



Knowsley Lane, Knowsley

Noise impact assessment

8199.1

26th May 2022

Revision B



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Contents

1	Summary	3
2	Introduction.....	4
3	Planning policy and noise criteria	5
4	Existing acoustic environment	7
5	Noise sources.....	7
6	Noise mitigation measures included.....	9
7	BS 4142 assessment results	9
8	Car park assessment	11
9	Plant and equipment noise limits	11
10	Vibration limits	12
11	Conclusion	12
12	References.....	13
	Appendix A Noise exposure hierarchy.....	14
	Appendix B Background sound levels.....	15
	Appendix C Representative noise measurements	16
	Appendix D Noise transmission and propagation.....	17
	Appendix E Specific sound level contours	18
	Appendix F Car Park L_{AFmax} sound level contours.....	19
	Appendix G Professional qualifications and competence	20

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1 Summary

- 1.1 This report has been prepared in support of a Planning Application for the proposed mixed use (70:30 B8:B2 use) development at Knowsley Lane, Knowsley.
- 1.2 Pre-application advice received from Knowsley Council suggests the assessment of potential noise and vibration associated with the development. Noise criteria and assessment methodology have been agreed with Knowsley Council Environmental Health department.
- 1.3 Background and residual sound levels have been measured at positions considered representative of the identified noise-sensitive receptors. Noise levels for potential sources have been based on previous representative measurements.
- 1.4 Noise propagation has been modelled with proprietary environmental noise modelling software CadnaA.
- 1.5 The potential noise impact due to HGV movements, loading/unloading activities, noise breakout from the units, and vehicle movements in the car park is calculated and rated in accordance with BS 4142. A scheme for the noise mitigation is proposed to reduce the risk for adverse impact from these sources.
- 1.6 Noise barriers, as shown in Figure 1, are proposed to reduce noise impact to below agreed limits. To be effective in practice, a barrier should have no cracks or gaps, be continuous to the ground, and have a surface density of at least 10 kg/m^2 , such as a timber fence with overlapping boards, brick wall, earth mound, or any combination of these.
- 1.7 With the proposed barriers, BS 4142 rated noise levels do not exceed the representative daytime and night-time background sound levels at the nearest residential noise sensitive receptors. The rated noise levels also do not exceed the lowest existing residual equivalent noise levels at the receptors, which is a positive indication that the noise due to the proposed sources are unlikely to be significantly distinguishable against existing ones.
- 1.8 It is understood from the client that reversing alarms will not be used during the night-time; this will be a management measure.
- 1.9 The noise breakout from the buildings is based on internal noise levels not exceeding the lower exposure action value in the Noise at Work Regulations of 80 dB(A) . Should the future end users wish to operate with noise levels higher than 80 dB(A) , the building sound insulation performance may need to be considered, and rollers shutters kept closed except when in use.
- 1.10 Noise impact due to the proposed car parks associated with the development is calculated to not exceed agreed night-time maximum noise level criteria. The calculated equivalent noise levels due to the car parks at the nearest residential noise sensitive receptors do not exceed the lowest existing residual equivalent sound levels and the calculated maximum noise levels are significantly lower than the highest existing residual maximum sound levels, which is a positive indication that

the noise due to cars at the car park is unlikely to be distinguishable against existing road traffic noise.

- 1.11 At this stage in the development, building services plant or other equipment specifications are unavailable. Rated noise limits are proposed for the cumulative impact of future plant and equipment noise at the nearest noise sensitive receptors to result in a rated BS 4142 noise impact that is 5 dB below the background sound level, as per Local Authority requirements.
- 1.12 As vibration levels cannot be predicted, vibration limits resulting in low probability of adverse impact to be achieved at the nearest residential noise sensitive receptors are proposed.
- 1.13 Adherence to vibration limits may be validated by measurement once the development is in full operation, should there be any significant source of vibration. It is however considered unlikely for vibration levels due to the proposed operation of the development to result in an adverse impact at the nearest residential noise sensitive receptors.
- 1.14 Based on the mitigation details and proposed limits outlined in this report, the noise and vibration risks may be mitigated and minimised, and the site is considered suitable for the proposed development.

