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FORMER NESTLE FACTORY, HAYES

Acoustic Assessment Report

Reference: 8231.RP01.AAR.3
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Acoustic Assessment Report

FORMER NESTLE FACTORY, HAYES

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Revision	Comment	Date	Prepared By	Approved By
0	First issue of report	30 April 2018	Callum Brewer	Alex J Wyatt
1	Changes to Section 3.0, 4.0 and 7.0	06 November 2018	Callum Brewer	Alex J Wyatt
2	Changes to Section 3.0 and 6.2	01 March 2019	Callum Brewer	Alex J Wyatt
3	Changed ventilation strategy to trickle ventilators (from MVHR)	17 October 2019	Callum Brewer	Alex J Wyatt

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1.0 INTRODUCTION

The re-development of the former Nestle factory site in Hayes is proposed. The development will include a combination of residential and commercial uses. There is a total of 29 proposed residential blocks ranging in height from 4 to 11 stories housing 1381 residential properties. A new industrial estate (distribution centre) is proposed to the east of the residential blocks, as part of the re-development, but these works are to be undertaken by a separate client, Segro.

Railway lines run along the north-western site boundary and the Grand Union Canal runs along the northern site boundary. To the west of the site lies Squirrel Trading Estate, which is an existing industrial estate predominantly formed of light-industrial use. Nestles Avenue runs along the southern site boundary and North Hyde Gardens road is to the east of site. Please see attached Site Plan Figure 1 for further details of the site layout.

RBA Acoustics has been commissioned to undertake an assessment in relation to the noise levels likely to be incident on the proposed building façades and to provide acoustic performance specifications such that acceptable internal noise criteria can be achieved. It should be noted that RBA has been appointed to carry out the acoustic assessment of the residential aspect of the development only.

This report details the results of the noise survey and sets out the acoustic performance requirements of the external building fabric elements. In addition, suitable plant noise emission criteria have also been developed based upon the survey results and the requirements of the Local Authority.

2.0 ENVIRONMENTAL NOISE SURVEY

2.1 Survey Methodology

In accordance with the requirements of the Local Authority, monitoring of the prevailing background noise was undertaken over the following 48 hour period:

Wednesday 17 January to Friday 19 January 2018.

As the surveying was unattended it is not possible to comment with certainty regarding meteorological conditions throughout the entire survey period, however based on observations during the site visits, and weather reports for the area, it was generally considered suitable for obtaining representative noise measurements, it being predominantly dry with little wind.

It is understood that high wind speeds were prevalent on site during the night-time period (between 23:00 and 07:00 hours) on Wednesday 17 January which adversely affected the measurement data at Measurement Positions 1, 2 and 4. As such, data captured during this period has been excluded in the analyses, as the noise levels measured are not considered representative of normal conditions. This period of activity has also been highlighted on the attached Time History Graphs 1-8.

Measurements were made of the L_{A90}, L_{Aeq} and L_{Amax} noise levels over sample periods of 15 minutes duration.

2.2 Measurement Locations

To determine the existing noise climate around the site, measurements were undertaken at the following locations.

Position 1 – Nestles Avenue

A microphone was positioned approximately 15m from the southern site boundary on a pole 2.5m high overlooking Nestles Avenue. The microphone at this measurement location was considered to be in the free-field.

The prevailing noise climate at this position was noted to mainly consist of road traffic movements along Nestles Avenue which runs the length of the southern site boundary, the road traffic was noted to generally consist of cars and other local traffic. Distant aircraft movements from Heathrow airport, which is located around 2.3km from site, are also expected to affect noise levels at this position, but to a lesser extent. It is considered that road traffic along Nestle Avenue is likely to provide the maximum noise levels to the south of the site.

Position 2 – Squirrels Trading Estate

A microphone was positioned approximately 5m from the western site boundary on a pole 2.5m high overlooking Squirrels Trading Estate. The microphone at this measurement location was considered to be in the free-field.

The prevailing noise climate at this position was noted to mainly consist of plant noise and activities from within Squirrels Trading Estate and, to a lesser extent, the railway and surrounding road network. It is considered that activities on the industrial estate are likely to provide the maximum noise levels to the west of the site.

Position 3 – Railway

A microphone was positioned at the north-western site boundary on a pole 2.5m high overlooking the railway, the nearest railway track was noted to be 5m from the measurement position. The site boundary and railway are located on an embankment approximately 4m high above the rest of the site. The microphone at this measurement location was considered to be in the free-field.

The prevailing noise climate at this position was noted to mainly consist of railway movements which run along the north-western site boundary. It is considered that railway movements provide the maximum noise levels to the north of site.

Position 4 – Centre of Site

A microphone was positioned towards the centre of the site on a pole 2m high. The microphone at this measurement location was at least 3.5m from the nearest building façade so as such, considered to be in the free-field.

The prevailing noise climate at this position was noted to mainly consist of screened traffic movements from the surrounding road network and is considered to be representative of levels towards the centre of site upon completion of the proposed development.

The measurement positions are also illustrated on the site plan attached in Figure 1.

The measurement positions are considered to be representative of worst-case noise levels incident on the proposed residential aspects of the re-development site.

2.3 Instrumentation

For information regarding the equipment used for the measurements please refer to Appendix C.

The sound level meters were calibrated both prior to and on completion of the survey with no significant calibration drifts observed.

2.4 Results

The noise levels measured are shown as time-histories on the attached Graphs 1-8.

The average daytime and night-time $L_{Aeq,T}$ noise levels for each measurement position are summarised in Table 1 below. Also shown are the typical night-time $L_{Amax,f}$ noise levels (90th percentile of 5-minute samples).

