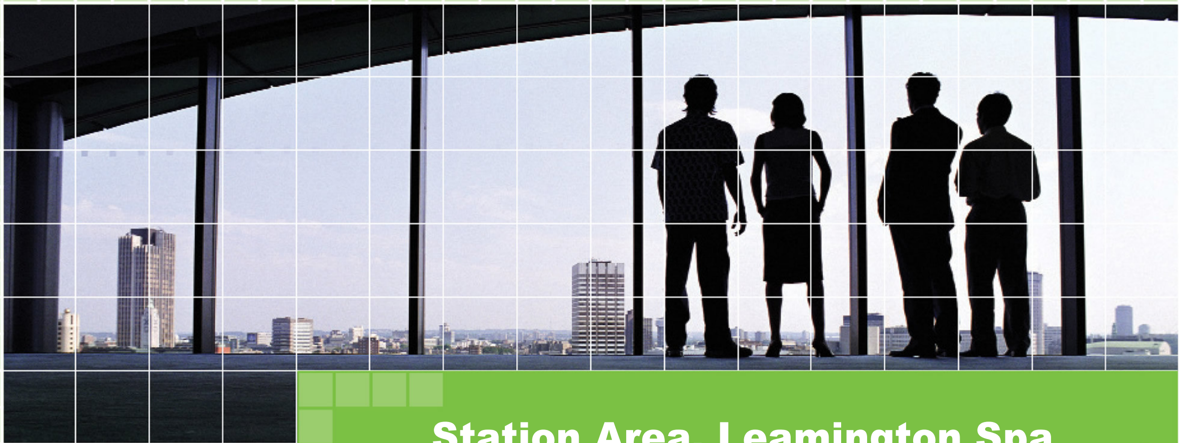

Station Area, Leamington Spa

Noise and Vibration Constraints

June 2008

QM

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Contents

1 Introduction

1.1 WSP Acoustics have been asked by WSP Environmental and Energy to undertaken a noise constraints appraisal for a site around the Train Station in Leamington Spa. The site comprises of a number of parcels of land. Some of which are currently open ground, some of which are being used for commercial operations.

1.2 At this stage no firm design proposals are in place.

1.3 This study has been undertaken to identify key noise sources in the vicinity of the site which have the potential to constrain any future development. As part of the study, consideration has been given to available noise mitigation measures such that these can be given due consideration in the preparation of the scheme masterplan.

1.4 At the outset of the project, consultation has been undertaken Warwick District Council (WDC). This consultation was undertaken to ensure WDC were accepting of the proposed methodology.

1.5 This assessment has been undertaken in accordance with Planning Policy Guidance Note (PPG) 24: *Planning and noise,* and the guidance contained therein, such as that contained in BS8233:1999: *Sound insulation and noise reduction for buildings – Code of practice*.

1.6 This assessment is based on the results of an environmental noise survey undertaken at the site commencing on the 8^{th} of April 2008 and concluding approximately 30 hours later.

1.7 This report is necessarily technical in nature so to assist the reader, a glossary of terminology relating to noise is contained in Appendix A.

2 Site Description

SITE LOCATION

2.1 The site comprises 14 individual land parcels. For the purposes of this document the reference system given in Appendix B1 of Appendix B has been adopted.

2.2 Area 1 is part of the Ford site and is bounded to the north by a railway line (4 lines), to the east by the A452 (Princes Drive), to the south by a retail site (Homebase, Lime Garage, Blockbuster, Dreams (Beds) and Pets at Home), and to the west by a number of residential properties.

2.3 Area 2 is another part of the Ford Site and is bounded to the north by a railway line (4 lines), to the east by the Spa Garage Site, to the south by the A425 (Old Warwick Road) and to the west by the A52 (Princes Drive).

2.4 Area 3 is another part of the Ford Site, but is currently leased to the Spa Garage Site and is bounded to the north by the railway line (4 tracks), to the east by Jewson's, to the south by the A425, (Old Warwick Road) and to the west by the Ford Site.

2.5 Area 4 is a Jewson's builder's merchants and is bounded to the north and east by Travis Perkins, to the south by the A425 (Old Warwick Road) and to the west by the Spa Garage.

2.6 Area 5 is a Travis Perkins builder's merchants and is bounded to the north by the railway line (6 tracks), to the east by Leamington Spa Train Station, to the south by the A425 (Old Warwick Road) and to the south east and south west by the Spa Garage and Jewsons respectively.

2.7 Areas 6, 7 and 8 make up Leamington Spa Train Station and are bordered to the north by residential properties and open land (Area 9), to east by Lower Avenue , to the south by the A425 (Old Warwick Road) and to the west by Travis Perkins and open land (Area 9)

2.8 Area 9 is open land bordered to the north by Station Approach, to the east by the Train Station, to the south by the railway line (6 tracks) and to the east by the Stagecoach bus depot.

2.9 Area 10 and 11 is part open land, part car-park and is bordered to the north by residential properties and a café and to all other sides by Station Approach.

2.10 Area 12 is the Stagecoach Bus Depot and is bordered to the north by car hire and car sales companies respectivly, to the east by open land (Area 9), to the south by the railway line (6 tracks) and to the west by more open land.

2.11 Area 13 is currently occupied by a car sales company and a car hire company. The car sales company occupies most of the North Eastern portion of the site with some spaces allocated to the car hire company. The remainder of the site is open land and is bordered to the north by residential properties and the A452 (Park Drive), to the east by the Bus Depot and Station Approach, to the south by the Bus Depot and the railway line (2 tracks) and to the west by the railway line (2 tracks).

2.12 Area 14 is another portion of the Ford site and is bordered to the north and east by the railway line (2 tracks), to the south by another section of line (4 tracks) and to the west by the A452 (Princes Drive).

3 Legislation And Guidance

PLANNING POLICY GUIDANCE NOTE 24: PLANNING AND NOISE

3.1 Planning Policy Guidance Note (PPG) 24: *Planning and Noise*, published in September 1994, sets out the Government's policies on noise related planning issues. It gives guidance to local authorities in England on the use of their planning powers to minimise the adverse impact of noise. Specifically, it:

- outlines the considerations to be taken into account when determining planning applications for both noise-sensitive developments and for those activities which will generate noise;
- sets out Noise Exposure Categories for residential development, encourages their use and recommends appropriate levels for exposure to different sources of noise; and
- advises on the use of planning conditions to minimise the impact of noise.

3.2 The four Noise Exposure Category (NEC) bands set out in PPG 24 are designed to assist local planning authorities in evaluating applications for residential development in noisy areas. Table 1 summarises the planning guidance for each NEC band. Table 2 sets out the noise levels relating to each NEC band for road traffic noise and mixed sources noise. PPG 24 states that 'mixed sources 'refers to any combination of road, rail, air and industrial noise sources, and there is a prescribed definition for when 'mixed sources' apply. This is considered further in the assessment section of this report.

TABLE 1 PLANNING ADVICE FOR EACH NOISE EXPOSURE CATEGORY

NEC	Planning Advice
A	Noise need not be considered as a determining factor in granting planning permission, although noise 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 are no quieter sites available, conditions should be imposed to ensure a commensurate level of protection against noise.
D	Planning permission should normally be refused.

TABLE 2 ROAD TRAFFIC AND MIXED SOURCES NOISE LEVELS CORRESPONDING TO THE NECS FOR NEW DWELLINGS $L_{AEQ\ T}$ dB, AS PRESENTED IN PPG 24

Noise Exposure Category	Road Traffic Noise Sources	
	Day 07:00-23:00	Night 23:00-07:00
A	<55	<45
B	55-63	45-57
C	63-72	57-66
D	>72	>66

3.3 In addition to the above, PPG 24 also states that, during the night (2300-0700 hours):

"*Sites where individual noise events regularly exceed 82 dB L_{Amax} (slow) several times in any hour should be treated as being in NEC C, regardless of the L_{Aeq} (8 hour) (except where the L_{Aeq} (8 hour) already puts the site into NEC D).*"

3.4 PPG 24 allows a degree of local authority discretion in the application of the above criteria, up to 3 dB(A) either way.