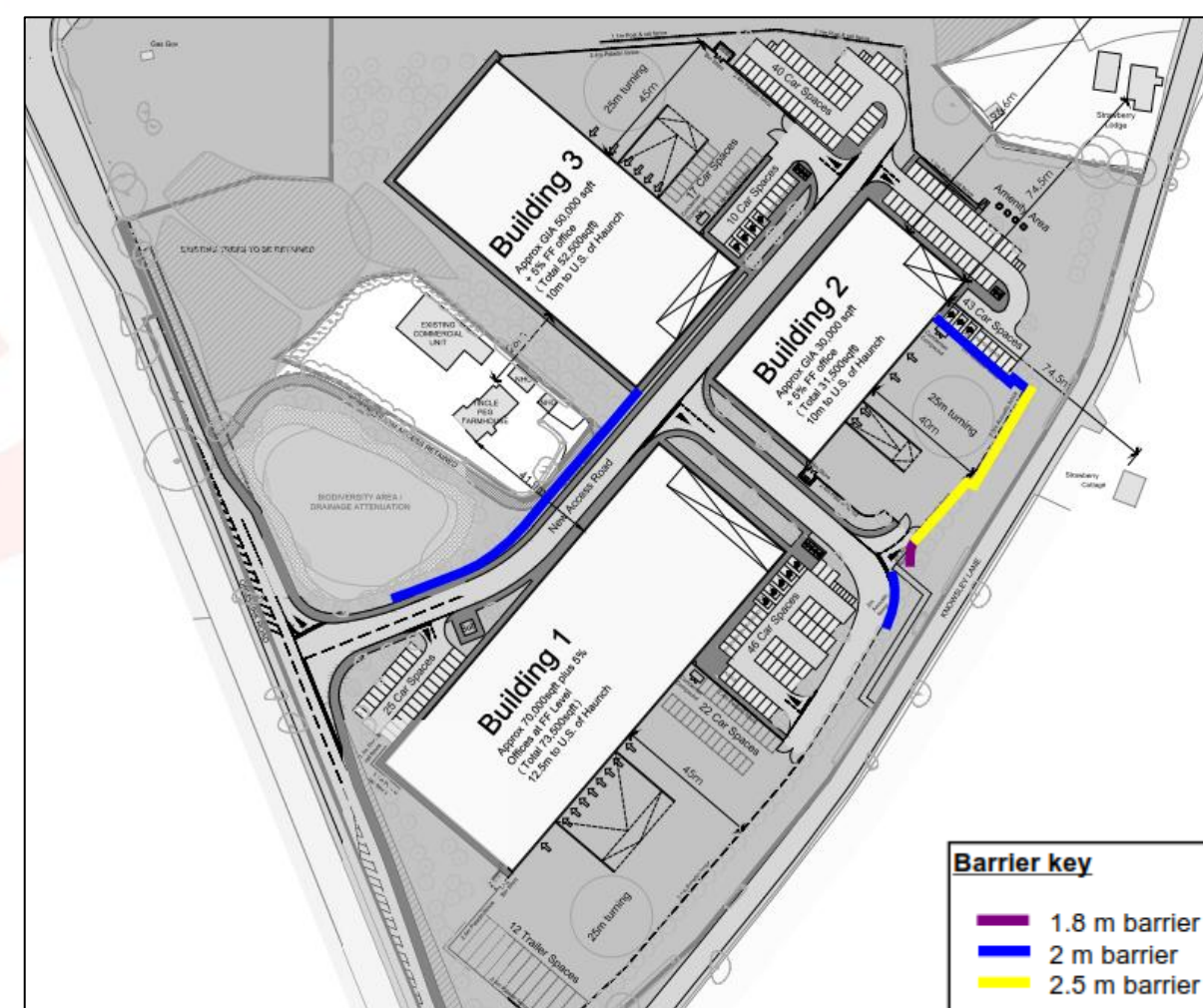


Figure 1: Proposed noise barrier locations

2 Introduction

- 2.1 A mixed-use development (70:30 B8:B2 use) consisting of three buildings has been proposed at Knowsley Lane, Knowsley; the end users are not at the time of writing this report.
- 2.2 The site location is shown in Figure 2.
- 2.3 Apex Acoustics has been commissioned to undertake a noise survey and assessment of the noise from potential operations of the development in support of a Planning Application.
- 2.4 The scope of our instruction includes:
- Measurement of the existing noise environment over a 24-hour period at two locations representative of the nearest noise-sensitive receptors;
 - Analysis of potential source noise levels, based on previously measured noise levels and historic measurement data;
 - Calculate noise propagation using proprietary noise modelling software to the noise-sensitive receptors and assess the impact in accordance with agreed criteria;
 - Advise on a scheme for noise mitigation to satisfy Local Authority requirements; and
 - Propose plant noise limits and vibration limits to satisfy Local Authority requirements.
- 2.5 This report presents the evaluation of the potential noise impact from the operation of the proposed development on the identified nearest noise-sensitive receptors (NSRs), in support of a Planning Application.
- 2.6 The NSRs are identified as the residential properties on Ormskirk Road to the west (NSR 1), and Knowsley Lane to the north-east (NSR 2) and east (NSR 3) of the site, as shown in Figure 2.



Figure 2: Proposed site outlined in red, measurement positions, and identified NSRs

3 Planning policy and noise criteria

3.1 National Planning Policy Framework (NPPF)

3.2 The National Planning Policy Framework (NPPF) Reference 1, sets out the Government's planning policies for England and how these should be applied. It provides a framework within which locally-prepared plans for housing and other development can be produced. In respect of noise, Paragraph 174, 185 and 187 of the NPPF states the following:

3.3 Paragraph 174:

"e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability..."

3.4 Paragraph 185:

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

a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life⁶⁵ [See Explanatory Note to the Noise Policy Statement for England];

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

3.5 Paragraph 187:

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

3.6 Noise Policy Statement for England (NPSE)

3.7 The Noise Policy Statement for England, Reference 2, states three policy aims as follows:

"Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

- avoid significant adverse impacts on health and quality of life;*
- mitigate and minimise adverse impacts on health and quality of life; and*
- where possible, contribute to the improvement of health and quality of life."*

3.8 The NPSE defines adverse noise impact as follows:

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

3.9 The first two aims of the NPSE require that no significant adverse impact should occur and that, where a noise level which falls between a level which represents the lowest observable adverse effect and a level which represents a significant observed adverse effect, then according to the explanatory notes in the statement:

"... all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life whilst also taking into consideration the guiding principles of sustainable development. This does not mean that such effects cannot occur."

3.10 Planning Practice Guidance – Noise

3.11 Further Government guidance on how planning can manage potential noise impact in new development is outlined in Planning Practice Guidance (PPG-N) notes on the Government website: www.gov.uk/guidance/noise--2

3.12 Pre-application advice

3.13 It is understood that the following pre-application advice has been provided for the development:

"Any future planning application must be accompanied by a scheme for the protection of the dwellings from noise and vibration from the proposed industrial and commercial units. The scheme shall be based on the findings of an approved noise survey or noise modelling procedure, although without knowing the end users, this will be difficult to do."

3.14 Local Authority correspondence

3.15 The following criteria has been agreed with Knowsley Council Environmental Health:

- Noise due to potential operation of the development and car park use will be assessed following BS 4142 assessment methodology, such that the rated noise impact does not exceed the daytime and night-time representative background sound levels at the NSRs;
- L_{AFmax} levels due to car door/ boot slams associated with the car parks will be assessed to not exceed 60 dB(A) externally at the NSRs, which is consistent with WHO Guidelines for Community Noise, Reference 3;
- As plant specification are not know at the time of writing this report, limits will be proposed such that the rated noise impact is 5 dB below existing background sound levels; and
- As vibration levels cannot be predicted, limits will be proposed for potential operations associated with the development, following pre-application advice. This may be validated by measurements once the development is in full operation, should there be any significant source of vibration; this is considered unlikely based on the development proposals.

3.16 BS 4142

3.17 BS 4142, Reference 4, defines an assessment method to quantify the potential level for adverse impact from commercial and / or industrial noise sources impacting upon sound sensitive receptors i.e. residential development.

3.18 The method estimates the impact significance by comparing the Rated noise against the background sound levels, as summarised below:

- Typically, the greater this difference, the greater the magnitude of the impact.
- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of around + 5dB is likely to be an indication of an adverse impact, depending on the context.
- The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound sources having a low impact, depending on the context.

3.19 The terminology used in BS 4142 to describe the various levels of potential adverse impact is respect to the PPG-N noise hierarchy, are summarised Appendix A.

3.20 BS 6472

3.21 While there are no absolute levels of vibration defined as acceptable, BS 6472, Reference 5, defines levels in terms of the vibration dose value (VDV) at which various potential for adverse comment may be anticipated.

3.22 The BS 6472 guidance levels for VDV in residential buildings are shown in Table 1.

Probability of adverse comment	Vibration Dose Value, $ms^{-1.75}$ in residential buildings	
	16 hour day	8 hour night
Low	0.2 – 0.4	0.1 – 0.2
Possible	0.4 – 0.8	0.2 – 0.4
Probable	0.8 – 1.6	0.4 – 0.8

Table 1: Guidance of BS 6472 on VDV ranges which may result in various probabilities of adverse comment in residential buildings

3.23 It is proposed that vibration levels due to the operations associated with the development should not exceed the VDV's resulting in low probability of adverse impact.

4 Existing acoustic environment

- 4.1 The existing acoustic environment was measured for a 24 hour period from 15:59 hours on 7th May 2021.
- 4.2 The measurement positions are shown in Figure 2.
- 4.3 The microphone was located 6 metres above ground level and away from other reflecting surfaces such that the measurements are considered free-field.
- 4.4 Data was recorded in single-octave band frequencies at one-second intervals throughout the measurement period.
- 4.5 The most significant noise source was the road traffic on A580 to the north and Knowsley Lane to the east of the site.
- 4.6 The equipment used is listed in Table 2.

Equipment	Model	Serial no.
Sound Level Meter	NTi XL2	A2A-12479-E0
Calibrator	Larson Davis CAL 200	13405
Sound Level Meter	NTi XL2	A2A-14176-E0
Calibrator	Larson Davis CAL 200	15307

Table 2: Equipment used

- 4.7 Both meter and calibrator have current calibration certificates traceable to national standards. The sound level meter has been calibrated within the last two years and calibrator has been calibrated within the last year in accordance with the guidance of BS 4142; calibration certificates are available on request.
- 4.8 The equipment was field-calibrated before and after the measurements with no significant drift in sensitivity noted.
- 4.9 **Background sound level**
- 4.10 Statistical analysis is undertaken of the results of all the $L_{A90, 1hr}$ and $L_{A90, 15min}$ data following the guidance of BS 4142, to determine a background sound level considered to be representative of the assessment periods. Results of the analysis are shown in Appendix B.
- 4.11 Based on the statistical analysis results, the background sound levels considered representative of the daytime and night-time assessment periods are shown in Table 3.
- 4.12 The range of measured existing daytime $L_{Aeq, 1hr}$ and night-time $L_{Aeq, 15min}$ and $L_{AFmax, 1 min}$ levels are also shown in Table 3.

Assessment period	$L_{A90, T}$ (dB)		$L_{Aeq, T}$ (dB)		$L_{AFmax, 1 min}$ (dB)	
	Position 1	Position 2	Position 1	Position 2	Position 1	Position 2
Daytime (07:00 – 23:00 hrs)	54	44	55 – 62	52 – 58	-	-
Night-time (23:00 – 07:00 hrs)	53	43	48 - 59	47 - 56	45 - 72	44 - 69

Table 3: Existing sound levels

- 4.13 The measurements at position 1 is considered representative for NSR 2 and 3, and at position 2 for NSR 1.