Table 1 – Measured L_{Aeq} and $L_{Amax,f}$ Noise Levels

Measurement Position	Period-averaged $L_{Aeq, period}$ Noise Level (dB)		Typical Night-time (23:00 – 07:00) $L_{Amax,f}$ (dB)
	Daytime (07:00 – 23:00)	Night-time (23:00 – 07:00)	
Position 1 – Nestles Avenue	59	57	69
Position 2 – Squirrels Trading Estate	61	56	73
Position 3 – Railway	73	67	89
Position 4 – Centre of Site	61	55	66

When considering the existing background levels of a site, BS 4142:2014, Methods for Rating and Assessing Industrial and Commercial Sound" recommends assessing to the "typical" measured $L_{A90, 15mins}$ background levels, BS 4142:2014 goes on to state:

> *"In using the background sound level in the method for rating and assessing industrial and commercial sound it is important to ensure that values are reliable and suitably represent both the particular circumstances and periods of interest. For this purpose, the objective is not simply to ascertain a lowest measured background sound level, but rather to quantify what is typical during particular time periods."*

BS 4142:2014 suggests that statistical analysis is a suitable method to determine the "typical" background level. This can be carried out by calculating the level of the most-commonly occurring $L_{A90, 15mins}$ period during the proposed operating hours of equipment.

"Typical-Lowest" Background Levels

We generally consider that designing to the most-commonly occurring $L_{A90,\ 15mins}$ period is not sufficient during those slightly quieter periods. In our opinion, a more representative value would be the "typical-lowest" level, which can be determined statistically as the lowest $L_{A90,\ 15mins}$ level which is exceeded for 90% of the assessment period, or alternatively termed the 10th percentile of the measured $L_{A90,\ 15mins}$ levels.

The "typical-lowest" background noise levels ($L_{A90,\ 15mins}$) at each measurement position are summarised in the following Table 2 below. This data can be used to set plant noise emission criteria for use in the assessment of noise emissions from any proposed plant at the development.

Table 2 – Measured Typical-Lowest $L_{A90,\ 15mins}$ Noise Levels

Measurement Position	Typical Lowest $L_{A90,\ 15mins}$ Noise Level during period (dB)	
	Daytime (07:00 – 23:00)	Night-time (23:00 – 07:00)
Position 1 – Nestles Avenue	55	52
Position 2 – Squirrels Trading Estate	56	52
Position 3 – Railway	54	52
Position 4 – Centre of Site	53	48

Averaged spectral noise levels are graphically represented on the attached Graphs 9-12.

3.0 ENVIRONMENTAL NOISE MODEL

In order to predict the noise levels at the different façades with increasing height an acoustic model of the proposed site, including all proposed buildings and existing surrounding buildings, has been generated using the CadnaA platform.

The software allows the site topography, existing buildings and sound sources to be built into the model such that the sound sources (i.e. the main surrounding roads and elevated railway) can then be calibrated according to the on-site measurement data. The buildings are subsequently built into the model and calculations using the methodology outlined in ISO 9613 are undertaken to predict façade incident noise levels at all floor heights. The incident noise levels, where not measured directly on site, have then been used in the assessment of façade elements.

Renders showing the site-wide CadnaA noise model is provided in Figure 7.

4.0 EXTERNAL BUILDING FABRIC CRITERIA

This section outlines typical assessment criteria in terms of the relevant standards. A brief explanation of the acoustic terminology used in this report is shown within Appendix A.

4.1 Planning Conditions

We understand the following planning conditions have been imposed:

BLOCKS B, C, D, E,F and G

Planning Condition 23

> *"Prior to the commencement of superstructure works for each phase of development a scheme which specifies the provisions to be made for the control of noise emanating from the site has been submitted to and approved in writing by the LPA. The scheme shall include such combination of physical, administrative measures, and or noise limits and other measures as may be approved by the LPA. Thereafter the scheme shall be implemented and maintained in full compliance with the approved measures."*

BLOCK F

Planning Condition 26

> *"Prior to the commencement of superstructure works for Phase 1 of the residential development a scheme for protecting Blocks F1 of the development from noise from the service yards of Units 1 and 4 shall be submitted to and approved in writing by the Local Planning Authority and approved in writing. All works which form part of the scheme by virtue of mitigation shall be fully implemented before the development is occupied and thereafter shall be retained and maintained in good working order for so long as the building remains in use."*

BLOCKS D and E

Planning Condition 27

> *"Prior to the commencement of superstructure works for the relevant phase of the residential development a scheme for protecting Blocks D and E of the development from noise from the Squirrels Industrial Estate shall be submitted to and approved in writing by the Local Planning Authority and approved in writing. All works which form part of the scheme by virtue of mitigation shall be fully implemented before the development is occupied and thereafter shall be retained and maintained in good working order for so long as the building remains in use."*

4.2 Residential Internal Noise Levels

British Standard 8233:2014

BS 8233:2014 *Guidance on Sound insulation and noise reduction for buildings* draws on the results of research and experience to provide information on achieving internal acoustic environments appropriate to their functions.

The noise level values given are in terms of an average (L_{Aeq}) level.

The standard advises internal ambient noise levels for achieving suitable resting and sleeping conditions within residential properties as set out in Table 3.

