:00 | 36 | 39 | 41 | 53 | |
| 16:17 | 05:00 | 37 | 46 | 43 | 63 | |
| 23:47 | 05:00 | 29 | 38 | 39 | 66 | 58 |
| 23:52 | 05:00 | 29 | 34 | 35 | 55 | 48 |
| 23:57 | 05:00 | 29 | 35 | 37 | 52 | 44 |
| 23:52 | 04:15 | 29 | 33 | 35 | 51 | 46 |
| 01:08 | 05:00 | 25 | 29 | 28 | 52 | 44 |
| 01:13 | 05:00 | 27 | 29 | 31 | 37 | 35 |
| 01:18 | 05:00 | 26 | 28 | 30 | 35 | 33 |

**Table B9 Measured noise levels at location 7, dB**

| Start Time (hh:mm) | Elapsed Time (mm:ss) | $L_{AE}$ | $L_{Aeq}$ | $L_{Amax,S}$ | $L_{AE}$ Details |
|---|---|---|---|---|---|
| 13:32 | 00:12 | 96 | 85 | 93 | Through train not stopping |
| 13:35 | 00:44 | 87 | 70 | 80 | Departing Train |
| 13:52 | 00:13 | 95 | 84 | 92 | Through train not stopping |
| 14:11 | 00:21 | 89 | 76 | 84 | Through train not stopping |
| 14:22 | 00:21 | 88 | 75 | 84 | Through train not stopping |
| 14:23 | 00:32 | 88 | 73 | 83 | Stopping Train |
| 14:35 | 00:30 | 87 | 73 | 81 | Departing Train |
| 16:32 | 00:10 | 97 | 87 | 93 | Through train not stopping |
| 16:33 | 00:30 | 87 | 72 | 80 | Departing Train |
| 23:41 | 00:32 | 85 | 70 | 78 | Departing Train |
| 23:42 | 00:17 | 79 | 67 | 74 | Stopping Train |
| 23:43 | 00:24 | 52 | 39 | 43 | Departing Train |

**Table B10 Measured $L_{AE}$ (sound exposure level) noise levels at location 7, dB**

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Appendix C

# Vibration Scoping Assessment

# C1 Vibration Survey

## C1.1 Survey

### C1.1.1 Vibration Measurements

A vibration scoping survey was conducted by Jamie Hladky of Arup Acoustics on 16 June 2010. The following equipment was used:

- 1 x SVAN type 958 four channel vibration analyzer; and
- 3 x PCB 393 B12 accelerometers.

The three measurement transducers were arranged such as to measure in orthogonal directions using a mounting block, attached to a metal ground spike hammered into the surface at each measurement location.

Triaxial vibration measurements were made at two locations distributed to be as far as practicable representative of the locations of the proposed buildings, within the constraints of the site. Approximate vibration monitoring locations are shown in Figure C1.

As the precise location of the proposed residential buildings is not yet known, the results of the scoping exercise are presented as indicative, to present gauge an approximate level of risk for informative purposes.

Measurements at location V1 were approximately 10m from the nearest rail.

Measurements at location V2 were approximately 8m from the nearest rail.

The south-western area of the development site was overgrown and access to the proposed housing area was not possible. Location V2 is an equivalent distance from the railway track and is considered to be a reasonable alternative. Geological conditions on the development site may differ from those close to the measurements location, therefore measured results may not be representative.