5 Noise sources

- 5.1 The following are considered as potential noise sources associated with the development:

- HGV movements;
- Loading/ unloading activities in the yard including reversing alarms;
- Activity noise breakout from the buildings;
- Vehicles in the car parks; and
- Future building services plant, and other operation specific equipment.

5.2 HGV movements

- 5.3 The potential number of HGV movements within the site has been estimated based on the trip data provided by the client.
- 5.4 The number of daytime HGV movements has been based on the worst-case one-hour period. It is assumed that 25% of the worst-case daytime one-hour movements could occur during the night-time 15-minute assessment period. The number of HGV movements used in the assessment are shown in Table 4.

Period	No. of deliveries
Daytime (07:00 – 23:00 hrs)	10 per 1 hour
Night-time (23:00 – 07:00 hrs)	3 per 15 minutes

Table 4: Number of HGV trips

- 5.5 During the daytime assessment period, 3 deliveries each are considered to Buildings 2 and 3, and 4 deliveries to Building 1, as this is the largest. During the night-time assessment period, 1 delivery is considered to each building.
- 5.6 The noise from HGV movements is assessed based on previously measured representative data.

5.7 Noise measurements used are shown in Appendix C, and the calculated sound power is shown in Table 5 below.

HGV movement	Single-octave band centre frequency (Hz) A-weighted sound power levels (dB)							dB(A)
	63	125	250	500	1k	2k	4k	
Sound power level	75	77	83	86	91	87	80	93

Table 5: HGV sound power

5.8 The resulting sound power for the 1-hour and 15-minute assessment periods are calculated in the noise model as a moving point source along the access roads and yards, on the basis that the HGV travels at a speed of 10 km/h.

5.9 The trailer parking spaces to the south of the site associated with Building 1 are located further away from all identified NSRs. HGV movements on the yard of Building 1 are modelled at worst-case locations with respect to the NSRs. HGV movements to and from the trailer parking space are unlikely to result in a higher noise impact at the NSRs and are not separately considered.

5.10 Loading/ unloading activities

5.11 Noise from forklift loading/ unloading activities is assessed based on previously measured representative data at a warehouse yard.

5.12 Noise measurements used are shown in Appendix C, and the calculated sound power is shown in Table 5 below.

Loading/unloading	Single-octave band centre frequency (Hz) A-weighted sound power levels (dB)							dB(A)
	63	125	250	500	1k	2k	4k	
Sound power level	69	80	81	82	83	81	75	89

Table 6: Loading/ unloading activities sound power

5.13 The calculated sound power level is attributed to point sources in the noise model, placed at worst-case locations with respect to the nearest NSRs. One point source is used for the night-time 15-minute assessment period considering one HGV movement per building, and four point sources for the daytime 1-hour assessment period. The loading/unloading activities are assumed to be continuous throughout the daytime and night-time assessment periods; this is a prudent assumption.

5.14 Reversing alarms

5.15 It is understood from the client that reversing alarms will not be used during the night-time; this will be a management measure.

5.16 Reversing alarms associated with the HGVs and forklifts are not separately modelled. A 4 dB penalty for tonality is applied in the BS 4142 daytime assessment, for a likely clearly perceptible tone. The tonality is unlikely to be highly perceptible at the NSRs during the daytime considering the existing residual noise levels.

5.17 Noise breakout from the buildings

5.18 End users and internal layout of the buildings are not known at this stage.

5.19 For the assessment of feasibility, it is considered that the maximum noise level inside the building will be 80 dB(A), which corresponds to the lower exposure action value in the Noise at Work Regulations, 2005.

5.20 The noise breakout from the building is calculated using the following equation:

$$SPL_{ext} = SPL_{int} - SRI - 6$$

where,

SPL_{ext} is the external free-field sound pressure level after breakout through the building element;

SPL_{int} is the internal reverberant sound pressure level;

SRI is the sound reduction index of the building element; and

6 dB is the correction between an internal diffuse field and external free field.

5.21 The noise breakout from the buildings is modelled as area sources to represent potential roller shutter locations. The area sources are modelled at worst-case locations with respect to the NSRs.

5.22 The roller shutters are considered open during the daytime and night-time assessment period, for worst case assessment, such that the $SRI = 0$ dB.

5.23 The noise breakout from the building is considered to be continuous throughout the daytime and night-time assessment periods; this is a prudent assumption.

5.24 Should the future end users wish to operate with noise levels higher than 80 dB(A), the building sound insulation performance may need to be considered, and roller shutters kept closed except when in use.

5.25 Vehicles in car parks

5.26 The most significant noise sources associated with the car parks, which have a potential to affect the NSRs, are identified as follows:

- car movements associated with each parking bay (a car entering and leaving the parking bay); and
- door/boot slams of each car.

5.27 The noise emission from the car parks associated with each building has been calculated using the RLS-90 calculation method, Reference 6, which is implemented to Cadna/A software.

5.28 This guidance describes the method for calculating the noise emitting from a car park based on:

- the type of the parking area, i.e. for car or bus parking;
- number of vehicle movements at daytime or night-time;
- number of parking spaces; and
- ground absorption and barrier shielding effect.

5.29 The Emission Level L^*_{mE} is calculated using the following equation:

$$L^*_{mE} = 37 + 10 \cdot \log(N \cdot n) + D_p$$

Where N is the number of vehicle movements per space per hour according to Table 5 of the standard, unless more precise figures are present (arrival and departure count as one movement each);

n is the number of spaces within the area or sub-area; and

D_p is an additional correction for different vehicle types.

5.30 It is assumed that all parking bays are accessed once in a 1-hour daytime assessment period, i.e., $N=1$.

5.31 During the night-time, it is assumed that 50% of the bays may be accessed. This would mean 12.5% of the bays are in accessed during the BS 4142 night-time 15 minute assessment period, i.e., $N=0.125$.

5.32 The N values assumed for the daytime and night-time assessment are greater than the values in Table 5 of RLS-90 and present a prudent assessment.

5.33 The L_{AFmax} levels due to car door slams has been measured by Apex, and due to boot slams has been taken from measurements done by others. Noise measurements used are shown in Appendix C and the sound power levels of the sources are shown in Table 7.

Source	L_w L_{AFmax} dB
Car door slam	95
Car boot slam	94

Table 7: Sound power levels of car door and boot slams

5.34 The highest of the above sources, due to car door slam, is modelled in Cadna/A as a point source and attributed the sound power level shown in Table 7. The point source is positioned at the worst-case car park location to calculate the highest impact at the NSRs.

5.35 Plant

5.36 As the end users are speculative, plant specifications and locations are not known at this stage.

5.37 Plant noise limits are proposed in Section 9.

5.38 Noise transmission and propagation

5.39 Noise transmission and propagation is modelled to the NSRs based on the noise source data detailed, using proprietary software, CadnaA, Reference 7.

5.40 This models noise propagation outdoors according to ISO 9613, Reference 8.

5.41 The model parameters and assumptions are summarised in Appendix D.

6 Noise mitigation measures included

6.1 Noise barriers with heights and locations as shown in Figure 2 are proposed to reduce noise levels at the NSRs.

6.2 To be effective in practice, a barrier should have no cracks or gaps, be continuous to the ground, and have a surface density of at least 10 kg/m², such as a timber fence with overlapping boards, brick wall, earth mound, or any combination of these.

7 BS 4142 assessment results

7.1 Sound level contours, at 4 m representative of worst-affected first floor window heights, showing the daytime $L_{Aeq,1hr}$ and night-time $L_{Aeq,15min}$ specific sound levels due to potential operation of the site are shown in Appendix E.