Table 3 – BS 8233:2014 Residential Criteria

Room	Daytime (07:00 – 23:00)	Night-time (23:00 – 07:00)
Living Rooms	35 dB $L_{Aeq,16hour}$	--
Dining Room/area	40 dB $L_{Aeq,16hour}$	--
Bedrooms	35dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$

Although generally no specific numerical requirement is set in terms of an L_{Amax} noise level, BS 8233:2014 does provide the following guidance with regards individual noise events:

> *"Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,f}$ depending on the character and number of events per night. Sporadic noise events could require separate values."*

Guidance provided in the World Health Organisation's Guidelines for Community Noise further refines the requirements for individual noise events as outlined below. However, Table H.3 of BS 8233:2014 does state a range of 45-55dB L_{Amax} for hotel bedrooms during the night-time period.

World Health Organisation: Guidelines for Community Noise

The document describes guideline levels that are *"essentially values for the onset of health effects from noise exposure".*

A table of guideline values is included, relating to adverse health effects, referred to as any temporary or long term deterioration in physical, psychological, or social functioning that is associated with noise exposure.

Table 4 sets out the guidance from *Table 4.1: Guideline values for community noise in specific environments*, as stated in the document.

Table 4 – Guideline Values for Community Noise

Specific Environment	Critical Health Effect(s)	L_{Aeq} (dB)	Time Base (hours)	$L_{Amax,f}$ (dB)
Outdoor living area	Serious annoyance, daytime and evening	55	16	-
	Moderate annoyance, daytime and evening	50	16	-
Dwelling, indoors	Speech intelligibility and moderate annoyance, daytime and evening	35	16	-
Inside bedrooms	Sleep disturbance, night-times	30	8	45
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60

With reference to maximum noise levels the following guidance is provided within the WHO guidance:

> *"For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45dB L_{Amax} more than 10-15 times per night (Vallet & Vernet 1991) and most studies show an increase in the percentage of awakenings at SEL values of 55-60 dBA (Passchier-Vermeer 1993; Finegold et al. 1994; Pearsons et al. 1995). For intermittent events that approximate aircraft noise, with an effective duration of 10-30s, SEL values of 55-60 corresponds to a L_{Amax} value of 45dB. Ten to 15 of these events during an 8 hour night-time implies a $L_{Aeq, 8h}$ of 20-25dB. This is 10-15dB below the $L_{Aeq, 8h}$ or 30dB for continuous night-time noise exposure, and shows that intermittent character of noise must be taken into account when setting night-time noise limits for noise exposure. For example, this can be achieved by considering the number of noise events and the difference between the maximum sound pressure level and the background of these events."*

Therefore the frequency of occurrence of maximum noise events should not typically exceed 10-15 times in any night.

4.3 Noise in External Amenity Areas

British Standard 8233:2014

BS 8233:2014 *Guidance on Sound insulation and noise reduction for buildings* draws on the results of research and experience to provide information on achieving suitable external levels for external amenity spaces. Recommended external noise levels are given, however, it is also recognized that the recommended values are not achievable in all circumstances such as urban areas.

With reference to noise levels in external amenity areas, the following guidance is provided within BS 8233:2014:

> *"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 recognised 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.*

The following relates specifically to balconies and terraces:

> *Other locations, such as balconies, roof gardens and terraces, are also important in residential buildings where normal external amenity space might be limited or not available, i.e. in flats, apartment blocks, etc. In these locations, specification of noise limits is not necessarily appropriate. Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses. However, the general guidance on noise in amenity space is still appropriate for larger balconies, roof gardens and terraces, which might be intended to be used for relaxation. 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."*

Therefore we have considered that noise levels within external amenity areas should not normally exceed 55dB $L_{Aeq,T}$, and that control measures such as acoustic screening of potential non-development noise sources will be utilised where practicable.

4.4 Non-Residential Criteria

British Standard 8233:2014

Ultimately the design criterion for non-residential spaces will depend on the end user activity. Hence, we outline criteria for these areas based on the guidance within BS 8233:2014. The standard advises the following internal ambient noise levels (L_{Aeq}) for the given activity and conditions for work requiring concentration.

Table 5 – BS 8233:2014 Non-Residential Criteria

Activity	Location	Design Range $L_{Aeq,T}$ (dB)
Speech or Telephone Communications	Department Store	50-55
	Corridor, Circulation Space	45-55
Study and Work Requiring Concentration	Staff/Meeting Room, Training Room	35-45
	Executive Office	35-40

The standard also advises that noise levels should be within the range of 45-50 dBA within open plan offices where acoustic privacy is important.

British Council for Offices 2014

BCO 2014 provides guidance on external noise intrusion levels (whether from road, rail or aircraft sources) should, after attenuation by the composite building envelope, not exceed the following design criteria:

Table 6 – BCO 2014 Design Criteria

Criterion	Environment	Design Range
External noise intrusion levels	Open plan offices	NR40 (≈45dBA)
	Speculative Offices*	NR38 (≈43dBA)
	Cellular Offices	NR35 (≈40dBA)

*Please note, the speculative office criterion is a compromise between the ideal for open plan and cellular offices. In addition, $L_{Amax\ (fast)}$ noise intrusion levels should not normally exceed 55dBA in open plan/speculative offices or 50dBA in cellular offices.

We consider it appropriate to design to the following criteria assuming daytime use only;

- Open Plan Offices 45dBA
- Commercial / Retail Units 50dBA

These criteria should prove satisfactory for most potential end users.

4.5 Summary

The project criteria adopted are therefore as follows;

Bedroom	Night-time (23:00-07:00)	30dB L_{Aeq} typically <45dB $L_{Amax,f}$ *
Living Rooms	Daytime (07:00-23:00)	35dB L_{Aeq}

* Under WHO, 10-15 occurrences during the night-time in excess of 45dBA are "allowable". The new 2014 version of BS 8233 states L_{max} levels in the region of 45-55dBA could be considered acceptable.

