

Tesco Express
Sky Gardens,
1 Castlefield
Manchester,
M15 4LY
Plant Noise
Impact Assessment

On behalf of



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Executive Summary

Noise Solutions Limited has undertaken a noise impact assessment of plant to be installed at a new Tesco Express store located at Sky Gardens, 1 Castlefield, Manchester, M15 4LY.

It is understood that air conditioning (AC) and refrigeration plant will be installed in an internal plant room behind the southern façade of the building with louvres on this façade.

The assessment shows that, with installation of the specified atmospheric-sided attenuators, noise from the proposed plant will comply with the local authority's requirements and should therefore be acceptable to them.

1.0 Introduction

- 1.1. Noise Solutions Ltd (NSL) has been commissioned by Tesco Stores Limited to provide a noise impact assessment for plant serving a proposed Tesco Express store located at Sky Gardens, 1 Castlefield, Manchester, M15 4LY.
- 1.2. An environmental sound survey has been undertaken to establish the prevailing background sound pressure levels at a location representative of the sound levels outside the nearest noise sensitive receptors to the site.
- 1.3. The cumulative plant noise levels have been predicted at the nearest noise-sensitive windows and assessed against recognised standards and guidance.
- 1.4. To assist with the understanding of this report a glossary of acoustic terms can be found in [Appendix A](#). An in-depth glossary of acoustic terms can be viewed online at www.acoustic-glossary.co.uk.

2.0 Details of development proposals

- 2.1. The proposed Tesco Store will occupy a unit on the ground floor of the newly constructed Sky Gardens development.
- 2.2. A VRF air conditioning unit (AC) and refrigeration plant will be installed internally with ventilation louvres on the southern façade of the building. The AC unit will operate only when the store is open. Refrigeration plant will operate 24 hours but generally at a reduced duty at night when cooling demands are lower. Nonetheless the assessment includes for plant running at full duty.
- 2.3. A site plan showing the site and surrounding area, the nearest noise sensitive properties and noise monitoring location used in this assessment is presented in [Appendix B](#).

3.0 Nearest noise sensitive receptors

- 3.1. The site is located in a mixed neighbourhood containing commercial and residential units.
- 3.2. The nearest noise sensitive dwelling will be the residential units directly above the store at a distance of approximately 3.7 metres.
- 3.3. R2, a house across Chester Road at a distance of approximately 71m, is also considered.
- 3.4. R3 represents the pavement 3m from the louvres.

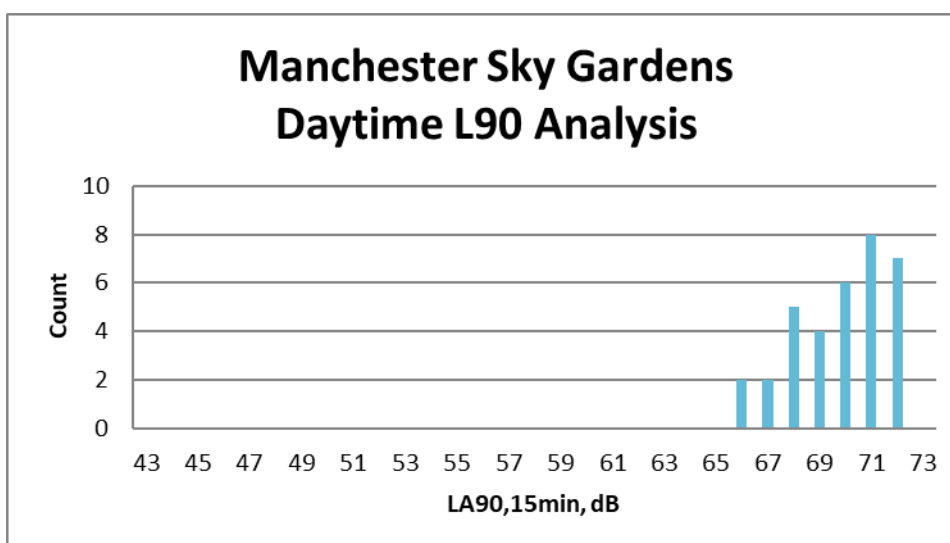
4.0 Existing noise climate

- 4.1. An environmental noise survey has been undertaken to establish the typical background sound levels at a location representative of the noise climate outside the façades of the nearest noise sensitive receptors to the proposed plant area during the quietest times at which the plant will operate.
- 4.2. The results of the environmental sound survey are summarised in Table 1 below. The full set of measurement results and details of the survey methodology are presented in [Appendix C](#).