3.5 Where the advice within PPG 24 is that conditions should be imposed to ensure a commensurate level of protection against noise, reference is made to other standards that establish suitable internal and external noise levels, such as BS8233: 1999: *Sound insulation and noise reduction for buildings – Code of practice*, the requirements of which are summarised below.

BRITISH STANDARD BS8233: 1999: SOUND INSULATION AND NOISE REDUCTION FOR BUILDINGS - CODE OF PRACTICE

3.6 The scope of this standard is the provision of recommendations for the control of noise in and around buildings. It suggests appropriate criteria and limits for different situations, which are primarily intended to guide the design of new buildings or refurbished buildings undergoing a change of use, rather than to assess the effect of changes in the external noise climate.

3.7 The standard suggests suitable internal noise levels within different types of buildings, including dwellings. The criteria for typical buildings is repeated in Table 3 below.

TABLE 3 RECOMMENDED INTERNAL NOISE LEVELS $L_{AEQ, T}$ DB

Criterion	Typical Situation	Design Range $L_{Aeq,T}$ dB	
		Good	Reasonable
Reasonable Speech or Telephone Communication	Department Store	50	55
	Cafeteria, canteen, kitchen	50	55
	Wash-room, toilet	45	55
	Corridor	45	55
Reasonable conditions for study and work requiring concentration	Library, cellular office, museum	40	50
	Staff room	35	45
	Meeting room executive office	35	40
Suitable resting/sleeping conditions	Living Rooms	30	40
	*Bedroom	30	35
*For a reasonable standard in bedrooms at night, individual noise events (measured with fast time weighting should not normally exceed 45 dB L_{Amax}).			

3.8 BS8233 goes on to recommend noise levels for residential gardens. According to the BS8233, it is desirable that the steady noise level does not exceed $L_{Aeq,T}$ 50dB, and 55dB should be regarded as the upper limit.

WORLD HEALTH ORGANISATION (WHO) 1999: GUIDELINES FOR COMMUNITY NOISE

3.9 As with the '*good*' and '*reasonable*' criteria in BS8233, the L_{AFmax} criterion is largely concordant with the World Health Organisation (WHO) guidance: 1999: *Guidelines for Community Noise* which states:

> "*For good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB L_{AFmax} more than 10-15 times per night*"

CALCULATION OF ROAD TRAFFIC NOISE

3.10 As the dominant source of noise in the area was Road Traffic, due regard was paid to the Department of Transport document entitled Calculation of Road Traffic Noise (CRTN). The CRTN document, published in 1988 by the Department of Transport and The Welsh Office, sets out standard procedures for calculation and measurement of noise levels from road traffic.

3.11 CRTN permits a shortened measurement procedure to be utilised to determine road traffic noise levels, subject to certain limits. Measurements of the L_{A10} are made over three consecutive hours between 10:00 and 17:00 hours and the arithmetic average of the three consecutive $L_{A10,1hour}$ results minus 1 dB is approximately equal to the $L_{A10,18hour}$.

3.12 The CRTN calculations predict the $L_{A10,18hour}$ which need to be corrected to provide the daytime $L_{Aeq,16hour}$ for comparison with BS8233 criteria. BS8233 states that an $L_{Aeq,16hour}$ is approximately equal to $L_{A10,18hour}$ minus 2 dB.

3.13 CRTN also permits a comparison measurement method where relative measurements at satellite positions can be made for a minimum of two 15 minute periods and compared against a control position measured through the period 06:00 to 24:00.

BRITISH STANDARD 6472: 1992: EVALUATION OF HUMAN EXPOSURE TO VIBRATION IN BUILDINGS (1HZ TO 80HZ)

3.14 BS6472 contains guidance relating to human response to vibration, and uses the 'vibration dose value' that an occupant would receive over the course of a 16 hour day or 8 hour night-time period. The vibration dose value provides a means of specifying the time-varying, frequency-dependent vibration level of a given duration as a single number.

3.15 In terms of the vibration dose value over a 16 hour daytime period or 8 hour night-time period, the guidance in BS6472 is set out as follows.

TABLE 4 VIBRATION DOSE VALUES ($MS^{-1.75}$) ABOVE WHICH VARIOUS DEGREES OF ADVERSE COMMENT MAY BE EXPECTED IN RESIDENTIAL BUILDINGS

	Low probability of adverse comment	Adverse comment possible	Adverse comment probable
Residential Buildings 16h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential Buildings 8h night	0.13	0.26	0.51

3.16 Below a VDV of 0.2 $ms^{-1.75}$ for a 16 hour day and a VDV of 0.13 $ms^{-1.75}$ for an 8 hour night-time, adverse comment is considered unlikely.

3.17 The above guidance relates to vibration measured at the point of entry into the human body, which is usually taken to mean the ground surface or at a point mid-span of an upper storey floor, rather than the point of entry into the building (a foundation element). It was not possible in this instance to measure at such a location, therefore, the guidance contained in British Standard 7385 relating to measurement of vibration on solid ground has been followed.

4 Environmental Noise & Vibration Survey

4.1 A detailed environmental noise and vibration survey was undertaken by WSP Acoustics. This survey was carried out to establish the prevailing noise environment at the site. Road traffic noise, rail traffic noise, rail traffic vibration and industrial / commercial noise measurements were undertaken.

4.2 The survey began on the 8 April 2008 at approximately 1pm and was completed at approximately 7pm the following date.

4.3 Over the course of the survey, the following key noise and/or vibration sources were identified on, and in the vicinity of, the site:

- Road traffic noise form the A452
- Road traffic noise from the A425
- Rail traffic noise and vibration
- Operations at the recycling depot
- Vehicle movements from the Stagecoach bus depot

4.4 There were other noise sources in the vicinity of the site such as fork lift truck, car & hgv movements at the two builder's merchants, road traffic noise from the minor roads and plant noise from the commercial buildings. However, these sources provided minimal contributions to the overall ambient levels in the area which were instead dominated by those sources listed above. Furthermore it was noted that neither the recycling centre nor the commercial/retail units operated during the evening.

4.5 The noise survey was completed using the following type one specification noise measurement equipment.

TABLE 5 NOISE MEASUREMENT EQUIPMENT

Equipment	Serial Number
01dB-Stell SIP95 data logging integrating sound level meter	001417
01dB-stell PRE 12N ½" n Pre-amplifier	991523
Microtech Gefell GmbH MH 250 ½" Microphone	5487
01dB-Stell Solo Master data logging integrating sound level meter	10330
01dB-stell PRE 21S Pre-amplifier	10423
Microtech Gefell GmbH MCE212 Condenser Microphone	37991
01dB-Stell Solo Master data logging integrating sound level meter	11750
01dB-stell PRE 21S Pre-amplifier	12309
Microtech Gefell GmbH MCE212 Condenser Microphone	61802
01dB-Stell Cal21 Sound Calibrator	51031216

4.6 All sound level meters had been calibrated to traceable standards within the preceding two years and the calibrator within the preceding 12 months.

4.7 Over the course of the noise survey, the weather remained conducive towards noise measurement, remaining mainly dry with wind speeds ranging from still to light. There was some precipitation for approximately two hours on the evening of the 8th April 2008.