External Amenity Areas	Daytime (07:00-23:00)	normally <55dB L_{Aeq}
Balconies/Terraces	Daytime (07:00-23:00)	ideally < 55dB L_{Aeq} if practicable
Commercial/Retail Units	Daytime (07:00-23:00)	50dB L_{Aeq}

5.0 PLANT NOISE EMISSION CRITERIA

5.1 Relevant Planning Condition

We understand the following site-wide planning conditions have been imposed:

BLOCKS B, C, D, E,F and G

Planning Condition 25 states:

> *"The rating level of noise emitted from the plant and/or machinery hereby approved shall be at least 5 dB below the existing background noise level. The noise levels shall be determined at the nearest residential property. The measurements and assessment shall be made in accordance with British Standard 4142:2014. A post installation noise assessment shall be carried out where required to confirm compliance with the noise criteria and additional steps to mitigate noise shall be taken, as necessary. Approved details shall be implemented prior to occupation of the development and thereafter be permanently retained."*

In line with the above, we would propose items of mechanical services are designed, such that noise emissions from the plant do not exceed the following levels when assessed at the nearest noise sensitive location:

Table 7 – Plant Noise Emission Limits

Measurement Position	L_{Aeq} Noise Level limit of all operating plant (dB) at 1m from the nearest noise sensitive façade	
	Daytime (07:00 – 23:00)	Night-time (23:00 – 07:00)
Position 1 – Nestles Avenue	50	47
Position 2 – Squirrels Trading Estate	51	47
Position 3 – Railway	49	47
Position 4 – Centre of Site	48	43

In line with BS 4142, should the proposed plant be identified as having intermittent or tonal characteristics, a further penalty should be applied to any of the above proposed noise emission limits in Table 7.

5.2 Emergency Equipment Criteria

We are not aware of any specific requirements that the London Borough of Hillingdon imposes on atmospheric noise emissions from emergency plant. However, based on our experience with other Local Authorities we suggest that a criterion of 10dB above the existing background noise levels is targeted for emergency/fire plant when tested. It is recommended that testing takes place only during daytime periods on weekdays (excluding evening hours). The following table presents the design target limits for emergency plant operation.

Table 8 – Emergency Plant Noise Emission Limits

Measurement Position	L_{Aeq} Noise Level limit of all operating plant (dB) at 1m from the nearest noise sensitive façade
	Daytime (07:00 – 23:00)
Position 1 – Nestles Avenue	65
Position 2 – Squirrels Trading Estate	66
Position 3 – Railway	64
Position 4 – Centre of Site	63

6.0 EXTERNAL BUILDING FABRIC ASSESSMENT

6.1 Background

Analyses of the external building fabric have been undertaken in order to ascertain the required acoustic performance of the glazing and other external fabric elements to achieve the project criteria.

6.2 Assumptions

Our external building fabric analyses have assumed the following:

(a) Drawings

Our assessment has been based on drawings provided by Makower Architects and DMFK Architects.

Stage 3 drawings:
Blocks D, F1 and G

Planning drawings
Blocks B, C, F2, F3, F4, G, H and I

(b) Noise Levels

The assessment has been based on the measured noise levels as detailed in Section 2.4.

(c) Room Absorption

The bedrooms are assumed to be acoustically "soft" with carpets, curtains and other soft furnishings. For the purposes of our analyses we have assumed the absorption coefficients detailed in Tables 9 and 10.

Table 9 – Bedroom Absorption Coefficients

Absorption Coefficient (α) at Octave Band Centre Frequency (Hz)							
63	125	250	500	1k	2k	4k	8k
0.15	0.18	0.25	0.27	0.31	0.32	0.32	0.32

The living rooms are assumed to be less acoustically absorptive (with a hard floor finish, although with furnishings). For the purposes of our analyses we have assumed the following absorption coefficients.

Table 10 – Living Room Absorption Coefficients

Absorption Coefficient (α) at Octave Band Centre Frequency (Hz)							
63	125	250	500	1k	2k	4k	8k
0.15	0.18	0.20	0.22	0.22	0.22	0.23	0.27

(d) External Walls

We understand that external non-glazed areas are to comprise the following constructions:

Brick/Block Cavity Construction

(Blocks F, G, H and I)

- Brickwork
- Thermal insulation and cavity
- Medium density blockwork
- 8mm scratch coat
- 1No. layer 15mm plasterboard on dabs

As such, we have assumed the following sound reduction indices (equating to an overall R_W of 52dB) for all non-glazed façade areas comprising the above construction within these blocks:

Table 11 – Non-Glazed SRIs (Brick/Block Construction)

Assumed Sound Reduction Index (dB) at Octave Band Centre Frequency (Hz)							
63	125	250	500	1k	2k	4k	8k
36	41	45	45	54	58	58	58

Brick-Metsec Type Frame Construction

(Blocks B, C, D and E)

- Brickwork or concrete outer layer
- Thermal insulation and cavity
- 12mm cement particle or calcium silicate board
- Metsec type frame with mineral wool in void
- 2No. layers 12.5mm dense plasterboard

As such, we have assumed the following sound reduction indices (equating to an overall R_W of 58dB) for all non-glazed façade areas comprising the above construction within these blocks:

Table 12 – Non-Glazed SRIs (Metsec Frame Construction)

Assumed Sound Reduction Index (dB) at Octave Band Centre Frequency (Hz)							
63	125	250	500	1k	2k	4k	8k
35	42	48	53	63	70	74	74

Should the proposals for non-glazed areas change, it is critical we are informed at the earliest opportunity as this could have a significant impact on the sound insulation performance requirements of the glazing systems.