Table 1 Summary of survey results

Measurement period	Range of recorded sound pressure levels (dB)			
	L _{Aeq} (15mins)	L _{AFmax} (15mins)	L _{A10} (15mins)	L _{A90} (15mins)
Daytime (07.00 – 23.00 hours)	75-79	83-106	77-80	66-72
Night-time (23.00 – 07.00 hours)	68-77	82-93	72-80	44-68

Figure 1 Histogram of daytime L_{A90} background sound pressure levels



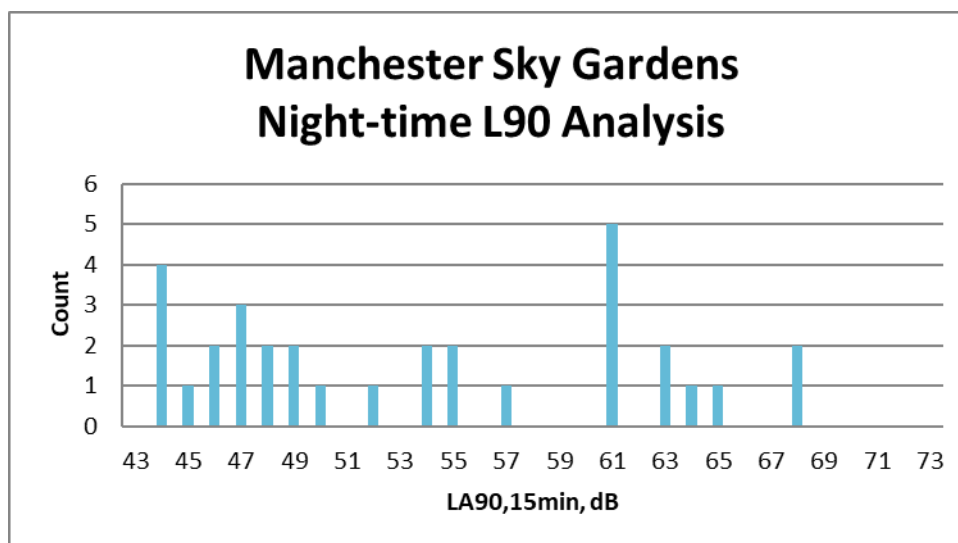
- 4.3. Further statistical analysis has been carried out on the data, and the mean and median values are shown in Table 2 below.

Table 2 Statistical analysis of L_{A90,15min} levels during the daytime period

dB, L _{A90} daytime period	
Mean	70
Modal	71
Median	70

- 4.4. From the histogram analysis, 66 dB(A) has been selected to be a robust representation of the background noise level during the daytime period.

Figure 2 Histogram of night-time L_{A90} background sound pressure levels



- 4.5. Further statistical analysis has been carried out on the data and the mean and median values are shown in Table 3 below.

Table 3 Statistical analysis of $L_{A90,15min}$ levels during the night-time period

dB, L_{A90} night-time period	
Mean	54
Modal	61
Median	53

- 4.6. From the histogram analysis, 44 dB(A) has been chosen to be representative of the background sound level during the night-time period.
- 4.7. Therefore, the following values are considered representative of the existing background sound pressure levels at nearby noise sensitive premises:
- 66 dB L_{A90} during the daytime period; and
 - 44 dB L_{A90} during the night-time period.

5.0 Plant noise design criteria

National Planning Policy Framework

- 5.1. A new edition of NPPF was published in July 2021 and came into effect immediately. The original National Planning Policy Framework (NPPF¹) was published in March 2012, with revisions in July 2018 and February 2019 - this document replaced the existing Planning Policy Guidance Note 24 (PPG 24) "Planning and Noise." The 2021 revised edition contains no new directions or guidance with respect to noise, and hence, all previous references remain extant. The paragraph references quoted below relate to the July 2021 edition.
- 5.2. Paragraph 174 of the NPPF states that the planning system should contribute to and enhance the natural and local environment by, (amongst others) *"preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, water or noise pollution or land stability."*
- 5.3. The NPPF goes on to state in Paragraph 185:
- "planning policies and decisions 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 quality of life;*
 - 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 ...*
- 5.4. The NPPF document does not refer to any other documents or British Standards regarding noise other than the Noise Policy Statement for England (NPSE²).
- 5.5. Paragraph 2 of the NPPF states that *"planning law requires that applications for planning permission must be determined in accordance with the development plan unless material considerations indicate otherwise."*
- 5.6. Paragraph 12 of the NPPF states that *"The presumption in favour of sustainable development does not change the statutory status of the development plan as the starting point for decision making. Where a planning application conflicts with an up-to-date development plan (including any neighbourhood plans that form part of the development plan), permission should not usually be granted. Local planning authorities may take decisions that depart from an up-to-date development plan, but only if material considerations in a particular case indicate that the plan should not be followed"*.

¹ National Planning Policy Framework, DCLG, March 2012

² Noise Policy Statement for England, DEFRA, March 2010

- 5.7. Paragraph 119 states that *"Planning policies and decisions should promote an effective use of land in meeting the need for homes and other uses, while safeguarding and improving the environment and ensuring safe and healthy living conditions. Strategic policies should set out a clear strategy for accommodating objectively assessed needs, in a way that makes as much use as possible of previously-developed or 'brownfield' land"*.