4.8 The measurement locations adopted during the noise survey can be seen in Figure B1 of Appendix B.

4.9 These are described as follows (all distances are approximate):

- Measurement Location 1, 30m north from the centre of the railway station and to the east of the northern platform. The microphone was located approximately 5m above ground level, but only 1m above platform height. Measurements at this location were undertaken to establish typical noise levels originating from the Train Station. This measurement was continuous over 24 hours.
- Measurement Location 2, 3.5m south from the edge of the carriageway of Station Approach. The microphone was positioned 1.5m above ground level. Measurements at this location were undertaken to establish typical levels of noise originating from Station Approach. Short term spot measurements were undertaken at this location.
- Measurement Location 3, 15m to the edge of the nearest railway line. For noise measurements the microphone was located 2.5m above ground level to avoid the fence and maintain line of site with the railway line. For vibration, the geophone was placed on the ground and data was measured over three orthogonal axis for a number of train pass-bys. Measurements at this location were undertaken to establish levels of noise and vibration of trains passing at the junction where two sets of lines meet. Short term spot measurements were undertaken at this location.
- Measurement Location 4, 14m from the edge of the carriageway of the A452 (Park Drive). The microphone was located 5m above ground level due to the topography of the land at that location. Measurements at this location were undertaken to establish levels of noise from the A452 (Park Drive). Continuous measurements over 24 hours were undertaken at this location.
- Measurement Location 5, 4m to the edge of the nearest railway line. For noise measurements the microphone was located 2.5m above ground level to avoid the fence and maintain line of site with the railway line. For the vibration, the geophone was placed on the ground and data was measured over three orthogonal axis for a number of train pass-bys. Measurements at this location were undertaken to establish noise and vibration levels along free train track. Short term spot measurements were undertaken at this location.
- Measurement Location 6, 7m from the edge of the carriageway of the A52 (Princes Drive). The microphone was positioned 1.5m above ground level. Measurements at this location were undertaken to establish the noise levels from the A52 (Princes Drive). Short term spot measurements were undertaken at this location.
- Measurement Location 7, 20m south of the recycling centre building approximately 2m from the southern edge to the access road. The microphone was positioned 1.5m above ground level. Measurements at this location were undertaken to establish the levels of noise originating from the Recycling Centre. Short term spot measurements were undertaken at this location.
- Measurement Location 8, 3.5m from the edge of the carriageway. The microphone was located 2.4m above the ground level to enable line of site with the centre of the carriageway. Measurements were undertaken at this location to establish levels of noise from the A425 (Old Warwick Road). A continuous measurement following the shortened measurement procedure in CRTN was undertaken at this location.

4.10 A summary of the measured noise levels is presented in the following Tables with the full tabulated measurement data presented in Appendix C.

TABLE 6 SUMMARY OF MEASURED NOISE LEVELS FOR MEASUREMENT LOCATIONS 1,2,3,6,7&8, FREE-FIELD dB

Measurement Location	Period	Time Period	$L_{Aeq,T}$	[1]Typical $L_{ASmax,T}$
1	Daytime	16 hours	60	-
	Night-time	8 hours	62	81
2	Daytime	16 hours	[3]56	-
4	Daytime	16 hours	68	-
	Night-time	8 hours	60	76
6	Daytime	16 hours	[3]73	-
7	Daytime	16 hours	[3]63	-
8	Daytime	16 hours	73	-
	Night-time	8 hours	[5]64	[2]82

[1] Taken as the 3rd highest L_{ASmax}, from any hour

[2] Value taken from daytime period in the absence of night-time data

[3] Value based on logarithmic average of two 15minute periods

[4] Value based on 3hr CRTN method

5 Value based on TRL method

TABLE 7 SUMMARY OF MEASURED TRAIN PASS-BYS AT LOCATIONS 3&5, FREE-FIELD dB

Measuremt Location	Start Time	End Time	Measured Noise Level dB L_{Aeq}	Duration (Seconds)
3	18:21:28	18:21:44	78.5	00:00:16
3	18:23:36	18:24:05	68.8	00:00:29
3	18:25:12	18:26:48	72	00:01:36
3	18:28:57	18:29:27	74.4	00:00:30
3	18:34:06	18:34:59	77.9	00:00:53
3	18:37:46	18:38:38	72.9	00:00:52
3	18:42:57	18:43:32	70.7	00:00:35
3	18:47:19	18:48:21	80	00:01:02
3	18:51:42	18:52:02	76.9	00:00:20
3	18:54:28	18:55:09	67.6	00:00:41
3	18:56:31	18:56:53	77.1	00:00:22
5	17:14:50	17:15:32	81.3	00:00:42
5	17:21:50	17:22:28	63.4	00:00:38
5	17:26:27	17:27:21	76.7	00:00:54
5	17:35:32	17:36:02	78	00:00:30
5	17:54:17	17:54:47	65.9	00:00:30
5	17:56:58	17:57:28	72.8	00:00:30
5	18:02:30	18:03:35	76.2	00:01:05
5	18:06:44	18:07:15	64.3	00:00:31
5	18:15:10	18:15:27	71.1	00:00:17

TABLE 8 SUMMARY OF PREDICTED VIBRATION LEVELS AT MEASUREMENT LOCATIONS 3&5

Location	Period	Duration, T	[1]No of train passby's	Vibration Dose Value (VDV $ms^{-1.75}$) at M3	Vibration Dose Value (VDV $ms^{-1.75}$) at M5
3	Daytime	16 hours	176	0.127	0.050
	Night-time	8 hours	25	0.078	0.031
[1] based on discussions with operator & counts applied to measured acoustic data					

5 Constraints Appraisal

NOISE MODEL

5.1 In order to establish the noise climate across the entire site, a detailed noise model has been prepared for the site and surrounding area in the PC based CadnaA ® noise modelling suite.

5.2 For the road, rail and recycling centre noise sources the model was prepared based on the results of the baseline noise survey. For the bus station discussions with the operator were used alongside site observations and noise levels from the WSP archive of historical measurement data.

5.3 Though there was a workshop on site & a coach-wash, the noise levels from the bus station were observed to be dominated by coach movements, particularly coaches driving by (pass-bys) and vehicles moving off (pull-offs). It was noted during the survey that coach movements occurred towards the coach station site boundary and also along station approach, consequently, noise from the coach station was modelled based on pass-bys and pull-offs occurring at the site boundary and along station approach.

5.4 The values given in Table 9 were used alongside the following assumptions to model the noise levels from the coach station:

- First bus leaves the depot at 05:47
- Last bus returns to the depot at 03:00
- Worst case typical hour would involve 50% of the vehicle stock and could occur within a 07:00-23:00 period or a 23:00-07:00 period.

TABLE 9 VEHICLE NOISE LEVELS

Operation	Noise Level (dB at 10m)	
	L_{AE}	L_{ASmax}
Passby	77	77
Pull off	85	82

5.5 The model was based on an open site in accordance with PPG24 and therefore all existing buildings which may in the future be removed have been ignored. However, it has been assumed that the Bus Depot and Train Station remain.

5.6 As at this stage the topography of the ground and the ground conditions cannot be confirmed, so flat hard ground has been assumed.

5.7 The model has been based on the dominant sources of noise in the area as follows:

- Road traffic noise form the A452
- Road traffic noise from the A425
- Rail traffic noise
- Operations at the recycling depot (Daytime only)

- Vehicle movements from the Stagecoach bus depot

5.8 The sound power level associated with each noise source was then calibrated using the noise levels measured during the survey and noise levels from the WSP archive of historical measurement data.

APPLICABLE NOISE EXPOSURE CATEGORIES

5.9 The final daytime and night-time noise models were used to determine the spread of noise across the entire site area. The models were run assuming hard ground and with 1st order reflections turned on.