(e) Ventilation

As part of a VE exercise we understand the ventilation strategy has changed from the previously proposed whole house mechanical ventilation system to natural ventilation via trickle ventilators. Due to the open nature of trickle vents, consideration needs to be made to ensure a product is selected which ensures the overall sound insulation of the façade is not compromised.

It should be noted that trickle ventilators provide background trickle ventilation only and that windows are to generally be openable to provide rapid ventilation. During those periods where windows are opened for purge / rapid ventilation, noise levels will naturally be increased internally. The exception to this is the windows on the east façade of Block G overlooking the new industrial estate, which are non-openable at the request of Segro.

Should the proposals for ventilation change, it is important that RBA Acoustics is informed at the earliest opportunity as alternative vents could have a significant impact on the sound insulation performance for the building.

6.3 Specification & Guidance Constructions

Appendix B details the sound reduction performance specification for the ventilators and glazed elements of the external building fabric.

The glazing performance specifications apply to the glazing package as a whole inclusive of glazing, louvres, spandrel panels, framing, opening lights, doors, seals, etc. The performance of the glazing system will depend on many factors such as the glazing configuration, size of window panels, quality of framing, quality of sealing, etc.

For guidance purposes we would typically expect the following glazing configurations detailed below to prove commensurate with achieving the sound insulation performance specifications detailed within Appendix B.

Please note – *The glazing configurations described in Table 13 and ventilator types described in Table 14 are given for costing purposes only. All window systems should be capable of meeting the performance specifications shown in Appendix B, with laboratory test certificates being made available in support of the quoted performance. Glazing proposals which simply reflect the guidance constructions indicated in this report will not, in isolation, be sufficient evidence that a window configuration will meet the performance specification.*

Table 13 – Glazing Guidance Constructions

Glazing Type	Glazing Configuration
G1	High specification double glazing comprising 10mm glass / 12mm cavity / 6.4mm laminated glass
G2	Medium specification double glazing, e.g. 6mm glass / 12mm cavity / 8mm glass
G3	Standard thermal double glazing with differing pane thicknesses, e.g. 4mm glass / 12mm cavity / 6mm glass
G4	Non-openable standard thermal double glazing with differing pane thicknesses, e.g. 4mm glass / 12mm cavity / 6mm glass

It should be noted that where there is a necessity for security laminated glass on the ground (lower / accessible) floors, the specifications may exceed those stated above in some locations.

For guidance purposes we would typically expect the following trickle ventilator types to prove commensurate with achieving the sound insulation performance specifications detailed within Appendix B.

Table 14– Guidance Trickle Ventilator Types

Ventilator Type	Example Ventilator Type
V1	High performance through-the-frame type trickle ventilator, e.g. Renson Invisivent EVO AK Extreme – $D_{n,e,w}$ 48dB or Renson PyrAcoust 2500EA with Pyramid Vent with 2 acoustic sets (inside and outside).
V2	Medium performance through-the-frame type trickle ventilator, e.g. Renson Invisivent EVO AK Ultra – $D_{n,e,w}$ 42dB or Renson PyrAcoust 2500EA with Pyramid Vent with 1 acoustic set (just inside or outside).
V3	Low performance through-the-frame type trickle ventilator, e.g. Renson Invisivent EVO AK Basic – $D_{n,e,w}$ 34dB.

Alternative guidance types of trickle ventilator suitable to achieve the V1 spec – as proposed by tenderers on the early phase blocks - comprise;

6.4 Applicable Zoning

Due to the differences in the prevailing noise climate around the site, four primary glazing zones have been defined, as indicated on the façade zoning plans provided in Figures 2 and 3 in Appendix E.

Table 15 – Façade Zoning Specification

Façade Zone	Room	Glazing Type	Ventilator Type
Zone 1	Bedroom	G1	V1
	Living Room*	G1	V1
	Commercial Units	G3	-
Zone 2	Bedroom	G2	V2
	Living Room*	G2	V2
	Commercial Units	G3	-
Zone 3	Bedroom	G3	V3
	Living Room*	G3	V3
	Commercial Units	G3	-
Zone 4	Residential areas e.g. common corridor	G4	-
	Commercial Units	G3	-

* "Living Room" also includes the Living Rooms, Dining Rooms & Kitchens of the flats and all other room types throughout the development, i.e. communal areas, bathrooms, WCs, concierge, circulation corridors, etc.

6.5 Flanking Specification

We also advise on the flanking specification for any curtain walling or continuous glazing systems proposed as follows to aid the development of such systems.

Flanking Performance Specification

The previous sections are in relation to external noise intrusion through any curtain walling systems to internal areas. Separating wall and floor sound insulation performance can often be compromised by curtain walling systems. It is thus important that an additional specification for the curtain walling package be introduced, which will limit the amount of sound transfer across separating wall and floor lines through the curtain walling system. A flanking performance specification is attached within Appendix B – Section 3.0.

Achievement of the specification can be demonstrated by laboratory acoustic testing in general accordance with BS EN ISO 10848-2:2006. This is admittedly a complex and costly testing procedure and therefore the supplier may – following tender reviews – be allowed to demonstrate by other means that the specification can be achieved. This is reflected in the specification wording. The specification should also be incorporated within any other packages, which could affect the transmission of flanking sound at separating wall and floor lines.

It is likely insulated double/split mullions and transoms will be required in order to achieve the attached flanking specification. This obviously has a large impact on the design and style of any curtain walling system and should be investigated at the earliest opportunity to ensure the specification is achieved.