Manchester City Council

- 5.8. On recently approved planning applications by Manchester City Council the guidance on noise criteria has been:

"Externally mounted ancillary plant, equipment and servicing shall be selected and/or acoustically treated in accordance with a scheme designed so as to achieve a rating level of 5dB (LAeq) below the typical background (LA90) level at the nearest noise sensitive location."

- 5.9. It can be assumed that a similar condition may be applied for this planning application.

BS 4142:2014 Methods for rating and assessing industrial and commercial sound

- 5.10. BS 4142:2014 is intended to be used to assess the likely effects of sound on people residing in nearby dwellings. The scope of BS 4142:2014 includes *"sound from fixed plant installations which comprise mechanical and electrical plant and equipment"*.
- 5.11. The procedure contained in BS 4142:2014 is to quantify the *"specific sound level"*, which is the measured or predicted level of sound from the source in question over a one hour period for the daytime and a 15 minute period for the night-time. Daytime is defined in the standard as 07:00 to 23:00 hours, and night-time as 23:00 to 07:00 hours.
- 5.12. The specific sound level is converted to a rating level by adding penalties on a sliding scale to account for either potentially tonal or impulsive elements. The standard sets out objective methods for determining the presence of tones or impulsive elements but notes that it is acceptable to subjectively determine these effects.
- 5.13. The penalty for tonal elements is between 0 dB and 6 dB, and the standard notes: *"Subjectively, this can be converted to a penalty of 2 dB for a tone which is just perceptible at the noise receptor, 4 dB where it is clearly perceptible, and 6 dB where it is highly perceptible."*
- 5.14. The penalty for impulsive elements is between 0 dB and 9 dB, and the standard notes: *"Subjectively, this can be converted to a penalty of 3 dB for impulsivity which is just perceptible at the noise receptor, 6 dB where it is clearly perceptible, and 9 dB where it is highly perceptible."*

- 5.15. The assessment outcome results from a comparison of the rating level with the background sound level. The standard states:
- *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 +5 dB 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 source having a low impact, depending on the context.*
- 5.16. The standard does state that *"adverse impacts include, but are not limited to, annoyance and sleep disturbance. Not all adverse impacts will lead to complaints and not every complaint is proof of an adverse impact."*
- 5.17. The standard goes on to note that: *"Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night."*
- 5.18. In addition to the margin by which the Rating Level of the specific sound source exceeds the Background Sound Level, the 2014 edition places emphasis upon an appreciation of the context, as follows:
- "An effective assessment cannot be conducted without an understanding of the reason(s) for the assessment and the context in which the sound occurs/will occur. When making assessments and arriving at decisions, therefore, it is essential to place the sound in context."*
- 5.19. BS 4142:2014 requires uncertainties in the assessment to be considered, and where the uncertainty is likely to affect the outcome of the assessment, steps should be taken to reduce the uncertainty.

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

- 5.20. BS8233 provides advice in relation to design criteria for external noise. It states that:

"for traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline

value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable.

In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited.

.....In high-noise areas, consideration should be given to protecting these areas by screening or building design to achieve the lowest practicable levels. Achieving levels of 55 dB $L_{Aeq,T}$ or less might not be possible at the outer edge of these areas, but should be achievable in some areas of the space."

Proposed criteria

- 5.21. In accordance with BS4142:2014, it is initially proposed that the plant noise level does not exceed a level 5 dB below the existing representative background sound level.
- 5.22. Noise from the new plant should therefore not exceed the limits shown in the table below:

Table 4 Proposed plant noise emissions level limits at noise sensitive residential receptors

Period	Cumulative plant noise level, dB(A)
Daytime (07.00 – 23.00 hours)	61
Night-time (23.00 – 07.00 hours)	39

- 5.23. The daytime L_{Aeq} at the survey location is in the range of 75-79 dBA; nonetheless levels at 3m in front of the louvres are assessed against a BS8233:2014 daytime amenity criterion level of 55 dBA.
- 5.24. The above limits have not been approved by the local authority at this stage.

6.0 Plant noise impact assessment

- 6.1. The cumulative plant noise levels at the nearest noise sensitive receptors have been predicted. The predictions have been based on all plant operating at their full day and night duty, as applicable.

- 6.2. Noise levels from the plantroom intake and discharge louvres have been predicted taking into account ductwork system losses, aperture size, directivity of sound propagation and distance and screening attenuation from the source to the receptors. Predictions are inclusive of the following atmospheric-side attenuation fitted to the louvres:

Table 4 Proposed atmospheric-side attenuator selections

Attenuator	Insertion loss (dB) at Octave Band Centre Frequencies (Hz)							
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Intake Louvre	6	13	26	41	45	45	43	36
Gas cooler Exhaust Louvre	6	13	26	41	45	45	43	36
AC/VRV Exhaust Louvre	6	13	26	41	45	45	43	36

- 6.3. It should be noted that the proposed plant is not anticipated to exhibit any tonal or impulsive characteristics provided it is well maintained. All proposed plant will be inverter driven and, therefore, will gently ramp up and down depending on the demands on the various systems. In order to be robust, however, a +3 dB feature correction has been applied to the noise level predictions as advised in BS 4142:2014.
- 6.4. Table 5 below summarises the results of the assessment at the identified receptors. All other nearby receptors benefit from increased distance/screening to the plant. The full set of calculations is given in [Appendix E](#).