7.2 BS 4142 assessment for the site, with the proposed noise mitigation measures is presented in Table 8.

Parameter	NSR 1		NSR 2		NSR 3		Relevant clause of BS 4142	Commentary
	Daytime	Night-time	Daytime	Night-time	Daytime	Night-time		
Background sound level	53 dB $L_{A90, 1hr}$	43 dB $L_{A90, 15min}$	54 dB $L_{A90, 1hr}$	44 dB $L_{A90, 15min}$	54 dB $L_{A90, 1hr}$	44 dB $L_{A90, 15min}$	8.1.2 8.1.4	Considered representative of the assessment period based on statistical analysis detailed in Appendix B.
Specific sound level L_s , due to all sources for the required assessment interval	41 dB $L_{Aeq, 1hr}$	40 dB $L_{Aeq, 15min}$	45 dB $L_{Aeq, 1hr}$	38 dB $L_{Aeq, 15min}$	47 dB $L_{Aeq, 1hr}$	41 dB $L_{Aeq, 15min}$	7.2 7.3.6	The calculated L_s contours across the site due to all sources during the assessment period are shown in Appendix E; the L_s assessed is the highest calculated level at the NSRs.
Acoustic feature correction	+ 7 dB	+ 3 dB	+ 7 dB	+ 3 dB	+ 7 dB	+ 3 dB	9.2	A subjective assessment to determine acoustic features is undertaken, and the following penalties are considered applicable: • Tonality – 4 dB (reversing alarms – daytime only, see Para 5.16); • Impulsivity – 0 dB; • Intermittency – 3 dB; and • Other – 0 dB.
Rating level, $L_{Ar,Tr}$	48 dB	43 dB	52 dB	41 dB	54 dB	44 dB		
Uncertainty of assessment							10	As the end users are not known at this stage, the assessment is based on a number of prudent assumptions for the type and location of potential noise sources. Uncertainty in the calculated impact has been reduced by the use of a calculation method in accordance with ISO 9613-2.
Excess of $L_{Ar,Tr}$ over background sound level	- 5 dB	0 dB	- 2 dB	- 3 dB	0 dB	0 dB	11	The rated noise impact does not exceed the representative background sound levels at any NSR, with the proposed noise barriers. Worst-case operational conditions and source locations have been used in the assessment for prudence. The rated noise impact also does not exceed the existing lowest residual daytime $L_{Aeq, 1hr}$ and night-time $L_{Aeq, 15min}$ at the NSRs. This is a positive indication that the specific levels due to the noise sources associated with the development are unlikely to be significantly distinguishable against existing road traffic noise at the NSRs. The assessment result indicates the likelihood of a low impact .

Table 8: BS 4142 assessment results, with proposed mitigation measures

8 Car park assessment

- 8.1 Sound level contours showing the L_{AFmax} levels at 4 m above the ground level due to car door/boot slams at worst case locations of the car parks are shown in Appendix F.
- 8.2 The highest calculated $L_{Aeq,T}$ and L_{AFmax} levels at the NSRs due to the car parks are shown in Table 9. The $L_{Aeq,T}$ levels have been determined from the partial levels in the BS 4142 noise model.

NSR	Daytime $L_{Aeq,1hr}$ dB	Night-time $L_{Aeq,15min}$ dB	L_{AFmax} dB
1	37	28	45
2	43	34	54
3	42	33	54

Table 9: Calculated noise levels due to car parks

- 8.3 The calculated L_{AFmax} levels do not exceed the agreed criteria at the NSRs, which is consistent with WHO Guidelines for Community Noise. As such, annoyance and sleep disturbance due to maximum noise levels are unlikely at the NSRs.
- 8.4 The calculated $L_{Aeq,T}$ levels do not exceed the lowest existing residual noise levels at the NSRs, and the calculated L_{AFmax} levels are significantly lower than the highest existing residual levels, as shown in Table 3. This is a positive indication that the noise associated with vehicles at the car parks are unlikely to be distinguishable against existing road traffic noise sources.

9 Plant and equipment noise limits

- 9.1 Future building services plant and other equipment noise limits have been determined at the NSRs, following the requirements of Local Authority Environment Health, such that the rated noise impact is 5 dB below existing representative background sound levels.
- 9.2 The proposed noise limits are presented in Table 10.

Period	Rated noise impact, $L_{Ar,Tr}$ (dB)		
	NSR 1	NSR 2	NSR 3
Daytime (07:00 – 23:00)	48	49	49
Night-time (23:00 – 07:00)	38	39	39

Table 10: Proposed noise limits

- 9.3 Rated noise levels below the proposed limits should be attained for all building services plant and equipment during all 1-hour periods during the daytime and all 15 minute periods throughout the night time.

10 Vibration limits

- 10.1 The pre-application advice suggests assessment of vibration levels associated with the development.
- 10.2 As vibration levels cannot be predicted, limits to be achieved at the NSRs are proposed in this section.
- 10.3 It is proposed that vibration levels due to the operations associated with the development should not exceed the VDV_s resulting in low probability of adverse impact, as shown in Table 11.

Parameter	Vibration Dose Value, ms ^{-1.75}	
	16 hour day	8 hour night
Proposed VDV limits	0.2 – 0.4	0.1 – 0.2

Table 11: Proposed vibration limits

- 10.4 This may be validated by measurement once the development is in full operation, but it is only considered appropriate to do so if there are any significant sources of vibration.
- 10.5 It is considered unlikely for vibration levels due to the proposed operation of the development to result in an adverse impact at the NSRs.

11 Conclusion

- 11.1 Potential noise sources associated with the development has been modelled based on previous representative measurements and assessed against proposed criteria.
- 11.2 Barriers as shown in Figure 2 are calculated as required to reduce BS 4142 rated noise impact due to potential HGV movements, loading/unloading activities, noise breakout from the buildings, and vehicle movements in the car parks to below agreed noise limits.
- 11.3 L_{AFmax} noise levels due to car door/boot slams associated with the proposed car parks are calculated to not exceed agreed noise criteria.
- 11.4 As end users are unknown, plant and equipment specifications are unavailable. Rated noise limits are proposed for the cumulative impact of future plant and equipment noise at the nearest noise sensitive receptors to result in a rated BS 4142 noise impact that is 5 dB below the background sound level, as per Local Authority requirements.
- 11.5 Vibration limits are proposed to result in low probability of adverse impact at the nearest residential noise sensitive receptors.
- 11.6 Based on the mitigation details and proposed limits outlined in this report, the noise and vibration risks may be mitigated and minimised, and the site is considered suitable for the proposed development.

12 References

- 1 National Planning Policy Framework, Ministry of Housing, Communities & Local Government, February 2021.
- 2 Noise Policy Statement for England, Department for Environment, Food and Rural Affairs, March 2010.
- 3 Guidelines for Community Noise, Edited by Birgitta Bergland, Thomas Lindvall, Dietrich H Schwela, World Health Organisation, 1999.
- 4 BS 4142 2014: A1+2019, Method for rating and assessing industrial and commercial sound.
- 5 BS 6472-1:2008, Guide to evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting.
- 6 RLS-90: Richtlinien für den Lärmschutz an Straßen, 1990.
- 7 CadnaA environmental noise modelling software, version 2017, Datakustik GmbH.
- 8 ISO 9613: Acoustics - Attenuation of sound during propagation outdoors.
- 9 Proposed site plan, Fletcher Rae Architects, 2022.
- 10 DEFRA LIDAR height data, 2017
<https://environment.data.gov.uk/DefraDataDownload/?Mode=survey>

Appendix A Noise exposure hierarchy

Planning Practice Guidance - Noise				Significant adverse effect Adverse effect Low Impact An initial estimate of the impact of the specific sound may be obtained by subtracting the measured background sound level from the rating level. Typically, the greater this difference, the greater the magnitude of impact + 10 dB + 5 dB 0 dB
Noise	Example of outcomes	Increasing effect level	Action	
Present and very distributive	Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	Prevent	
Present and distributive	The noise causes a material change in behaviour, attitude or other physiological response, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid	
Significant Observed Adverse Effect Level (SOAEL)				
Present and intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum	
Lowest Observed Adverse Effect Level (LOAEL)				
Present and not intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life.	No Observed Adverse Effect	No specific measures required	
No Observed Adverse Effect Level (NOAEL)				
Not present	No effect	No Observed Effect	No specific measures required	
No Observed Effect Level (NOEL)				

Table 12: PPG-N Noise Exposure Hierarchy and BS 4142 initial estimate of impact

Appendix B Background sound levels

B.1 Analysis to determine the typical background sound level representative of the daytime and night-time period is undertaken following the guidance of BS 4142, with results shown below.