7.0 NOISE IMPACT FROM INDUSTRIAL UNITS

7.1 Proposed Segro Industrial Unit

Consideration has been made for potential noise impact on the residential properties from the proposed Segro industrial unit, which is to be located to the east of the site. An assessment has previously been carried out by others (Peter Brett Associates), which included noise predictions of service yard activities. This model has been reproduced while incorporating the updated site layouts, and a subsequent noise impact assessment has been carried out.

Non-Glazed Residential Areas

In order to protect future residents from service yard noise, apartments in Block G which are located on the north and east façades should have no apartment windows overlooking the service yard of the proposed Segro industrial estate. The DMFK Stage 3 architectural drawings show that common corridors, or apartment façades with no windows, will be located on these façades, as requested by Segro.

Common corridor windows located on the north and east façades should be sealed shut, these areas are as shown in Figure 3.

Retained Façade

DMFK architects have advised that a retained façade, 16.5m high, will separate the residential and industrial sites, the existing windows on this retained façade are to be solid-backed with masonry or concrete. Our assessment has shown that this will sufficiently protect the residential windows to the north-east of Block F1 from service yard activity noise, the extent of this retained façade is shown in Figure 4.

Timber Fence at Eastern Site Boundary

It is noted that the proposed Unit 4 building located within the Segro industrial estate will be 17m high and will run along the majority of the eastern site boundary (towards the north), therefore this building itself should sufficiently screen the residential areas from service yard activity noise occurring within the Segro industrial estate.

In order to further protect the external amenity areas of Blocks F and G from industrial noise produced by the proposed Segro industrial unit, a 3m high close-boarded timber fence with minimal perforations should be installed to the eastern site boundary. The extent of where this should be installed is shown in the attached Figure 5.

7.2 Existing Squirrels Trading Estate

Consideration has been made for potential noise impact on the residential properties from the existing Squirrels Trading Estate, which is located to the west of the site. A perforated chain link fence is currently installed on this site boundary. Observations on site showed that various plant and broken windows belonging to the industrial units are located on the site boundary, which noise was noted to break out from.

Imperforate Acoustic Barrier at Western Site Boundary

In order to protect the external amenity areas of Blocks D and E from industrial noise produced by the existing Squirrels Trading Estate, a 3m acoustic barrier (e.g. imperforate solid timber fence with a minimum surface density of 10kg/m^2), should be installed on the western site boundary. The extent of where this should be installed is shown in the attached Figure 5. In addition to noise mitigation, we understand this barrier is also required to improve the security and privacy of the future residents of the development.

Our assessment shows that without the barrier, noise levels produced by industrial noise can exceed 62dBA in some areas of the external amenity areas of Blocks D and E. With the proposed barrier, the predicted level of industrial noise produced by Squirrels Trading Estate will generally be below 50dBA.

A render showing CadnaA noise model of the barrier assessment is provided in Figure 6.

8.0 COMMERCIAL TENANTS' AGREEMENT FOR LEASE

In order to protect the existing nearby residents and future noise-sensitive receptors of the new development we recommend the following clauses be introduced into the commercial unit tenants' agreements for lease to prevent common noise issues from occurring:

(1) *The tenant, when fitting out the unit, is to ensure that adequate sound insulation is provided to suit their intended use, to ensure the avoidance of a noise nuisance to other occupiers within or in the vicinity of the building. The tenant shall control noise emissions from the Leased Area at all times to prevent disturbance to others and shall comply with any additional noise emission limits or restrictions on operating hours imposed by the local authority and/or licensing authority.*

(2) *Activity noise, either airborne or structure-borne, from any commercial unit must not exceed the following NR criteria in any adjacent residential unit:*

NR20 $L_{1,\ 5mins}$ - daytime (07:00 – 23:00 hours)
NR15 $L_{1,\ 5mins}$ - night-time (23:00 – 07:00 hours)

For guidance, the following noise levels are not to be exceeded in the commercial unit:

Overall level: 80dBA, and 75dB per octave L_1 from 63Hz-4000Hz (daytime)
Overall level: 75dBA, and 70dB per octave L_1 from 63Hz-4000Hz (night-time)

(3) *If a higher noise level is needed in the commercial unit, it is the responsibility of the tenant to install additional sound insulation measures in their unit so that the above NR criteria are not exceeded in the residential unit due to noise from the commercial unit.*

(4) *This requirement will normally only arise if the commercial unit is to be used for amplified music of some kind or the commercial unit is to be used during the night-time period. Seek advice from Barratt in case of any doubt.*

(5) *Speakers must be resiliently mounted to avoid structure-borne transmission of noise into adjoining areas.*

(6) *Full details of typical noise levels and any proposed sound insulation measures should be forwarded to Barratt for approval.*

(7) Following implementation of any additional sound insulation measures, Barratt reserve the right to undertake acoustic tests within the adjacent residential units to demonstrate their effectiveness. Barratt reserve the right to impose further noise limits if required.

(8) The cumulative rating noise level (as defined in BS4142:2014) from all items of plant, shall not exceed a level equivalent to 5dBA below the otherwise prevailing background level (L_{A90}) as measured at 1m from the façade of the nearest noise sensitive adjacency (both within and outside the development). This is in line with the requirements of Planning Condition 25. Any items of plant having a tonal or impulsive content shall be designed to a further 5dBA below this level.