Table 5 Assessment of predicted noise levels at the nearest noise sensitive receptors

Receptor	Period	Predicted rating noise level at receptor, L_{Aeq} (dB)	Design criterion (dB)	Difference (dB)
R1	Daytime (07.00 - 23.00 hours)	48	61	-13
	Night-time (23.00 - 07.00 hours)	38	39	-1
R2	Daytime (07.00 - 23.00 hours)	26	61	-35
	Night-time (23.00 - 07.00 hours)	15	39	-24
R3	Daytime (07.00 - 23.00 hours)	54	55	-1

- 6.5. The assessment shows that, when attenuated, plant noise levels comply with the proposed design criteria and would therefore meet Manchester City Council's usual requirements.

Context and uncertainties

- 6.6. Where possible uncertainty in the above assessments has been minimised by taking the following steps:
- The meter and calibrator used have a traceable laboratory calibration and the meter was field calibrated before and after the measurements;
 - Uncertainty in the calculated impacts has been reduced by the use of a well-established calculation method;
 - Care was taken to ensure that the measurement positions were representative of the noise climate outside the nearby residential dwellings and not in positions where higher noise levels were present.
- 6.7. As BS4142: 2014 advises, the impact must be considered within the context of the site and the surrounding acoustic environment. The following must, therefore, also be taken into consideration when determining the potential impact that may be experienced:
- The assessment is undertaken at the nearest residential windows. The impact on all other nearby residential windows will be lower due to screening and distance attenuation.

Plant vibration

- 6.8. It is recommended that all plant, and connected ducts and pipes, is resiliently isolated to reduce the risk of vibration entering the building structure.

7.0 Summary

- 7.1. Noise Solutions Ltd has been commissioned by Tesco Stores Limited to provide a noise impact assessment for plant serving a proposed Tesco Express store located at Sky Gardens, 1 Castlefield, Manchester, M15 4LY.
- 7.2. An environmental noise survey has been undertaken to establish the existing prevailing noise levels at locations representative of the noise climate outside the nearest noise sensitive receptors to the proposed plant area.
- 7.3. The assessment shows that the proposed plant will comply with Manchester City Council's requirements.
- 7.4. Additional recommendations have been made to control plant vibration transmission to other areas within the building.

Appendix A Acoustic terminology

Parameter	Description
Ambient Noise Level	The totally encompassing sound in a given situation at a given time, usually composed of a sound from many sources both distant and near ($L_{Aeq,T}$).
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s_1 and s_2 is given by $20 \log_{10} (s_1/s_2)$. The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is $20\mu\text{Pa}$. The threshold of normal hearing is in the region of 0 dB and 140 dB is the threshold of pain. A change of 1 dB is only perceptible under controlled conditions.
dB(A), L_{Ax}	Decibels measured on a sound level meter incorporating a frequency weighting (A weighting) which differentiates between sounds of different frequency (pitch) in a similar way to the human ear. Measurements in dB(A) broadly agree with people's assessment of loudness. A change of 3 dB(A) is the minimum perceptible under normal conditions, and a change of 10 dB(A) corresponds roughly to halving or doubling the loudness of a sound. The background noise in a living room may be about 30 dB(A); normal conversation about 60 dB(A) at 1 metre; heavy road traffic about 80 dB(A) at 10 metres; the level near a pneumatic drill about 100 dB(A).
Fast Time Weighting	Setting on sound level meter, denoted by a subscript F, that determines the speed at which the instrument responds to changes in the amplitude of any measured signal. The fast time weighting can lead to higher values than the slow time weighting when rapidly changing signals are measured. The average time constant for the fast response setting is 0.125 (1/8) seconds.
Free-field	Sound pressure level measured outside, far away from reflecting surfaces (except the ground), usually taken to mean at least 3.5 metres
Façade	Sound pressure level measured at a distance of 1 metre in front of a large sound reflecting object such as a building façade.
$L_{Aeq,T}$	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
$L_{max,T}$	A noise level index defined as the maximum noise level recorded during a noise event with a period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
$L_{10,T}$	A noise level index. The noise level exceeded for 10% of the time over the period T. L_{10} can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise. $L_{A10,18h}$ is the A-weighted arithmetic average of the 18 hourly $L_{A10,1h}$ values from 06:00-24:00.
$L_{90,T}$	A noise level index. The noise level that is exceeded for 90% of the measurement time interval, T. It gives an indication of the lower levels of fluctuating noise. It is often used to describe the background noise level and can be considered to be the "average minimum" noise level and is a term used to describe the level to which non-specific noise falls during quiet spells, when there is lull in passing traffic for example

Appendix B Areas of interest



Appendix C Environmental sound survey

Details of sound survey

- C.1 Measurements of the existing background sound levels were undertaken between 18.30 on the 22nd February and 11.00 on the 23rd February 2022.
- C.2 The sound level meter was programmed to record the A-weighted L_{eq} , L_{90} , L_{10} and L_{max} noise indices for consecutive 15-minute sample periods for the duration of the noise survey.