B.2 Position 1

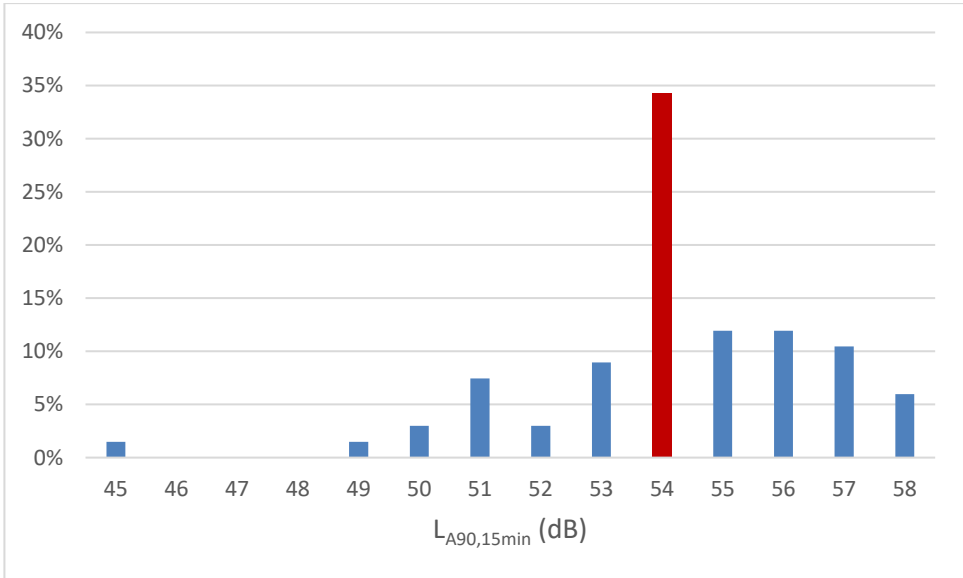


Figure 3: Analysis of daytime background levels, LA90, 1hr – Position 1

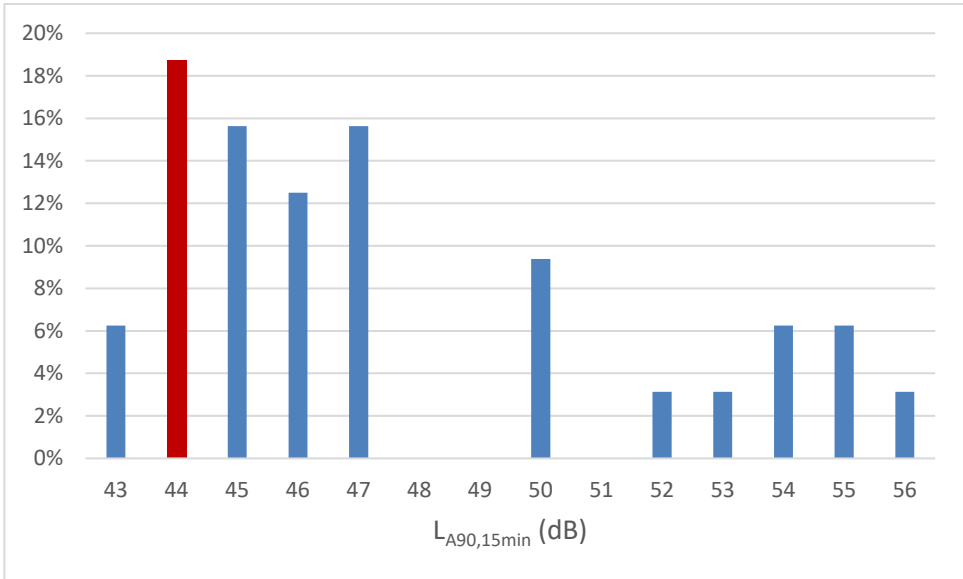


Figure 4: Analysis of night-time background levels, LA90, 15min – Position 1

B.3 Position 2

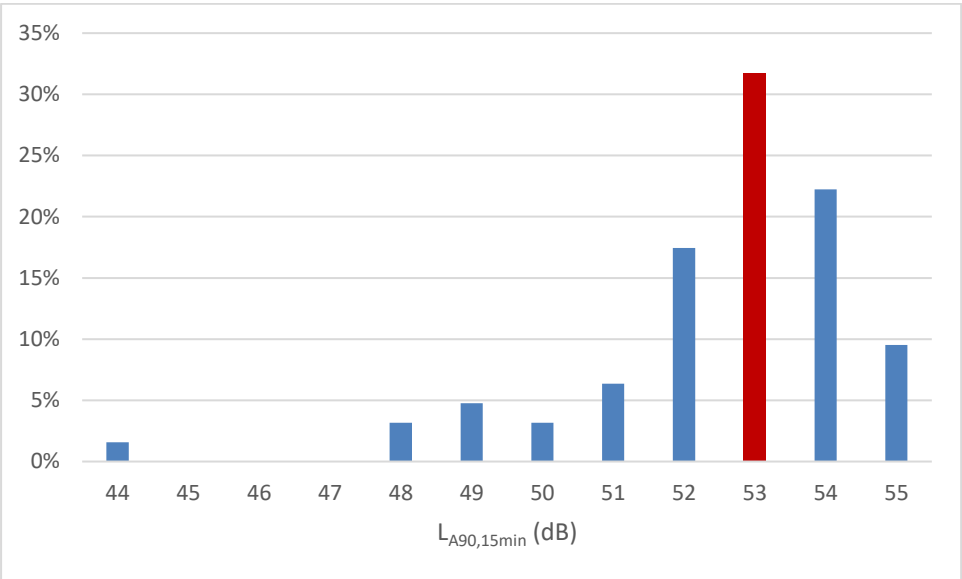


Figure 5: Analysis of daytime background levels, LA90, 1hr – Position 2

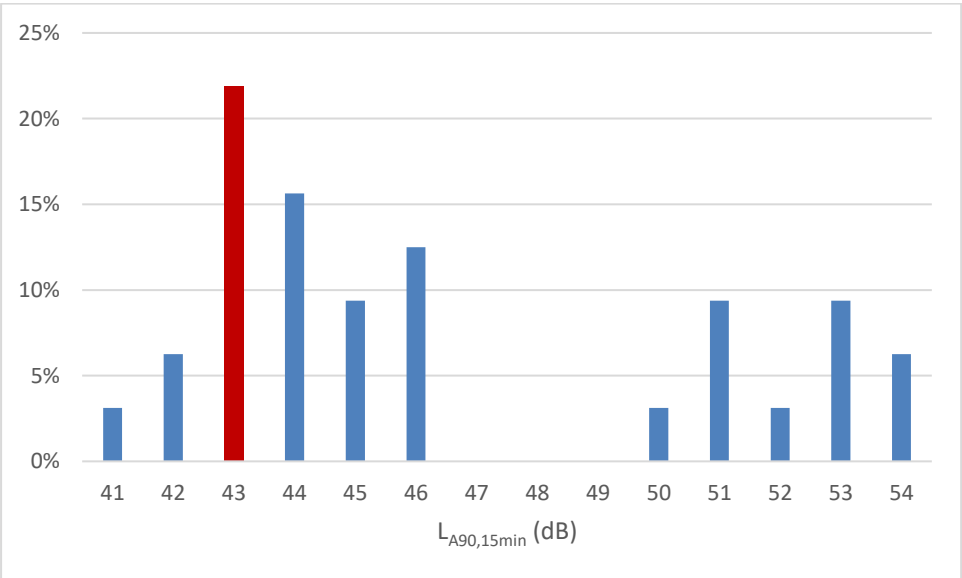


Figure 6: Analysis of night-time background levels, LA90, 15min – Position 2

Appendix C Representative noise measurements

C.1 The below measurements have been undertaken previously by Apex Acoustics, and sources are considered representative of those proposed.