Based on noise survey information collected by RBA Acoustics, the following design targets should be met at the nearest noise sensitive receptors:

(a) Development and non-development windows to the south and east of site

Emergency plant items (testing between 09:00 – 17:00 hours)	65dBA
Daytime plant operation (07:00 – 23:00 hours)	50dBA
Night-time plant operation (23:00 – 07:00 hours)	47dBA

(b) Development and non-development windows to the west of site

Emergency plant items (testing between 09:00 – 17:00 hours)	66dBA
Daytime plant operation (07:00 – 23:00 hours)	51dBA
Night-time plant operation (23:00 – 07:00 hours)	47dBA

(c) Development and non-development windows to the north of site

Emergency plant items (testing between 09:00 – 17:00 hours)	64dBA
Daytime plant operation (07:00 – 23:00 hours)	49dBA
Night-time plant operation (23:00 – 07:00 hours)	47dBA

(d) Development windows facing to the centre of site

Emergency plant items (testing between 09:00 – 17:00 hours)	63dBA
Daytime plant operation (07:00 – 23:00 hours)	48dBA
Night-time plant operation (23:00 – 07:00 hours)	43dBA

9.0 CONCLUSION

RBA Acoustics have undertaken noise monitoring at the proposed development site at the Former Nestle Factory site in Hayes. The measured noise levels are presented herein. The resultant noise levels have been used in our assessment of the glazing requirements to ensure suitable internal noise levels are achieved at the proposed development with reference to BS 8233 and WHO.

The data has also been used to set plant noise emission criteria for future assessment of any proposed plant at the development to ensure the adjacent neighbour's and own amenity spaces are protected from plant noise emissions in line with the Local Authority requirements.

General guidance configurations have been suggested for the glazing constructions that should be capable of achieving the required specifications detailed within Appendix B. A worst case configuration of 10/12/6.4 laminated double glazing is required to the bedrooms of the north facing façades overlooking the railway lines in order to protect the residences from train noise. However, other areas only require more standard double glazing. Suitable trickle ventilator specification and guidance types have also been state herein.

Suitable tenancy lease clauses have been developed to cover noise breakout noise transmission from commercial units, as well as atmospheric noise emissions from any items of plant associated with the commercial spaces.

In order to protect the ground floor amenity areas located near the east and west site boundaries from noise from the industrial estates, an imperforate acoustic barrier has also been proposed.

Appendix A - Acoustic Terminology

dB	Decibel - Used as a measurement of sound pressure level. It is the logarithmic ratio of the noise being assessed to a standard reference level.
dB(A)	The human ear is more susceptible to mid-frequency noise than the high and low frequencies. To take account of this when measuring noise, the 'A' weighting scale is used so that the measured noise corresponds roughly to the overall level of noise that is discerned by the average human. It is also possible to calculate the 'A' weighted noise level by applying certain corrections to an un-weighted spectrum. The measured or calculated 'A' weighted noise level is known as the dB(A) level. Because of being a logarithmic scale noise levels in dB(A) do not have a linear relationship to each other. For similar noises, a change in noise level of 10dB(A) represents a doubling or halving of subjective loudness. A change of 3dB(A) is just perceptible.
L_{eq}	L_{eq} is defined as a notional steady sound level which, over a stated period of time, would contain the same amount of acoustical energy as the actual, fluctuating sound measured over that period (1 hour).
L_{Aeq}	The level of notional steady sound which, over a stated period of time, would have the same A-weighted acoustic energy as the A-weighted fluctuating noise measured over that period.
L_{An} (e.g. L_{A10}, L_{A90})	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.
$L_{max,T}$	The instantaneous maximum sound pressure level which occurred during the measurement period, T. It is commonly used to measure the effect of very short duration bursts of noise, such as for example sudden bangs, shouts, car horns, emergency sirens etc. which audibly stand out from the general level of, say, traffic noise, but because of their very short duration, maybe only a very small fraction of a second, may not have any effect on the L_{eq} value.

Appendix B – External Building Fabric Acoustic Specification

1.0 Window Sound Insulation Performance

Glazed units (inclusive of glazing, louvres, timber panels, spandrel panels, infill panels, framing, opening lights, balcony/terrace doors, seals, etc. as appropriate) should achieve the following minimum sound reduction indices as tested in general accordance with BS EN ISO 10140-2:2010:

Type	Minimum Recommended Sound Reduction Index (dB) at Octave Band Centre Frequency (Hz)								R_w (dB)
	63	125	250	500	1k	2k	4k	8k	
G1	23	27	29	36	41	42	52	52	39
G2	23	23	23	30	38	36	43	43	35
G3	19	23	22	27	38	36	41	41	33

Note: R_w is the "overall weighted sound reduction index" tested in a laboratory.

N.B. as the internal noise criteria are expressed in dBA terms, other frequency-specific performance levels may ultimately prove acoustically acceptable. Test data for representative samples of all glazing systems shall be submitted to RBA Acoustics for approval to demonstrate compliance with the above performance specifications.

2.0 Trickle Ventilator Sound Insulation Performance

Trickle ventilators (in their open state) should achieve the following minimum element-normalised level differences as tested in accordance with BS EN 20140-10:1992:

Type	Minimum Recommended $D_{n,e}$ (dB) at Octave Band Centre Frequency (Hz)								$D_{n,e,w}$ (dB)
	63	125	250	500	1k	2k	4k	8k	
V1	34	38	40	44	49	53	64	64	48
V2	33	37	37	35	41	52	61	61	42
V3	32	36	35	32	32	37	47	47	34

Note: $D_{n,e,w}$ is the "overall weighted element normalised level difference" tested in a laboratory.

Please note the above specification(s) assumes one trickle ventilator will be installed per room, i.e. a continuous mechanical extract system (ADF System 3) will be utilised. The specification(s) should be increased by a factor of 10Log(N) should N ventilators be required per room, i.e. increase by +3dB or +5dB respectively should two or three ventilators be required per room.