Measurement position

- C.3 The measurement position was located on a lamppost on the corner of Barrack Street and Chester Road, as indicated on the site plan in [Appendix B](#).
- C.4 In accordance with BS 7445-2:1991 '*Description and measurement of environmental noise – Part 2: Guide to the acquisition of data pertinent to land use*', the measurements were undertaken under free-field conditions.

Equipment

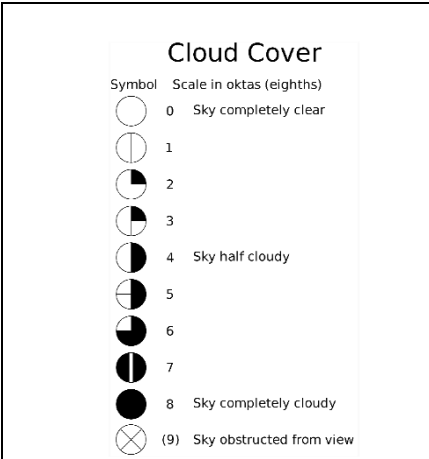
- C.5 Details of the equipment used during the survey are provided in the table below. The sound level meter was calibrated before and after the survey; no significant change (+/-0.2 dB) in the calibration level was noted.

Environmental noise survey

Description	Model / serial no.	Calibration date	Calibration certificate no.
Class 1 Sound level meter	Rion NL-52 / 00654035	07/06/2021	1500431
Condenser microphone	Rion UC-59 /08290		
Preamplifier	Rion NH-25 / 54080		
Calibrator	Rion NC-74 /34235932	23/09/2021	1500910-1