C.2 HGV movements

Source	Data type	Single-octave band centre frequency (Hz) A-weighted sound pressure levels at 8 m, free field (dB)							dB(A)
		63	125	250	500	1k	2k	4k	
HGV movements	L _p @ 8 m	49	51	57	60	64	61	54	67

Table 13: Measured HGV movements at 8 m



Figure 7: Measurement of HGV movements at 8 m

C.3 Forklift loading/ unloading activities

Source	Data type	Single-octave band centre frequency (Hz) A-weighted sound pressure levels at 8 m, free field (dB)							dB(A)
		63	125	250	500	1k	2k	4k	
Forklift loading/ unloading	L _p @ 8 m	43	54	55	56	57	55	49	63

Table 14: Measured loading/ unloading activities at 8 m



Figure 8: Measurement of forklift loading/ unloading

- 13.1 Car door and boot slams
- 13.2 Measurements of a car door slam was made by Apex at a petrol station, and of the car boot slam has been taken from measurements made by others.
- 13.3 The measured levels are shown in Table 15.

Source	Data type	dB(A)
Car door slam	L _p L _A F _{max} @ 12 m	65
Car door slam	SEL @ 1m	86

Table 15: Measured car door and boot slam noise levels

- 13.4 Due to the short duration of noise emitted from a boot slam, the measured SEL levels are considered representative of the likely L_AF_{max} level.

Appendix D Noise transmission and propagation

D.1 The parameters used in modelling of RLS 90 are shown in Table 10.

Parameter	Details
Model dimensions	British Transverse Mercator coordinates
Site location and layout	Architect's drawings, Reference 9
No. of vehicle movement	1 car per car parking space per hour during the daytime 0.125 cars per space per 15 minutes during the night-time
D_p , correction for different parking types	Car park: +0 dB
D_B , shielding	Within RLS 90 calculation method
Source height	0.5 m

Table 16: Modelling parameters and assumptions – RLS 90

D.2 Noise transmission and propagation is modelled using proprietary software, CadnaA. This models noise propagation outdoors according to ISO 9613. The parameters used, source of data and details are described in Table 17.

Parameter	Source	Details
Model dimensions	Google Earth	British Transverse Mercator coordinates
Site location and layout	Reference 9	Architect's drawings
Topography – within and outside site	Reference 10	Modelled with changes in topography
Building heights – proposed buildings	-	Provided by client
Building heights – outside of site	Site observations and Google Street view	3 m per storey + 3 m roof (residential properties)
Receptor positions	Site observations and Google Street view	On the NSR façade closest to the source at a height of 1.5 and 4 m to represent ground and floor window heights respectively
Building and barrier absorption coefficient	ISO 9613-2	0.21 to represent a reflection loss of 1 dB
G, Ground factor	ISO 9613-2	Hard ground, $G = 0$; Porous ground, $G = 1$ (locally on model)
Max. order of reflections	Apex Acoustics	Three

Table 17: Modelling parameters and assumptions - CadnaA

Appendix E Specific sound level contours

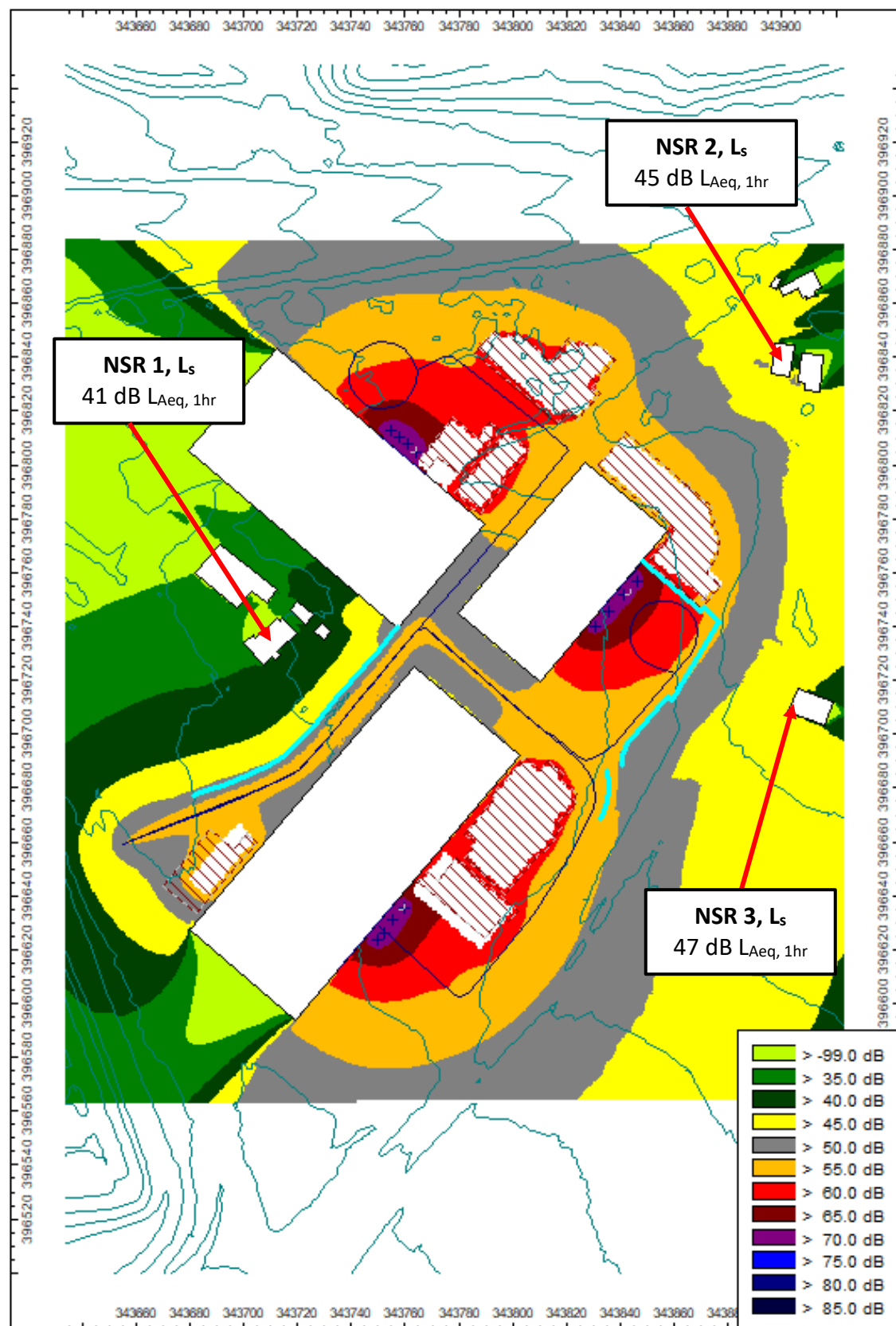


Figure 9: Sound contours at 4 m, showing the calculated specific sound level, $L_{Aeq, 1hr}$ – with proposed barriers