5.10 The resulting daytime and night-time noise plots can be seen in Figures D1 and D2 of Appendix D. It can be seen from these Figures that road traffic noise dominates across the whole site and therefore the NECs for road traffic have been implemented. At locations close to other sources, the source in question dominates. However, looking at the site in its entirety road traffic is the dominant source of noise.

5.11 It is worth noting that the NECs for road traffic are identical to those for mixed sources.

5.12 The predicted noise levels have been categorised into accordingly to the PPG24 Noise Exposure Categories.

5.13 From Figure D1 it can be seen that during the daytime the site is mainly categorised as NEC C. However, close to the major sources of noise the noise levels increase and these parts of the site are categorised as NEC D. Typically this only occurs within 5m of the site boundaries. However, it is also evident that the A452 (Princes Drive) which is a duel carriageway connecting two roundabouts is the major source of noise in the area and that noise levels from this source results in 40m wide (Approx) strips of land being categorised as NEC D on the east side of areas 2 & 14 and the west side of area 1.

5.14 From Figure D2 it can be seen that during the night-time the site is again mainly categorised as NEC C. However, there area some noticeable differences when compared to the daytime situation. Most areas are categorised as NEC C right up to their boundaries. The NEC D strips in areas 1, 2 & 14 are reduced to around 20m. However the areas around the train station have areas categorised as NEC D. Ignoring the train station areas (6&7), around 50% of area 8, most of area 13 and all of area 9 is categorised at NEC D at night.

5.15 The increase in NEC D area on the night-time plot (to the north) results because NEC categories are more stringent during the night-time yet noise levels at the train station and bus station are similar during the night-time and daytime, therefore these sources both contribute. However, it is likely that more area is attributable to the bus depot.

5.16 The guidance in PPG 24 to the local planning authority for areas of the site identified as falling within NEC C would be:

> "*Planning permission should not normally be granted. Where it is considered that permission should be given, for example because there are not alternative quieter sites available, conditions should be imposed to insure a commensurate level of protection against noise.*"

5.17 The guidance in PPG 24 to the local planning authority for areas of the site identified as falling within NEC D would be:

> "*Planning permission should normally be refused.*"

5.18 Based on the above areas 1, 2, 3, 4, 5 and 14 maybe suitable for residential development, but planning permission would be unlikely to be given for residential development in areas 6, 7, 8, 9, 10, 11, 12 based on the night-time noise levels.

Although it should be noted that following a strict interpretation of PPG 24, the Local Authority could reject a planning application for residential development in this region, if for example they believe that other quieter sites are available.

VIBRATION

5.19 The Vibration Dose Value is used to analyse the cumulative effects of bursts of intermittent vibration such as rail traffic. These effects can be estimated by combining the VDV's of individual events according to the fourth power law:

$$V_T = (V_1^4 + V_2^4 + \ldots + V_N^4)^{0.25}$$

5.20 Based on this relationship, the VDV's presented in Table 8, and the observed number of rail movements also presented in Table 8 the vibration dose value can be calculated for both the daytime and night-time periods.

5.21 By comparing the total daytime and night-time VDV values presented in Table 8 with the assessment criteria presented in Table 4, it can be seen that the measured vibration levels at Measurement Locations 3 & 5 *correspond to level below 'low probability of adverse comment'*. This is true for both daytime and night-time periods.

5.22 It should be noted that measurements were undertaken at the boundary fence of area 13 and as such, if the boundary fence was moved closer to the railway line, further investigation would be required.

5.23 Typical work environments such as offices and work-shops have higher VDV thresholds, therefore given the results of this assessment it is considered that on-site vibration levels do not cause a constraint to either office, residential or industrial developments and consideration to railway induced vibration is un-warranted. Only critical work areas would require further investigation.

6 Mitigation

RESIDENTIAL

6.1 Given that the site has been identified as falling within NECs C and D, consideration has been given to appropriate acoustic attenuation measures to provide a commensurate level of protection against noise for those areas falling within NEC C. The areas falling within NEC D have been ignored as planning permission is usually refused for residential development falling within NEC D.

6.2 These mitigation measures have been considered to inform the scheme masterplanning process.

6.3 Therefore, as well as consideration to good practice scheme layout techniques, consideration has also been given to the general glazing and ventilation requirements.

6.4 For areas of the site falling within NEC C, with a well designed noise mitigation scheme, it would be possible to ensure a commensurate level of protection against noise for future occupants. Although, as detailed in the previous section, it should be noted that following a strict interpretation of PPG 24, the Local Authority could reject a planning application with development in this region, if for example they believe that other quieter sites are available.

6.5 Such a well designed noise mitigation scheme is likely to include some, or all of the following measures.

- Incorporation of advanced glazing systems such as acoustic laminates or secondary systems where habitable rooms must overlook the one of the key noise sources (Where line of site is prevented between the glazing and the source of noise the levels of noise will be reduced).
- Incorporation of ‘acoustic barrier blocks’, such as contiguous dwellings, located between the major sources of noise (roads/rail/bus depot/recycling site) and other dwellings. Such blocks can be used as noise barriers to dwellings located in their acoustic shadow or to ensure that the site regions behind them become NEC B or even NEC A. Typically such blocks would have habitable rooms (living rooms & bedrooms) on the opposite side of the building to the major source of noise and other rooms (bathrooms & corridors etc) on the side of the building facing the noise source.
- Where possible, gardens should not be located within NEC C. Where these are essential, these areas should be well screened from noise sources, for example by the proposed building envelopes or acoustically rated garden fences.
- Installation of an alternative means of rapid ventilation such as acoustically treated mechanical ventilation for rooms overlooking the major noise sources, to allow windows to remain closed whilst providing adequate background and rapid ventilation.

6.6 Incorporation of ‘acoustic barrier blocks’ as detailed above can be used as noise barriers to dwellings located in their acoustic shadow or to ensure that the site regions behind them become NEC B (or even NEC A). The actual mitigation requirements would depend on the actual noise levels. However, in practical terms, NEC B usually equates to a reduction in specification for glazing to operable double glazing systems and a reduction in ventilation requirements so that they can be met using the operable windows for rapid ventilation and standard trickle vents for background ventilations.

USAGE

As can be seen from Table 3, the criteria for residential buildings is more stringent than for typical commercial buildings, therefore, areas which are unsuitable for residential development may be suitable for another usage. This type of usage can then be used to formulate 'acoustic barrier blocks' as detailed above.

6.7 For comparative purposes Table 10 details BS8233 against typical situations.

TABLE 10 COMPARISON OF BS8233 CRITERIA WITH TYPICAL USAGES

USAGE	Reasonable Design Range $L_{Aeq,T}$ dB
Department Store	55
Cafeteria, canteen, kitchen	55
Wash-room, toilet	55
Corridor	55
Library, cellular office, museum	50
Staff room	45
Meeting room executive office	40
Living Rooms	40

SCHEME LAYOUT

6.8 The barrier effects of building perimeters are effective at reducing noise levels. This can be seen in Figures D1 & D2 of Appendix D, where areas of lower noise levels (NEC B) occur when a building prevents line of site with the noise source in question.

6.9 Incorporation of 'acoustic barrier blocks', located between the major sources of noise (roads/rail/bus depot/recycling site) and dwellings can be important in the scheme design. Such blocks can be used as noise barriers to dwellings located in their acoustic shadow or to ensure that the site regions behind them become NEC B or even NEC A.

6.10 Typically, alternatives to residential would lend themselves to this, such commercial or retail premises. However, residential blocks could be used if habitable rooms (living rooms & bedrooms) are located on the opposite side of the building to the major source of noise, leaving other rooms (bathrooms & corridors etc) on the side of the building facing the noise source.

7 Conclusion

7.1 WSP Acoustics have been asked by WSP Environmental and Energy to undertaken a noise constraints appraisal for a site around the Train Station in Leamington Spa. The site comprises of a number of parcels of land. Some of which are currently open ground, some of which are being used for commercial operations.