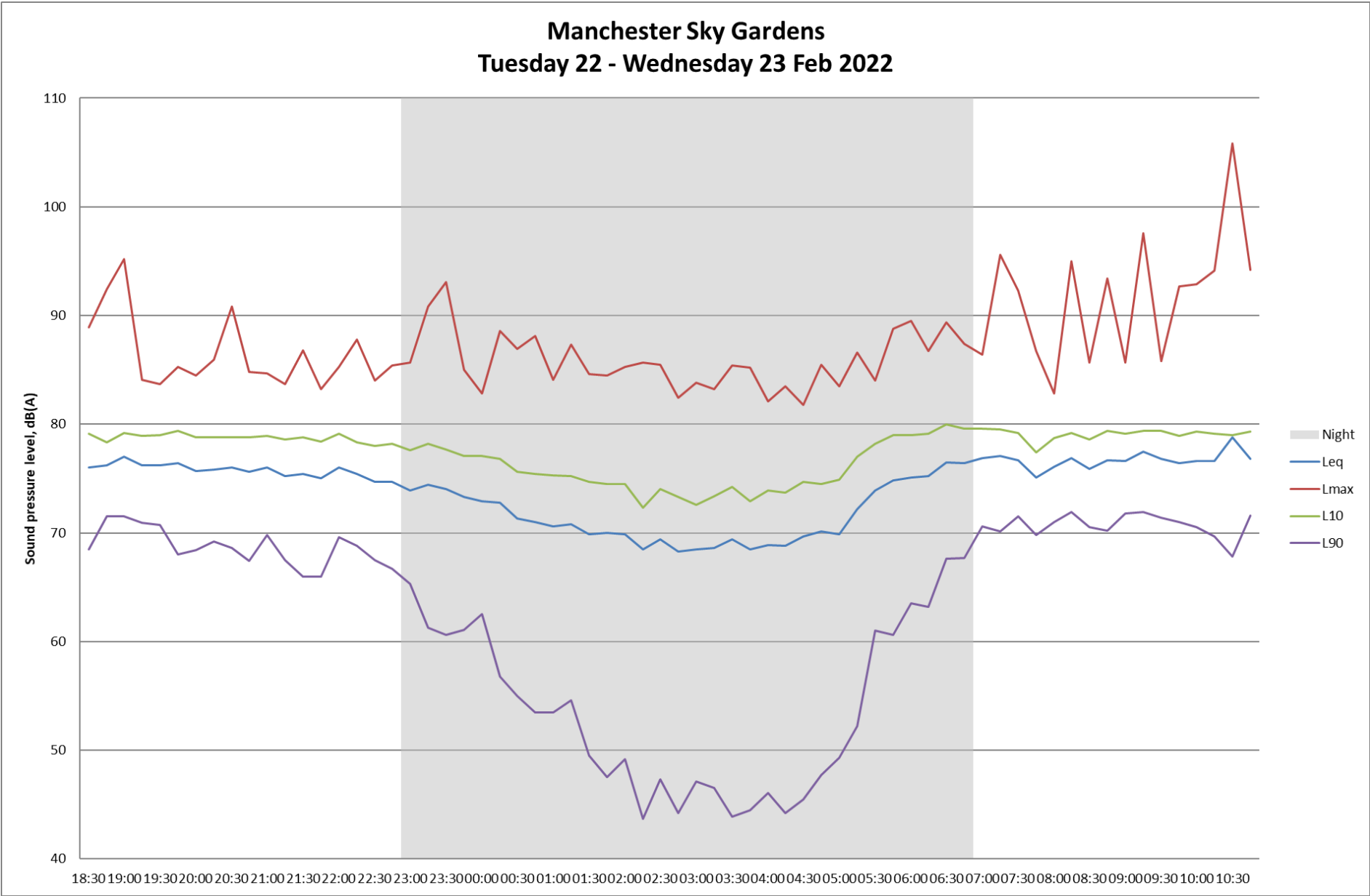
Weather conditions

- C.6 Weather conditions were determined both at the start and on completion of the survey. It is considered that the meteorological conditions were appropriate for environmental noise measurements. The table below presents the weather conditions recorded on site at the beginning and end of the survey.

Weather Conditions				
Measurement Location	Date/Time	Description	Beginning of Survey	End of Survey
As indicated on Appendix B	18.30 22/2/22 - 11.00 23/2/22	Temperature (°C)	7	9
 Cloud Cover Symbol Scale in oktas (eighths) 0 Sky completely clear 1 2 3 4 Sky half cloudy 5 6 7 8 Sky completely cloudy (9) Sky obstructed from view		Precipitation:	No	No
		Cloud cover (oktas - see guide)	N/A (dark)	7
		Presence of fog/snow/ice	No	No
		Presence of damp roads/wet ground	No	No
		Wind Speed (m/s)	2.7	2.2
		Wind Direction	W	SE
		Conditions that may cause temperature inversion (i.e. calm nights with no cloud)	No	No

Results

- C.7 The results of the environmental survey are considered to be representative of the background sound pressure levels at the façades of the nearest noise sensitive receptors during the quietest times at which the plant will operate.
- C.8 Local traffic was noted to dominate the ambient noise during setup and collection.
- C.9 The results of the survey are presented in a time history graph overleaf.



Appendix D Plant noise data

Unit / Model	Operating Period	Fan side	Sound power level (dB) at octave band centre frequencies (Hz)								L _{w,A} (dB)
			63	125	250	500	1000	2000	4000	8000	
Kelvion/GE-MA102G4	Day	N/A	92	92	88	82	82	80	76	72	87
	Night	N/A	82	82	78	72	72	70	66	62	77
Hubbard pack	Day and Night	N/A	77	71	73	69	65	62	58	51	71
Daikin/REYQ8T	Day	N/A	80	77	78	77	73	67	64	59	78

Appendix E Plant noise calculations

Plantroom – Daytime

Description	Notes	Sound level (dB) at octave band centre frequency								LAeq (dB)
		63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	
Plant room										
Intake										
Reverberant level in plant room	Rev Lp	76	74	68	61	54	50	44	38	64
All plant running										
Opening area (m2)	5.70	8	8	8	8	8	8	8	8	
SRI of opening	I.L	-6	-13	-26	-41	-45	-45	-43	-36	
Inside-outside correction		-6	-6	-6	-6	-6	-6	-6	-6	
Lw of opening	Lw	72	62	44	21	10	6	3	4	49
R1										
Directivity correction	(2000,90deg x 2850,0deg)	1	1	-4	-7	-7	-7	-7	-7	
Distance correction (m)	3.7	-19	-19	-19	-19	-19	-19	-19	-19	
Screening ($\delta = /m$)	-	0	0	0	0	0	0	0	0	
Surface Directivity		0	0	0	0	0	0	0	0	
BS4142		3	3	3	3	3	3	3	3	
Resultant at receptor R1	Lp @ R1	56	46	24	-2	-13	-17	-20	-20	33
R2										
Directivity correction	(2000,0deg x 2850,45deg)	2	3	4	4	4	4	4	4	
Distance correction (m)	71	-45	-45	-45	-45	-45	-45	-45	-45	
Screening ($\delta = /m$)	-	0	0	0	0	0	0	0	0	
Surface Directivity		0	0	0	0	0	0	0	0	
BS4142		3	3	3	3	3	3	3	3	
Resultant at receptor R2	Lp @ R2	32	23	5	-17	-28	-32	-35	-34	9