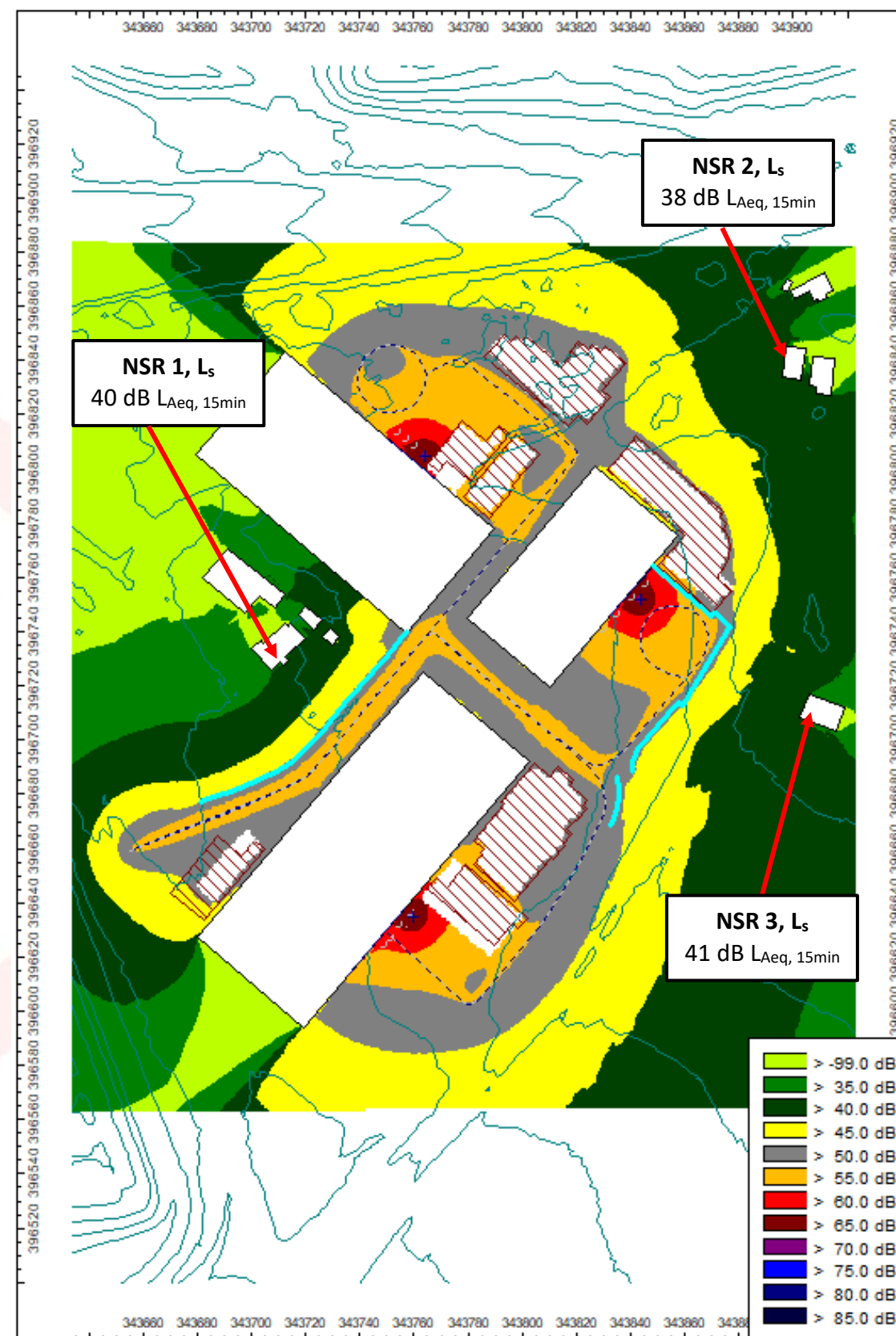


Figure 10: Sound contours at 4 m, showing the calculated specific sound level, $L_{Aeq, 15min}$ – with proposed barriers

Appendix F Car Park L_{AFmax} sound level contours

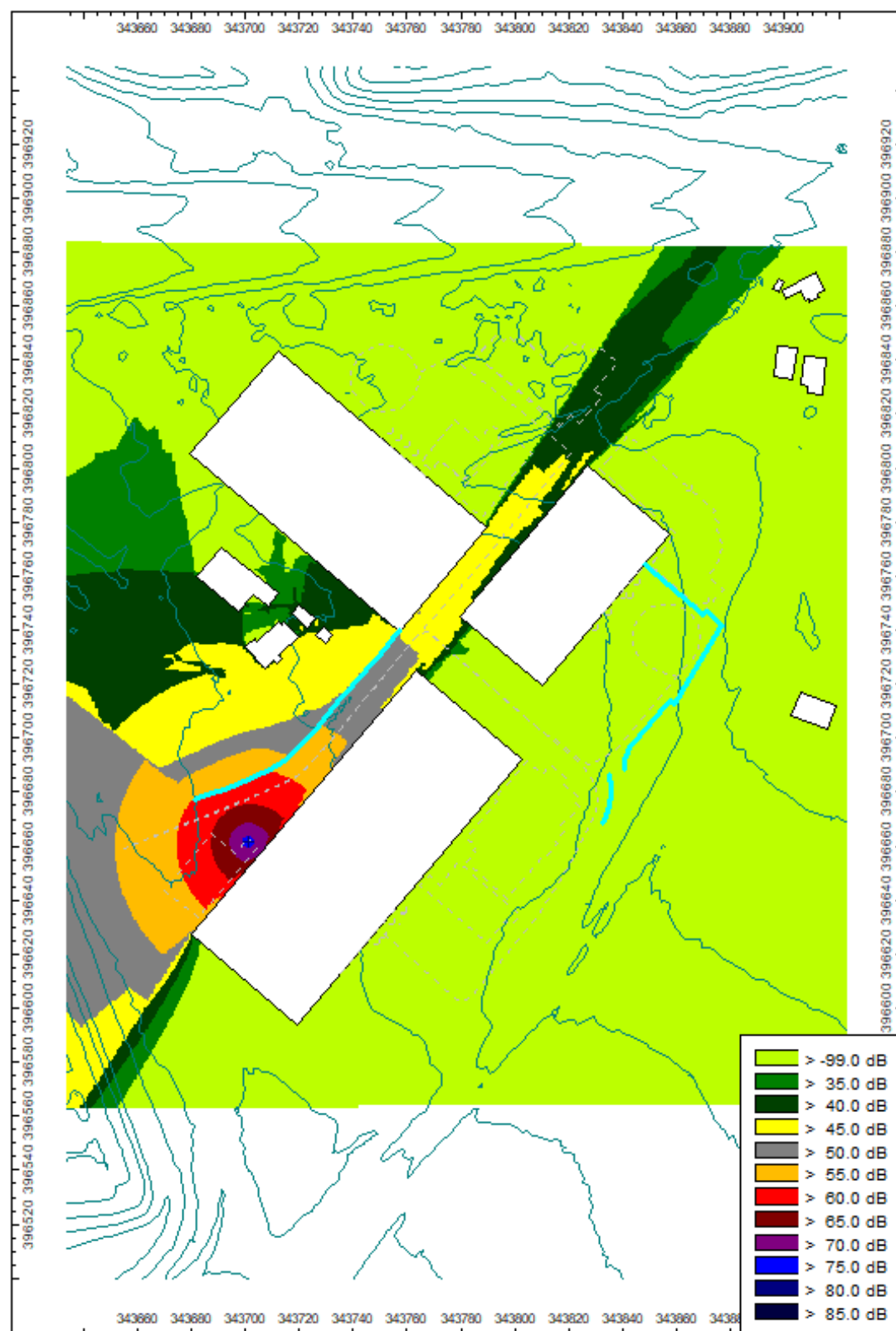


Figure 11: Sound contours at 4 m, showing the calculated L_{AFmax} levels due to the car door slam at worst-case location with respect to NSR 1 – with proposed barriers