7.2 This study has been undertaken to identify key noise sources in the vicinity of the site which have the potential to constrain any proposed development. As part of the study, consideration has been given to available noise mitigation measures such that these can be given due consideration in the preparation of the scheme masterplan.

7.3 The assessment has identified that key noise sources in the vicinity of the site are road traffic on the A452 (Princes Drive/Park Drive and Avenue Road) and the A425 (Old Warwick Road), with contributions from the Train Station, the Bus Depot and the Recycling Centre.

7.4 Over the course of the noise survey, some noise from the nearby retail premises and builders merchants were audible. However, this was observed to be insignificant when compared to the dominant sources.

7.5 It has been identified that regions of the site fall within Noise Exposure Categories (NECs) C and D.

7.6 For NEC C, consideration has been given to the mitigation measures likely to be required to ensure a commensurate level of protection against noise for future occupants. Recommendations have been made to inform the development of the scheme layout. Identified mitigation measures and recommendations are presented in Section 6.

7.7 Subject to incorporation of the identified measures, it is anticipated that a commensurate level of protection could be incorporated into the scheme for residential development in areas 1,2,3,4,5 & 14, but that it is likely that planning permission for development would be refused for residential development in areas 6,7,8,9,10,11,12 and 13 based on the night-time noise levels. However, other development such as commercial/industrial or retail may be suitable for these areas.

7.8 It should be noted that even so, following a strict interpretation of Planning Policy Guidance Note 24: *Planning and noise* the Local Authority could reject a planning application with development in NEC C regions, if for example they believe that other quieter sites are available.

7.9 It should also be noted that incorporation of ‘acoustic barrier blocks’, located between the major sources of noise (roads/rail/bus depot/recycling site) and dwellings can be important in the scheme design. Such blocks can be used as noise barriers to dwellings located in their acoustic shadow or to ensure that the site regions behind them become NEC B or even NEC A.

7.10 Given the results of the vibration aspect of this assessment, it is considered that on-site vibration levels do not cause a constraint to either commercial or residential development and further consideration to railway induced vibration is un-warranted.

WSP ACOUSTICS

Appendix A Glossary Of Acoustic Terminology

NOISE

Noise is defined as unwanted sound. Human ears are able to respond to sound in the frequency range 20 Hz (deep bass) to 20,000 Hz (high treble) and over the audible range of 0 dB (the threshold of perception) to 140 dB (the threshold of pain). The ear does not respond equally to different frequencies of the same magnitude, but is more responsive to mid-frequencies than to lower or higher frequencies. To quantify noise in a manner that approximates the response of the human ear, a weighting mechanism is used. This reduces the importance of lower and higher frequencies, in a similar manner to the human ear.

Furthermore, the perception of noise may be determined by a number of other factors, which may not necessarily be acoustic. In general, the impact of noise depends upon its level, the margin by which it exceeds the background level, its character and its variation over a given period of time. In some cases, the time of day and other acoustic features such as tonality or impulsiveness may be important, as may the disposition of the affected individual. Any assessment of noise should give due consideration to all of these factors when assessing the significance of a noise source.

The most widely used weighting mechanism that best corresponds to the response of the human ear is the 'A'-weighting scale. This is widely used for environmental noise measurement, and the levels are denoted as dB(A) or L_{Aeq}, L_{A90} etc, according to the parameter being measured.

The decibel scale is logarithmic rather than linear, and hence a 3 dB increase in sound level represents a doubling of the sound energy present. Judgement of sound is subjective, but as a general guide a 10 dB(A) increase can be taken to represent a doubling of loudness, whilst an increase in the order of 3 dB(A) is generally regarded as the minimum difference needed to perceive a change under normal listening conditions.

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

TYPICAL SOUND LEVELS FOUND IN THE ENVIRONMENT

Sound Level	Location
0 dB(A)	Threshold of hearing
20 to 30 dB(A)	Quiet bedroom at night
30 to 40 dB(A)	Living room during the day
40 to 50 dB(A)	Typical office
50 to 60 dB(A)	Inside a car
60 to 70 dB(A)	Typical high street
70 to 90 dB(A)	Inside factory
100 to 110 dB(A)	Burglar alarm at 1m away
110 to 130 dB(A)	Jet aircraft on take off
140 dB(A)	Threshold of pain

ACOUSTIC TERMINOLOGY

dB (decibel)	The scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and a reference pressure ($2x10^{-5}$Pa).
dB(A)	A-weighted decibel. This is a measure of the overall level of sound across the audible spectrum with a frequency weighting (i.e. 'A' weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
$L_{Aeq,\ T}$	LAeq is defined as the notional steady sound level which, over a stated period of time (T), would contain the same amount of acoustical energy as the A - weighted fluctuating sound measured over that period.
L_{Amax}	L_{Amax} is the maximum A - weighted sound pressure level recorded over the period stated. L_{Amax} is sometimes used in assessing environmental noise where occasional loud noises occur, which may have little effect on the overall Leq noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
L_{10} & L_{90}	If a non-steady noise is to be described it is necessary to know both its level and the degree of fluctuation. The L_n indices are used for this purpose, and the term refers to the level exceeded for n% of the time. Hence L_{10} is the level exceeded for 10% of the time and as such can be regarded as the 'average maximum level'. Similarly, L_{90} is the 'average minimum level' and is often used to describe the background noise. It is common practice to use the L_{10} index to describe traffic noise.
Free-field Level	A sound field determined at a point away from reflective surfaces other than the ground with no significant contributions due to sound from other reflective surfaces. Generally as measured outside and away from buildings.
Façade Level	A sound field determined at a point 1 metre away from a vertical reflective surface. The acoustic contribution from reflections is generally taken to increase measured noise levels by 3 dB.
Specific Noise Level	The noise level measured in $L_{Aeq,T}$ attributed to the industrial noise source under consideration alone.
Background Noise Level	The noise level in the absence of the industrial source noise under consideration, measured in L_{A90}.
Fast	A time weighting used in the root mean square section of a sound level meter with a 125millisecond time constant.
Slow	A time weighting used in the root mean square section of a sound level meter with a 1000millisecond time constant.

VIBRATION

Vibration is defined as a repetitive oscillatory motion. Vibration can be transmitted to the human body through the supporting surfaces; the feet of a standing person, the buttocks, back and feet of a seated person or the supporting area of a recumbent person. In most situations, entry into the human body will be through the supporting ground or through the supporting floors of a building.

Vibration is often complex, containing many frequencies, occurring in many directions and changing over time. There are many factors that influence human response to vibration. Physical factors include vibration magnitude, vibration frequency, vibration axis, duration, point of entry into the human body and posture of the human body. Other factors include the exposed persons experience, expectation, arousal and activity.

Experience shows that disturbance or annoyance from vibration in residential situations is likely to arise when the magnitude of vibration is only slightly in excess of the threshold of perception.