Description	Notes	Sound level (dB) at octave band centre frequency								LAeq (dB)
		63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	
R3										
Directivity correction	(2000,0deg x 2850,0deg)	4	5	6	6	6	6	6	6	
Distance correction (m)	3	-18	-18	-18	-18	-18	-18	-18	-18	
Screening (δ = /m)	-	0	0	0	0	0	0	0	0	
Surface Directivity		0	0	0	0	0	0	0	0	
BS4142		3	3	3	3	3	3	3	3	
Resultant at receptor R3	Lp @ R3	61	52	35	13	2	-2	-6	-5	39
Discharge										
Condenser Discharge										
Sound power	Lw	92	92	88	82	82	80	76	72	87
End reflection	3.2	-1	0	0	0	0	0	0	0	
SRI of opening	I.L	-6	-13	-26	-41	-45	-45	-43	-36	
Lw of opening		85	79	62	41	37	35	33	36	64
R1										
Directivity correction	(2000,90deg x 1600,0deg)	0	0	-4	-7	-7	-7	-7	-7	
Distance correction (m)	3.9	-20	-20	-20	-20	-20	-20	-20	-20	
Screening (δ = /m)	-	0	0	0	0	0	0	0	0	
Surface Directivity		0	0	0	0	0	0	0	0	
BS4142		3	3	3	3	3	3	3	3	
Resultant at receptor R1	Lp @ R1	68	62	41	17	13	11	9	12	47
R2										
Directivity correction	(2000,0deg x 1600,45deg)	2	3	3	4	4	4	4	4	
Distance correction (m)	71	-45	-45	-45	-45	-45	-45	-45	-45	
Screening (δ = /m)	-	0	0	0	0	0	0	0	0	
Surface Directivity		0	0	0	0	0	0	0	0	
BS4142		3	3	3	3	3	3	3	3	
Resultant at receptor R2	Lp @ R2	45	39	23	3	-1	-3	-5	-2	25

Description	Notes	Sound level (dB) at octave band centre frequency								LAeq (dB)
		63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	
R3										
Directivity correction	(2000,0deg x 1600,0deg)	3	4	5	6	6	6	6	6	
Distance correction (m)	3	-18	-18	-18	-18	-18	-18	-18	-18	
Screening (δ = /m)	-	0	0	0	0	0	0	0	0	
Surface Directivity		0	0	0	0	0	0	0	0	
BS4142		3	3	3	3	3	3	3	3	
Resultant at receptor R3	Lp @ R3	73	68	52	32	28	26	24	27	54
VRV Unit Discharge										
Sound power	Lw	80	77	78	77	73	67	64	59	78
sound power inline fan	Lw	78	83	83	84	83	79	75	71	
End reflection	1.6	-3	-1	0	0	0	0	0	0	
SRI of opening	I.L	-6	-13	-26	-41	-45	-45	-43	-36	
Lw of opening		73	70	58	44	38	34	32	35	56
R1										
Directivity correction	(2000,90deg x 800,0deg)	-1	-1	-5	-8	-8	-7	-7	-7	
Distance correction (m)	2.9	-17	-17	-17	-17	-17	-17	-17	-17	
Screening (δ = /m)	-	0	0	0	0	0	0	0	0	
Surface Directivity		0	0	0	0	0	0	0	0	
BS4142		3	3	3	3	3	3	3	3	
Resultant at receptor R1	Lp @ R1	58	55	39	21	17	13	11	14	40
R2										
Directivity correction	(2000,0deg x 800,45deg)	2	3	3	4	4	4	4	4	
Distance correction (m)	71	-45	-45	-45	-45	-45	-45	-45	-45	
Screening (δ = /m)	-	0	0	0	0	0	0	0	0	
Surface Directivity		0	0	0	0	0	0	0	0	
BS4142		3	3	3	3	3	3	3	3	
Resultant at receptor R2	Lp @ R2	32	30	19	5	0	-4	-6	-3	17

Description	Notes	Sound level (dB) at octave band centre frequency								LAeq (dB)
		63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	
R3										
Directivity correction	(2000,0deg x 800,0deg)	2	3	4	5	6	6	6	6	
Distance correction (m)	3	-18	-18	-18	-18	-18	-18	-18	-18	
Screening (δ = /m)	-	0	0	0	0	0	0	0	0	
Surface Directivity		0	0	0	0	0	0	0	0	
BS4142		3	3	3	3	3	3	3	3	
Resultant at receptor R3	Lp @ R3	60	58	48	34	29	26	24	27	45

SUMMARY

	63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	
Receptor R1									
Intake	56	46	24	-2	-13	-17	-20	-20	33
Condenser Discharge	68	62	41	17	13	11	9	12	47
VRV Discharge	58	55	39	21	17	13	11	14	40
Cumulative	69	63	43	23	18	15	13	16	48
Receptor R2									
Intake	32	23	5	-17	-28	-32	-35	-34	9
Condenser Discharge	45	39	23	3	-1	-3	-5	-2	25
VRV Discharge	32	30	19	5	0	-4	-6	-3	17
Cumulative	45	40	24	7	2	-1	-3	0	26
Receptor R3									
Intake	61	52	35	13	2	-2	-6	-5	39
Condenser Discharge	73	68	52	32	28	26	24	27	54
VRV Discharge	60	58	48	34	29	26	24	27	45
Cumulative	73	69	53	36	32	29	27	30	54