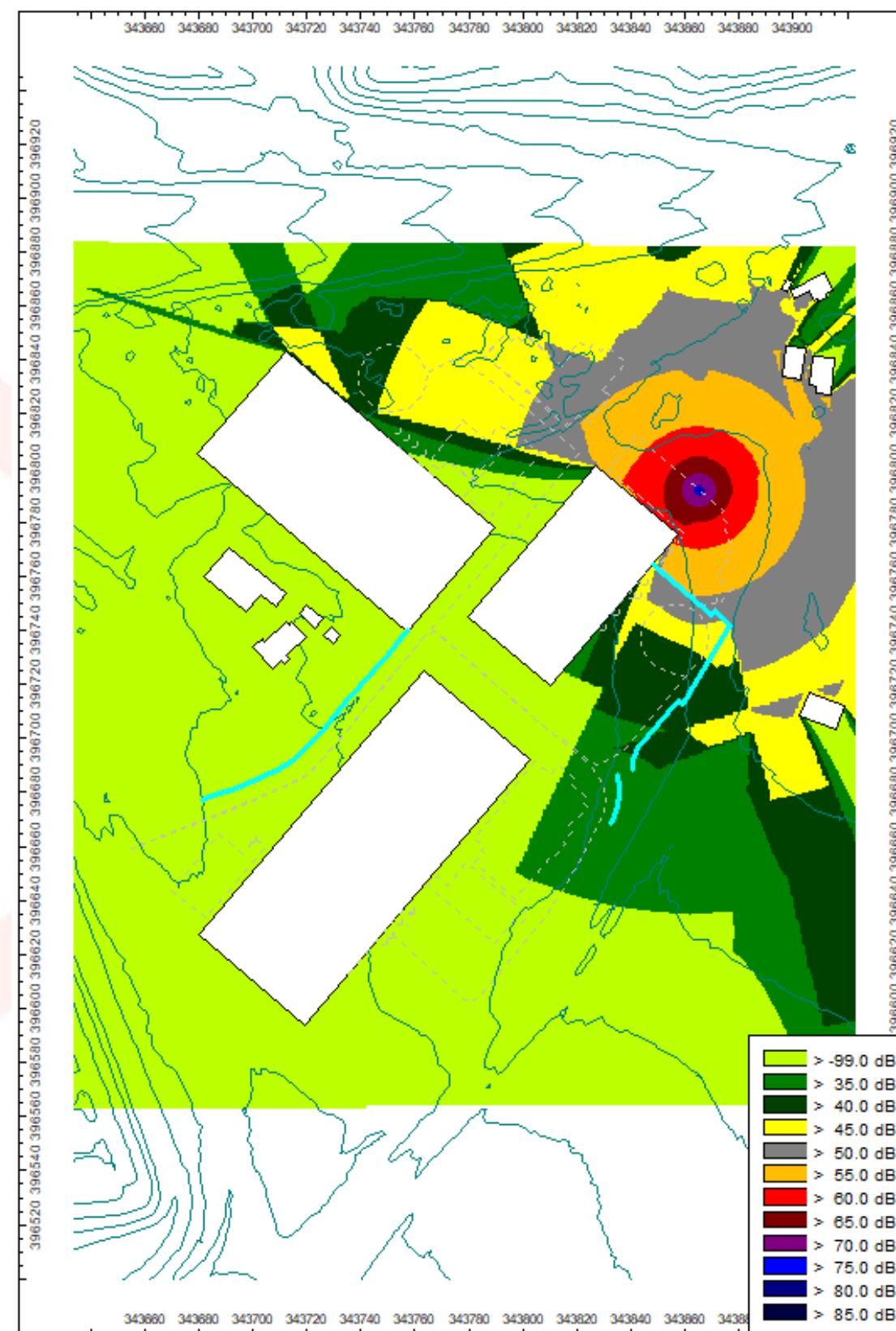


Figure 12: Sound contours at 4 m, showing the calculated L_{AFmax} levels due to the car door slam at worst-case location with respect to NSR 2 – with proposed barriers

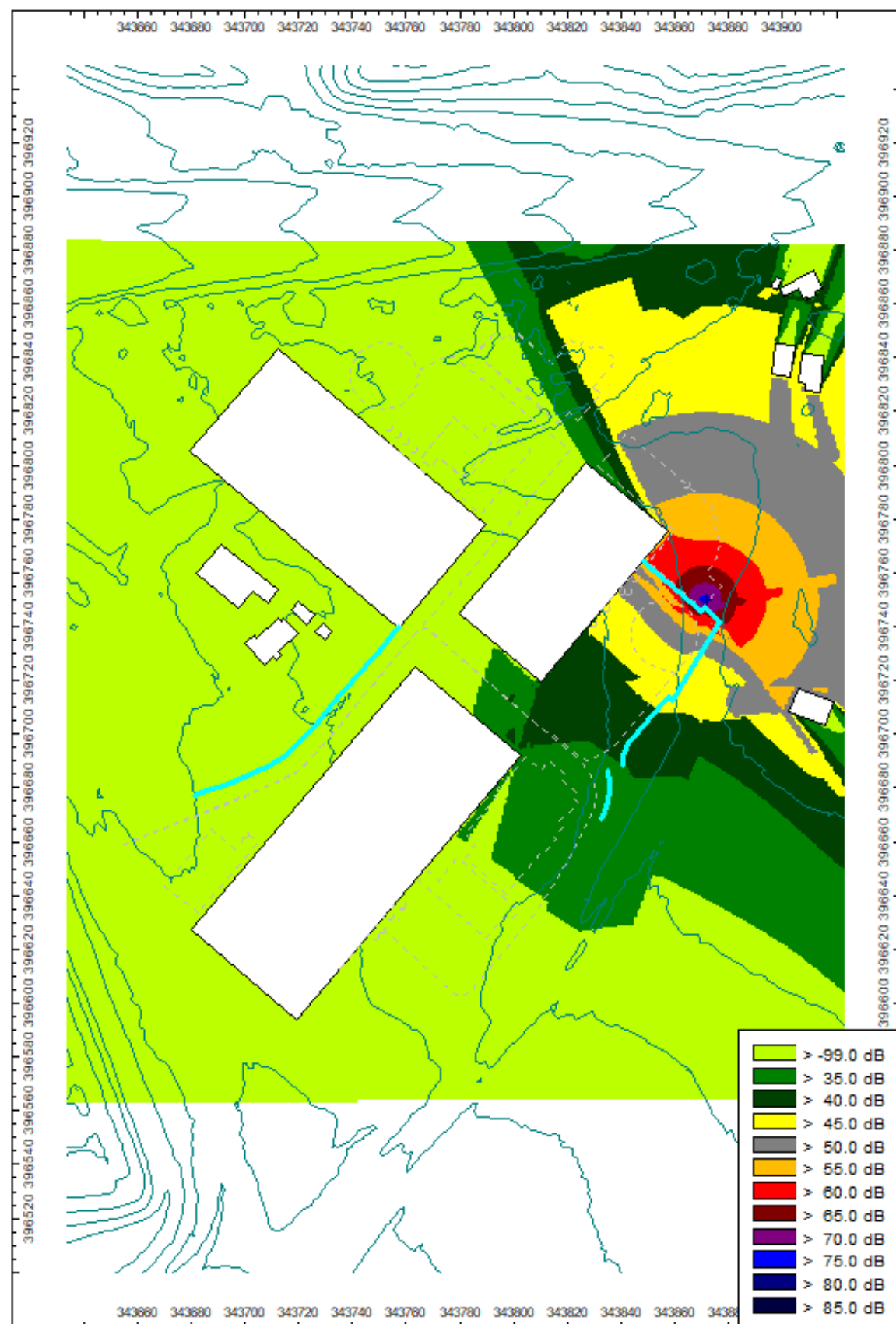


Figure 13: Sound contours at 4 m, showing the calculated L_{AFmax} levels due to the car door slam at worst-case location with respect to NSR 3 – with proposed barriers

Appendix G Professional qualifications and competence

- G.1 All Apex Acoustics consultants work under the close supervision of a member who holds qualification in acoustics and is a member of the IOA.
- G.2 This can be verified by searching the Institute of Acoustics' list of Members, available here, with the surname of the consultant.
<http://www.ioa.org.uk/membership-check>
- G.3 Apex Acoustics is a member of the Association of Noise Consultants (ANC). The ANC is a trade organisation which seeks to raise the standards of acoustic consultancy and as such there are barriers to entry to ensure member's competency.
- G.4 This report has been checked by an appropriately qualified and experienced acoustic consultant.