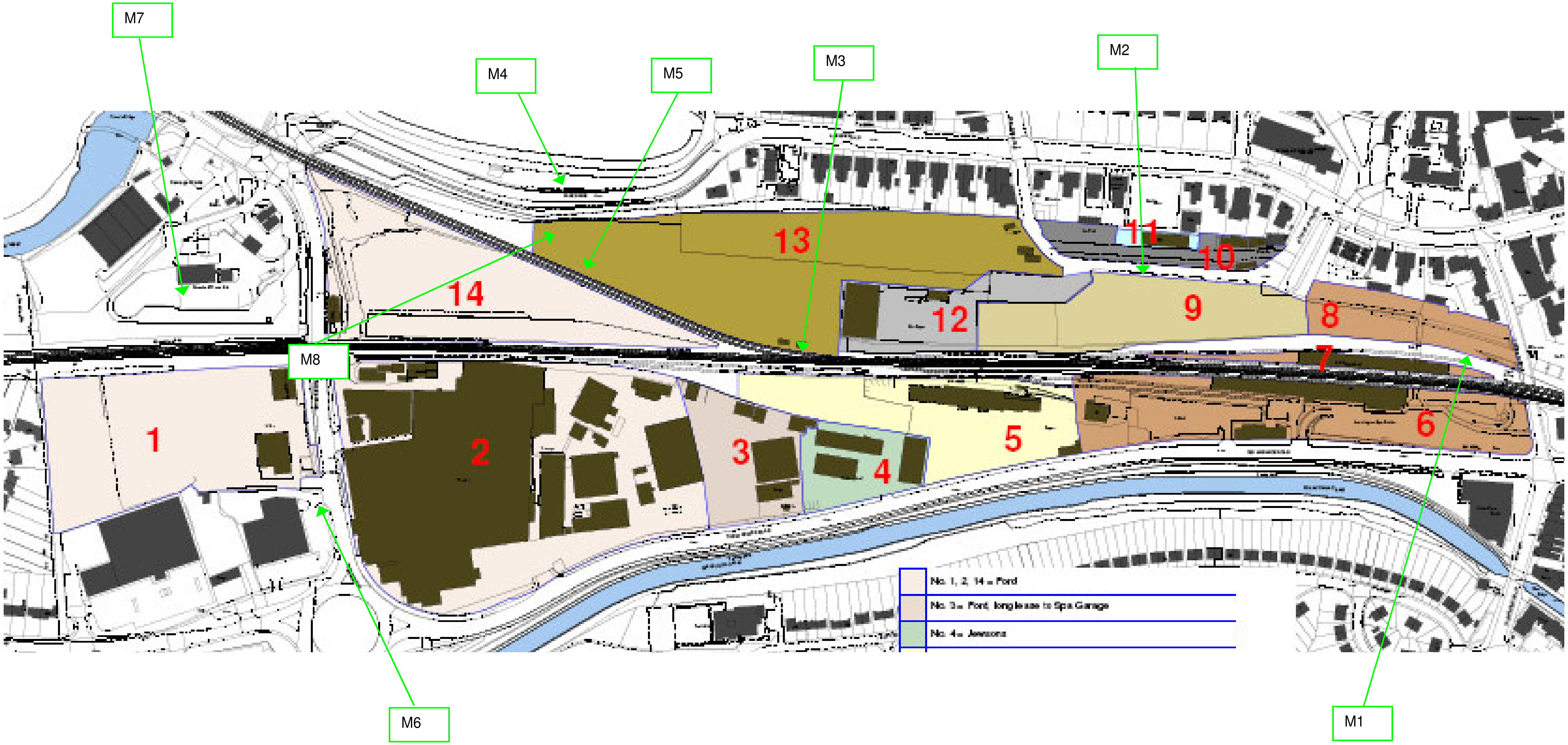
The threshold of perception depends on the frequency of vibration and the orientation of the individual. The human body is most sensitive to vibration in the vertical direction (head to toe) and in the frequency range 1-80Hz, and especially sensitive to vibration in the range 4-8Hz. As with noise, a frequency weighting mechanism is used to quantify vibration in a way that best corresponds to the frequency response of the human body. For occupants within buildings, the frequency weighting curve is defined in British Standard BS6472: 1992: Evaluation of human exposure to vibration in buildings.

BS6472 contains a series of base curves and multiplying factors relating to human response to vibration, and also introduces the concept of a "vibration dose value" that an occupant would receive over the course of a 16 hour day or 8 hour night-time period. The vibration dose value provides a means of specifying the frequency dependent vibration level of a given duration as a single number. Alternatively, vibration can be specified in terms of the peak velocity (peak particle velocity, or ppv) which, in addition to human response, provides a good correlation with the likelihood of vibration causing damage to buildings and structures.

TERMINOLOGY RELATING TO VIBRATION

Displacement, Acceleration and Velocity Root Mean Square (r.m.s.) and Peak Values Peak Particle Velocity (PPV)	Vibration is an oscillatory motion. The magnitude of vibration can be defined in terms of displacement (how far from the equilibrium position that something moves), velocity (how fast something moves), or acceleration (the rate of change of velocity). When describing vibration, one must specify whether peak values are used (i.e. the *maximum* displacement or *maximum* velocity) or r.m.s. / r.m.q. values (effectively an average value) are used. Standards for the assessment of building damage are usually given in terms of peak velocity (usually referred to as Peak Particle Velocity, or PPV), whilst human response to vibration is often described in terms of r.m.s. or r.m.q. acceleration.
Root Mean Square (r.m.s.)	The r.m.s. value of a set of numbers is the square root of the average of the squares of the numbers. For a sound or vibration waveform, the r.m.s. value over a given time period is the square root of the average value of the square of the waveform over that time period.
Root Mean Quad (r.m.q.)	The r.m.q. value of a set of numbers is the fourth root of the average of the fourth powers of the numbers. For a vibration waveform, the r.m.q. value over a given time period is the fourth root of the average value of the fourth power of the waveform over that time period.
Attenuation	A general term used to indicate the reduction of noise or vibration, or the amount (in decibels) by which it is reduced.
Amplification	A general term used to indicate the increase in noise or vibration, or the amount (in decibels) by which it is increased.
Transfer Function	…of a vibrating system is the ratio of the output or response of the system to the input excitation, usually expressed as a complex function of frequency.
Vibration Dose Value (VDV)	This is a measure of the amount of vibration that is experienced over a specified period, and has been defined so as to quantify the human response to vibration in terms of comfort and annoyance. The Vibration Dose Value is used to assess the likely levels of adverse comment about vibration, and is defined mathematically as the fourth root of the time integral of the fourth power of the acceleration, after it has been frequency weighted to take into account the frequency response of the human body to a vibration stimulus. Measured in units of $ms^{-1.75}$.

Appendix B Site And Measurement Locations


M7
M4
M5
M3
M2
13
11
10
14
12
9
8
M8
7
1
2
3
4
5
6
No. 1, 2, 14 = Ford
No. 3 = Ford, long lease to Spa Garage
No. 4 = Jewsons
M6
M1

Appendix C Full Tabulated Noise Survey Results

TABLE C1 MEASURED NOISE LEVELS AT LOCATION 1, FREE-FIELD, dB

Period start	L_{Aeq}	L_{A90}	L_{A10}	L_{ASmax}	L_{AFmax}
08/04/2008 15:11	57.8	49.4	59.4	78	74.5
08/04/2008 16:11	57.9	49.9	59	77.2	73.9
08/04/2008 17:11	58.6	51	60.6	76.5	74.7
08/04/2008 18:11	61.5	53.7	62.9	76.9	75.8
08/04/2008 19:11	61.1	50.9	67.6	78.3	77
08/04/2008 20:11	58.1	48.2	58	81.8	80.2
08/04/2008 21:11	56.5	47.1	56.4	77.3	75.8
08/04/2008 22:11	55.8	44.5	56	79	77.1
08/04/2008 23:11	55.7	41.3	55.8	77	76.3
09/04/2008 00:11	53.9	38.4	49.7	78.8	77.5
09/04/2008 01:11	52.9	37.6	52.2	77.5	76.6
09/04/2008 02:11	48	33.8	45.5	77.8	74.8
09/04/2008 03:11	51.8	36.1	50	75.4	74.3
09/04/2008 04:11	52.5	36.7	49.8	74.2	73.4
09/04/2008 05:11	69.3	49.5	69.2	83.7	82.5
09/04/2008 06:11	66.5	52.6	69.1	82	79.4
09/04/2008 07:11	59.6	52.7	61	79.6	78.4
09/04/2008 08:11	60.6	52.2	61.5	81.8	80.3
09/04/2008 09:11	58.7	49.7	59.3	78.2	76.1
09/04/2008 10:11	59.7	48.7	60.2	81.2	80.2
09/04/2008 11:11	58.7	49.1	60	80.1	77.4
09/04/2008 12:11	58.8	49	58.6	79.3	78.6
09/04/2008 13:11	59.2	49	60.1	81.8	80.6
09/04/2008 14:11	58.8	49.4	60.5	79.2	75.1
09/04/2008 15:11	57.7	49.7	59.2	76.1	74.4
09/04/2008 16:11	58.4	49.4	60.2	75.6	74.3
09/04/2008 17:11	57.1	50.2	59.6	74	71.3