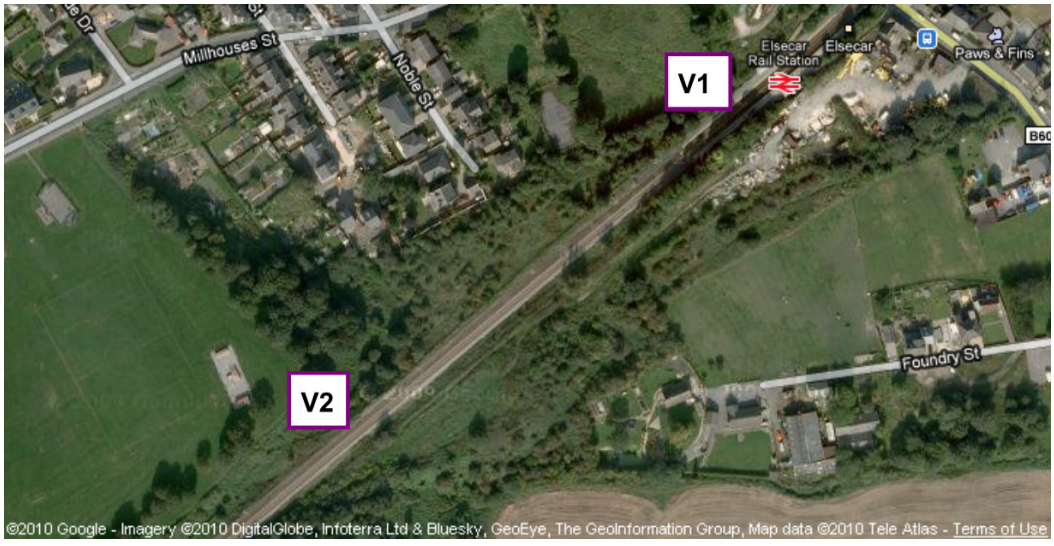



**Figure C1: Vibration monitoring locations**

### C1.1.2 Number of trains passing the site

Day and night VDV values are predicted based a sample of individual train pass-bys, factored to an 8 or 16-hour VDV according to BS6472[1]. Passenger train movement

[1] BS 6472 Guide to evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting, 2008. British Standards Institution.

numbers have been estimated from train timetables and information provided by SYPTE as shown in Table 14, reproduced as Table C1 for clarity.

| Train Movement Description | Train Movements | |
|---|---|---|
| | Daytime, 16 hours | Night, 8 hours |
| Non-stopping, through trains | 70 | 9 |
| Local stopping trains | 47 | 8 |

**Table C1: Estimated train movements**

# C2 Perceptible Vibration – Scoping Study

## C1.1 Assessment Criteria

This assessment relates to the risk of vibration resulting from trains passing the site being perceptible to occupants inside the proposed residences.

For the assessment of impulsive and intermittent vibration, such as occurs from train pass-bys, BS 6472 describes the vibration dose value (VDV) to define the relationship between disturbance and the magnitude and duration of exposure. The VDV is calculated from the acceleration according to weightings defined in BS 6841[2].

VDV ranges which might result in various probabilities of adverse comment within residential buildings are reproduced in Table C2, after BS 6472.

| Time period | Adverse comment not expected | Low probability of adverse comment | Adverse comment possible | Adverse comment probable | Adverse comment very likely |
|---|---|---|---|---|---|
| 16h day | <0.2 | 0.2 - 0.4 | 0.4 - 0.8 | 0.8 - 1.6 | >1.6 |
| 8h night | <0.1 | 0.1 - 0.2 | 0.2 - 0.4 | 0.4 - 0.8 | >0.8 |

**Table C2: Vibration Dose Values ($m/s^{1.75}$) which might result in various probabilities of adverse comment, in residential buildings (from BS 6472)**

## C1.3 Results of Perceptible Vibration Prediction

Table C3 presents a summary of the predicted day and night time period vibration dose values (VDV), calculated from the mean of sampled event VDVs for each measurement location. Values are predicted inside a typical residential dwelling at each of the measurement locations.

Calculations account for the appropriate proportion of stopping and through trains as indicated in Table C1, based on data measured during the vibration survey.

[2] BS 6841 Guide to measurement and evaluation of human exposure to whole-body mechanical vibration and repeated shock, 1987. British Standards Institution.

Presented VDVs are based on data recorded using the vertically orientated accelerometer. Post-analysis of each result identified the vertical (z-axis) vibration to be significantly higher than data recorded via the two horizontally orientated transducers.

| Measurement location (see Figure 2) | Residential building level | Time period, T | $VDV_T$, $m/s^{1.75}$ | Comment, as BS 6472 (Table C2) |
|---|---|---|---|---|
| V1 | Ground | 16hr day | 0.072 | Adverse comment not expected |
| | | 8hr night | 0.043 | |
| V1 | First | 16hr day | 0.144 | |
| | | 8hr night | 0.086 | |
| V2 | Ground | 16hr day | 0.412 | Adverse comment possible |
| | | 8hr night | 0.247 | |
| V2 | First | 16hr day | 0.825 | Adverse comment probable |
| | | 8hr night | 0.494 | |

**Table C3: Summary of predicted Vibration Dose Values for ground and first floor residential rooms, with probability of adverse comment as suggested by BS6472**

## C1.4 Discussion

Based on the vibration scoping survey and subsequent predictions, the risk of adverse comment due to perceptible vibration in residential buildings proposed for the north eastern part of the site is low.

The predicted VDV's suggest that perceptible vibration could be a risk if residential properties are developed in the south western areas of the site, where the predicted vibration values suggest probability of adverse comment between 'possible and 'probable'.

The south western area of the development site was overgrown and access to the proposed housing area was not possible. Measurement Location V2 is an equivalent distance from the railway track but some distance along it. Geological conditions on the development site may differ from those close to the measurement locations, therefore measured results may not be wholly representative.

If residential buildings are to be developed for any part of this site, it is strongly recommended that a more detailed vibration assessment is undertaken.