Plantroom – Night-time

Description	Notes	Sound level (dB) at octave band centre frequency								LAeq (dB)
		63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	
Plant room										
Intake										
Reverberant level in plant room	Rev Lp	71	66	63	56	47	43	38	30	58
All plant running										
Opening area (m2)	5.7	8	8	8	8	8	8	8	8	
SRI of opening	I.L	-6	-13	-26	-41	-45	-45	-43	-36	
Inside-outside correction		-6	-6	-6	-6	-6	-6	-6	-6	
Lw of opening	Lw	66	54	38	16	4	0	-4	-4	42
R1										
Directivity correction	(2000,90deg x 2850,0deg)	1	1	-4	-7	-7	-7	-7	-7	
Distance correction (m)	3.7	-19	-19	-19	-19	-19	-19	-19	-19	
Screening ($\delta = /m$)	-	0	0	0	0	0	0	0	0	
Surface Directivity		0	0	0	0	0	0	0	0	
BS4142		3	3	3	3	3	3	3	3	
Resultant at receptor R1	Lp @ R1	51	38	19	-7	-20	-24	-27	-28	27
R2										
Directivity correction	(2000,0deg x 2850,45deg)	2	3	4	4	4	4	4	4	
Distance correction (m)	71.0	-45	-45	-45	-45	-45	-45	-45	-45	
Screening ($\delta = /m$)	-	0	0	0	0	0	0	0	0	
Surface Directivity		0	0	0	0	0	0	0	0	
BS4142		3	3	3	3	3	3	3	3	
Resultant at receptor R2	Lp @ R2	27	15	0	-22	-34	-38	-42	-42	3

Description	Notes	Sound level (dB) at octave band centre frequency								LAeq (dB)
		63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	
R3										
Directivity correction	(2000,0deg x 2850,0deg)	4	5	6	6	6	6	6	6	
Distance correction (m)	3.0	-18	-18	-18	-18	-18	-18	-18	-18	
Screening (δ = /m)	-	0	0	0	0	0	0	0	0	
Surface Directivity		0	0	0	0	0	0	0	0	
BS4142		3	3	3	3	3	3	3	3	
Resultant at receptor R3	Lp @ R3	55	44	29	8	-5	-9	-12	-13	32
Discharge										
Condenser Discharge										
Sound power	Lw	82	82	78	72	72	70	66	62	77
End reflection	3.2	-1	0	0	0	0	0	0	0	
SRI of opening	I.L	-6	-13	-26	-41	-45	-45	-43	-36	
Lw of opening		75	69	52	31	27	25	23	26	54
R1										
Directivity correction	(2000,90deg x 1600,0deg)	0	0	-4	-7	-7	-7	-7	-7	
Distance correction (m)	3.9	-20	-20	-20	-20	-20	-20	-20	-20	
Screening (δ = /m)	-	0	0	0	0	0	0	0	0	
Surface Directivity		0	0	0	0	0	0	0	0	
BS4142		3	3	3	3	3	3	3	3	
Resultant at receptor R1	Lp @ R1	58	52	31	7	3	1	-1	2	37
R2										
Directivity correction	(2000,0deg x 1600,45deg)	2	3	3	4	4	4	4	4	
Distance correction (m)	71.0	-45	-45	-45	-45	-45	-45	-45	-45	
Screening (δ = /m)	-	0	0	0	0	0	0	0	0	
Surface Directivity		0	0	0	0	0	0	0	0	
BS4142		3	3	3	3	3	3	3	3	
Resultant at receptor R2	Lp @ R2	35	29	13	-7	-11	-13	-15	-12	15

Description	Notes	Sound level (dB) at octave band centre frequency								LAeq (dB)
		63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	
R3										
Directivity correction	(2000,0deg x 1600,0deg)	3	4	5	6	6	6	6	6	
Distance correction (m)	3.0	-18	-18	-18	-18	-18	-18	-18	-18	
Screening (δ = /m)	-	0	0	0	0	0	0	0	0	
Surface Directivity		0	0	0	0	0	0	0	0	
BS4142		3	3	3	3	3	3	3	3	
Resultant at receptor R3	Lp @ R3	63	58	42	22	18	16	14	17	44

SUMMARY

	63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	
Receptor R1									
Intake	51	38	19	-7	-20	-24	-27	-28	27
Condenser Discharge	58	52	31	7	3	1	-1	2	37
Cumulative	59	52	31	7	3	1	-1	2	38
Receptor R2									
Intake	27	15	0	-22	-34	-38	-42	-42	3
Condenser Discharge	35	29	13	-7	-11	-13	-15	-12	15
Cumulative	35	29	13	-7	-11	-13	-15	-12	15
Receptor R3									
Intake	55	44	29	8	-5	-9	-12	-13	32
Condenser Discharge	63	58	42	22	18	16	14	17	44
Cumulative	64	58	42	22	18	16	14	17	44

Summary

Summary of results	R1		R2		R3
	Day	Night	Day	Night	Day
Intake Louvre	33	27	9	3	39
Condenser Discharge Louvre	47	37	25	15	54
AC Discharge Louvre	40		17		45
Cumulative	48	38	26	15	54
Target	61	39	61	39	55
Excess	-13	-1	-35	-24	-1

Appendix F Plantroom drawing and location