TABLE C2 MEASURED NOISE LEVELS AT LOCATION 2, FREE-FIELD, dB

Period start	L_{Aeq}	L_{Amax}	L_{A90}	L_{A10}
09/04/2008 15:29	56.1	72.1	48.1	58
09/04/2008 14:10	56	77.2	47.3	58.4

TABLE C3 MEASURED TRAIN PASS-BYS AT LOCATION 3 (9/4/08), FREE-FIELD, dB

Start	End	dB L_{Aeq}	Duration in seconds
18:21:28	18:21:44	78.5	16
18:23:36	18:24:05	68.8	29
18:25:12	18:26:48	72	96
18:28:57	18:29:27	74.4	30
18:34:06	18:34:59	77.9	53
18:37:46	18:38:38	72.9	52
18:42:57	18:43:32	70.7	35
18:47:19	18:48:21	80	62
18:51:42	18:52:02	76.9	20
18:54:28	18:55:09	67.6	41
18:56:31	18:56:53	77.1	22

TABLE C4 MEASURED NOISE LEVELS AT LOCATION 4, FREE-FIELD, dB

Period start	L_{Aeq}	L_{Amax}	L_{A90}	L_{A10}
08/04/2008 13:56	68.6	91.1	60.4	70.7
08/04/2008 14:56	67.8	74.7	61.3	70.3
08/04/2008 15:56	68.2	75.5	62.2	70.6
08/04/2008 16:56	69.7	77	64	72.1
08/04/2008 17:56	70.4	79.7	64.1	72.9
08/04/2008 18:56	69.1	77.1	60.1	72.2
08/04/2008 19:56	66.6	76.3	53.5	70.5
08/04/2008 20:56	65.8	78.1	50	70
08/04/2008 21:56	64.3	75.3	44.9	68.9
08/04/2008 22:56	62	76.8	40.7	67
08/04/2008 23:56	57.4	74	37.1	60.6
09/04/2008 00:56	57.5	82.1	37.6	60.5
09/04/2008 01:56	51.9	70	35.1	47.5
09/04/2008 02:56	55.5	76.2	35.4	55.9
09/04/2008 03:56	56.5	75.8	36.3	60.1
09/04/2008 04:56	61.8	80.3	44.9	66.3
09/04/2008 05:56	64.8	76.7	49	69.6
09/04/2008 06:56	68.2	83.3	57	71.6
09/04/2008 07:56	68.3	87.1	60.2	71.3
09/04/2008 08:56	69.2	78.6	61.8	72
09/04/2008 09:56	68.1	90.7	59	70.9
09/04/2008 10:56	67.4	77.5	59	70.2
09/04/2008 11:56	68	76.2	60	70.8
09/04/2008 12:56	68.2	75.5	60.9	70.9
09/04/2008 13:56	68.1	81.5	61.2	70.7
09/04/2008 14:56	67.6	74.7	60.2	70.4
09/04/2008 15:56	68.2	75	61.8	70.9
09/04/2008 16:56	69.5	74.9	63.5	71.9

TABLE C5 MEASURED TRAIN PASS-BYS AT LOCATION 5 (8/4/08), FREE-FIELD, dB

Start	End	dB L_{Aeq}	Duration in seconds
17:14:50	17:15:32	81.3	42
17:21:50	17:22:28	63.4	38
17:26:27	17:27:21	76.7	54
17:35:32	17:36:02	78	30
17:54:17	17:54:47	65.9	30
17:56:58	17:57:28	72.8	30
18:02:30	18:03:35	76.2	65
18:06:44	18:07:15	64.3	31
18:15:10	18:15:27	71.1	17

TABLE C6 MEASURED NOISE LEVELS AT LOCATION 6, FREE-FIELD, dB

Period start	L_{Aeq}	L_{Amax}	L_{A90}	L_{A10}
09/04/2008 16:02	73.4	87.7	68.8	75.3
09/04/2008 14:37	72.7	85.9	68.6	74.6

TABLE C7 MEASURED NOISE LEVELS AT LOCATION 7, FREE-FIELD, dB

Period start	L_{Aeq}	L_{Amax}	L_{A90}	L_{A10}
09/04/2008 16:02	62.5	83.1	52.1	63
09/04/2008 14:37	64.2	82	49.7	63.9

TABLE C8 MEASURED NOISE LEVELS AT LOCATION 8, FREE-FIELD, dB

Period start	L_{Aeq}	L_{Amax}	L_{A90}	L_{A10}
09/04/2008 10:34	73.1	86.9	60.5	76.8
09/04/2008 11:34	72.7	96.2	58.5	76.2
09/04/2008 12:34	72.5	84.7	58.2	76.4
09/04/2008 13:34	72.7	83.3	58.2	76.2

TABLE C9 MEASURED VIBRATION DOSE VALUE LEVELS AT LOCATION 3

date	time	Vibration Levels		
		vdv (acc) - Trans (W_d mm/s^2)	vdv (acc) - Vert (W_g mm/s^2)	vdv (acc) - Long (W_d mm/s^2)
09/04/2008	18:12:01	4.86	31.2	5.77
09/04/2008	18:18:06	0.502	0.658	0.376
09/04/2008	18:20:43	5.71	33.9	6.34
09/04/2008	18:23:02	2.22	24.9	3.62
09/04/2008	18:25:08	3.42	24.4	4.46
09/04/2008	18:28:24	5.02	39.6	6.78
09/04/2008	18:33:48	8.32	38	7.79
09/04/2008	18:37:19	3.74	17.8	4.27
09/04/2008	18:42:29	2.69	24.8	3.9
09/04/2008	18:46:44	4.39	34.5	6.07
09/04/2008	18:51:03	5.5	45.1	7.97
09/04/2008	18:53:51	1.7	15	2.49
09/04/2008	18:55:54	6.46	45	7.67

TABLE C10 MEASURED VIBRATION DOSE VALUE LEVELS AT LOCATION 5

date	time	Vibration Levels		
		vdv (acc) - Trans (W_d mm/s^2)	vdv (acc) - Vert (W_g mm/s^2)	vdv (acc) - Long (W_d mm/s^2)
08/04/2008	17:15:06	2.8	7.37	3.35
08/04/2008	17:21:56	0.048	3.73	0.915
08/04/2008	17:26:35	3.07	13.1	3.12
08/04/2008	17:35:34	4.44	16.5	4.74
08/04/2008	17:54:19	0.939	3.08	0.849
08/04/2008	17:57:07	1.98	16.2	3.31
08/04/2008	18:02:35	4.4	19.8	4.3
08/04/2008	18:06:49	0.83	3.26	0.854
08/04/2008	18:13:37	2.52	7.27	2.44

Appendix D Site Noise Maps

FIGURE D1 DAYTIME NOISE EXP0SOURE CATEGORIES

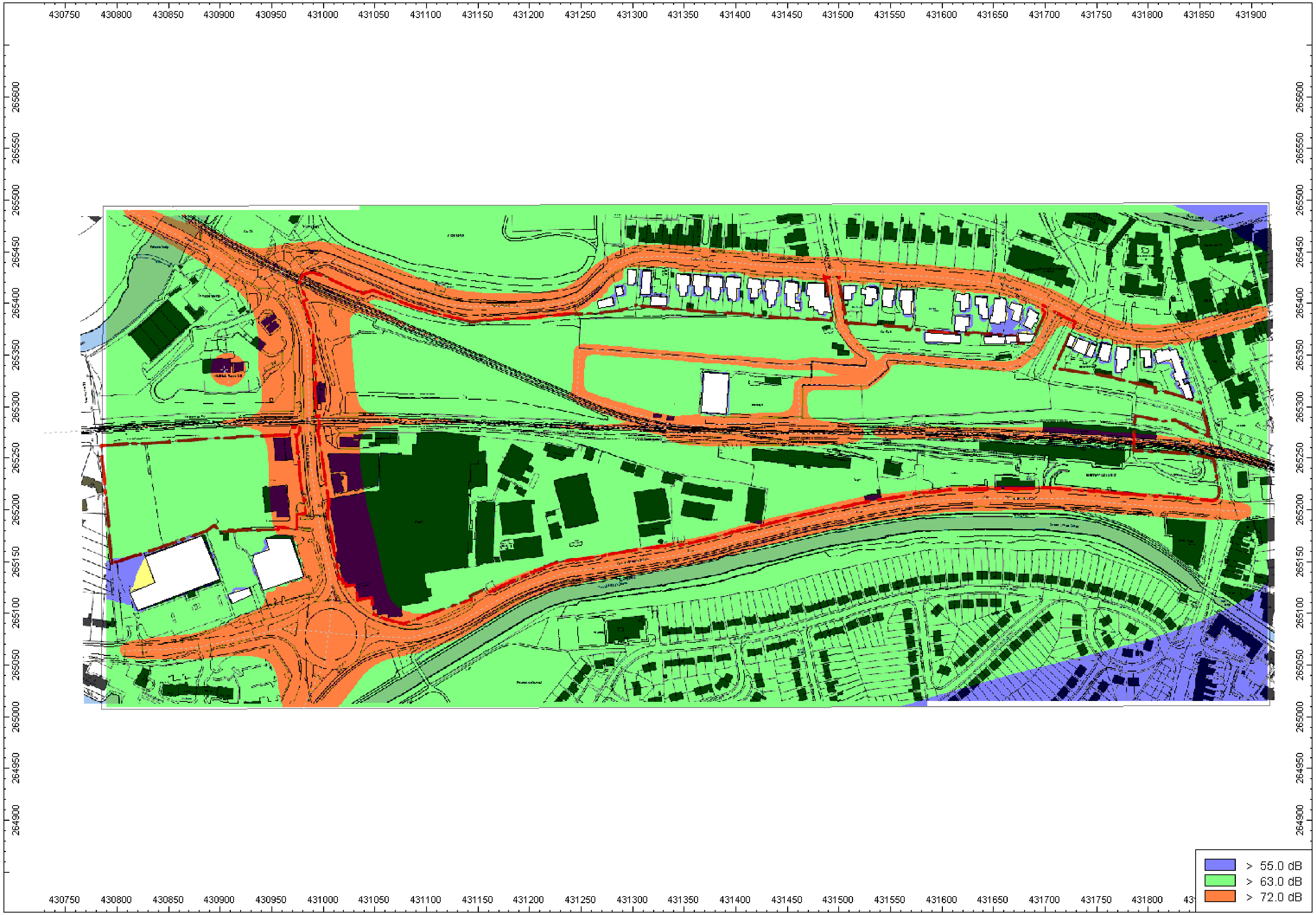
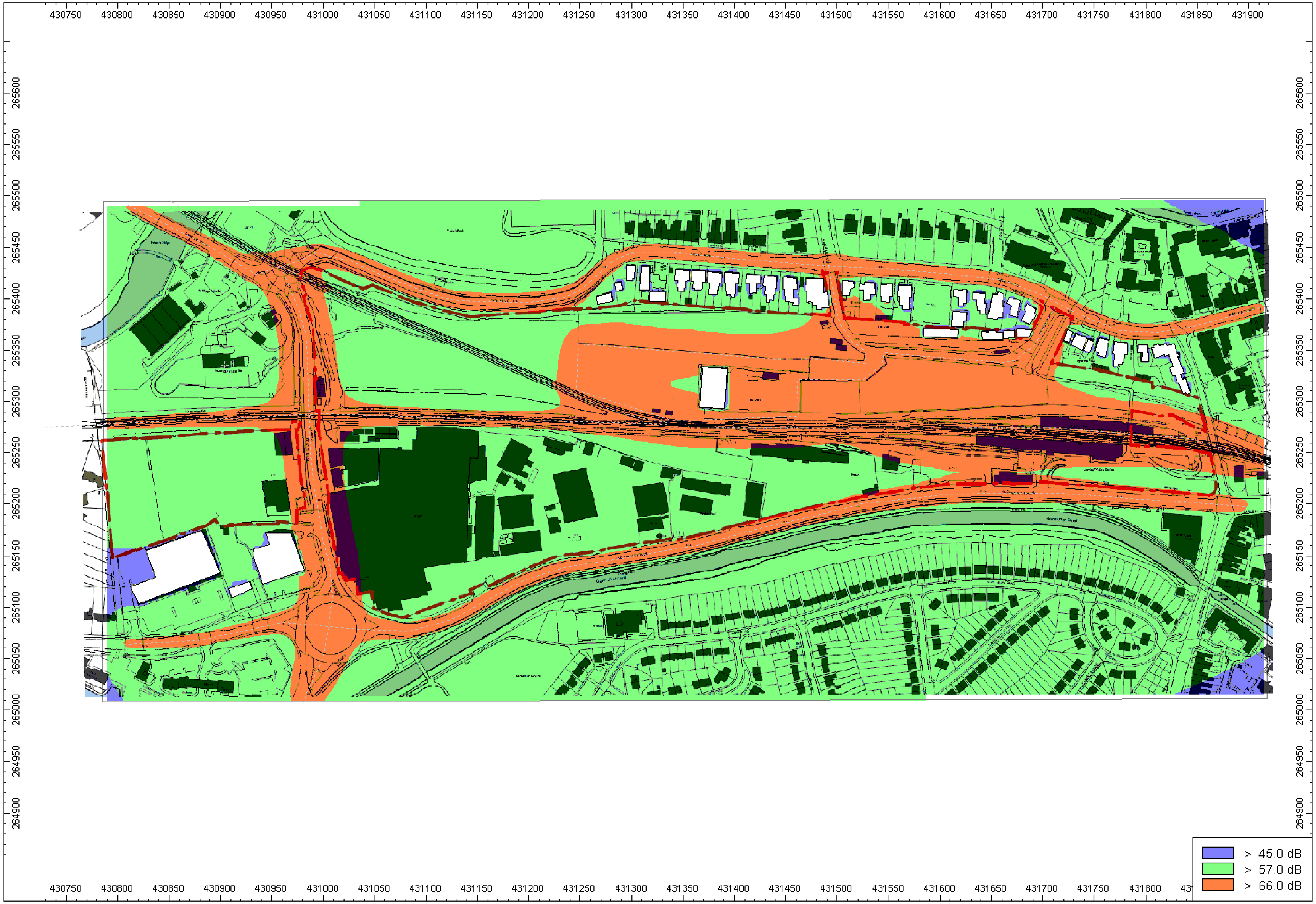


FIGURE D2 NIGHT-TIME NOISE EXPOSURE CATEGORIES



Appendix E Limitations

NOTES ON LIMITATIONS

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