N.B. as the internal noise criteria are expressed in dBA terms, other frequency specific performance levels may ultimately prove acoustically acceptable. Test data for the trickle vents in their open state shall be submitted to RBA Acoustics for approval.

3.0 Acoustic Flanking Specification

Extent

There is potential for any curtain walling or continuous system to transmit sound across the separating floors and walls, and to thus result in future sound insulation problems.

The following specification should therefore be introduced within the tender documentation in order to ensure the system components are adequately designed.

The following specifications apply to all curtain walling or continuous elements between residential units and, if applicable, between residential units and commercial areas. Between non-residential areas (e.g. commercial to commercial, etc.) it is standard practice to relax the specification to a value of 50dB $D_{n,f,w}$.

With regard to potential flanking through the panels, the specification is commensurate with relatively high sound insulation levels. Achievement of this specification will require careful consideration of the panel design, in particular the insulation type and construction make-up of the panel skin. In addition it is likely to be necessary to design the cladding such that double/twin insulated mullions and transoms are included.

Horizontal Flanking at Separating Wall Lines

The curtain walling/continuous system shall achieve a horizontal weighted normalised flanking level difference of 60dB $D_{n,f,w}$ when tested in general accordance with BS EN ISO 10848-2:2006 [previously BS EN 20140-9:1994] (the methodology amended accordingly).

The supplier shall demonstrate by the provision of previous test reports (and comparative calculations if required) that the specification can be achieved. The Client, however, reserve the right to insist on laboratory acoustic testing if any doubts remain in relation to the flanking performance of the system.

The curtain walling system shall provide suitable surfaces against which a good acoustic seal can be made with future separating walls.

Vertical Flanking at Separating Floor Lines

The curtain walling system shall achieve a vertical weighted normalised flanking level difference of 60dB $D_{n,f,w}$ when tested in general accordance with BS EN ISO 10848-2:2006 [previously BS EN 20140-9:1994] (the methodology amended accordingly).

The supplier shall demonstrate by the provision of previous test reports (and comparative calculations if required) that the specification can be achieved. The Client, however, reserve the right to insist on laboratory acoustic testing if any doubts remain in relation to the flanking performance of the system.

The curtain walling system shall provide suitable surfaces against which a good acoustic seal can be made with future separating floors.

Appendix C – Instrumentation

The following equipment was used for the measurements

Manufacturer	Model Type	Serial No.	Calibration	
			Certificate No.	Expiry Date
Norsonic Type 1 Sound Level Meter	Nor140	1406116	U23172	24 November 2018
Norsonic Pre Amplifier	1209	20295		
Norsonic ½" Microphone	1225	215486	23171	24 November 2018
Norsonic Sound Calibrator	1251	34307	U23170	24 November 2018
Norsonic Type 1 Sound Level Meter	Nor140	1406258	U25097	23 March 2019
Norsonic Pre Amplifier	1209	20490		
Norsonic ½" Microphone	1225	225526	25096	23 March 2019
Norsonic Sound Calibrator	1251	34397	U25095	23 March 2019
Norsonic Type 1 Sound Level Meter	Nor140	1406407	U26539	6 September 2019
Norsonic Pre Amplifier	1209	20688		
Norsonic ½" Microphone	1225	226839	26538	6 September 2019
Norsonic Sound Calibrator	1251	34482	U26537	6 September 2019
01dB A&V Type 1 Sound Level Meter	Black Solo 01	65678	U27729 / U27730(RT's)	8 February 2020
01dB A&V Pre Amplifier	PRE 21 S	16316		
01dB A&V ½" Microphone	MCE 212	166503	27728	8 February 2020
01dB-Stell Calibrator	Cal 21	35242481	U28011	12 March 2020

Appendix D – CDM Considerations

The likelihood the harm will occur can be assessed by applying an indicative score (from 1 to 5) as follows:

1 – Remote (almost never)
2 – Unlikely (occurs rarely)
3 – Possible (could occur, but uncommon)
4 – Likely (recurrent but not frequent)
5 – Very likely (occurs frequently)

The severity of harm can be assessed by applying an indicative score (from 1 to 5) as follows:

1 – Trivial (e.g. discomfort, slight bruising, self-help recovery)
2 – Minor (e.g. small cut, abrasion, basic first aid need)
3 – Moderate (e.g. strain, sprain, incapacitation > 3 days)
4 – Serious (e.g. fracture, hospitalisation > 24 hrs, incapacitation > 4 weeks)
5 – Fatal (single or multiple)

The rating value is obtained by multiply the two scores and is then used to determine the course of action.

Rating Bands (Severity x Likelihood)		
Low Risk (1 – 8)	Medium Risk (9 -12)	High Risk (15 – 25)
May be ignored but ensure controls remain effective	Continue, but implement additional reasonable practicable controls where possible	Avoidance action is required; therefore alternative design solutions must be examined. Activity must not proceed until risks are reduced to a low or medium level

The following hazards pertinent to our design input have been identified and control measures suggested:

Hazard	Risk Of	At Risk	Rating			Control Measures	Controlled		
			L	S	R		L	S	R
Mineral wool within drywalls and linings	Skin and respiratory irritation	Contractors	4	3	12	Wear gloves and mask	1	3	3
Acoustic glazing - weight	Strain of neck, limbs or back. Fall from height.	Contractors	3	5	15	Provide sufficient manpower, lifting gear and structural support	1	5	5

L: Likelihood S: Severity R: Rating

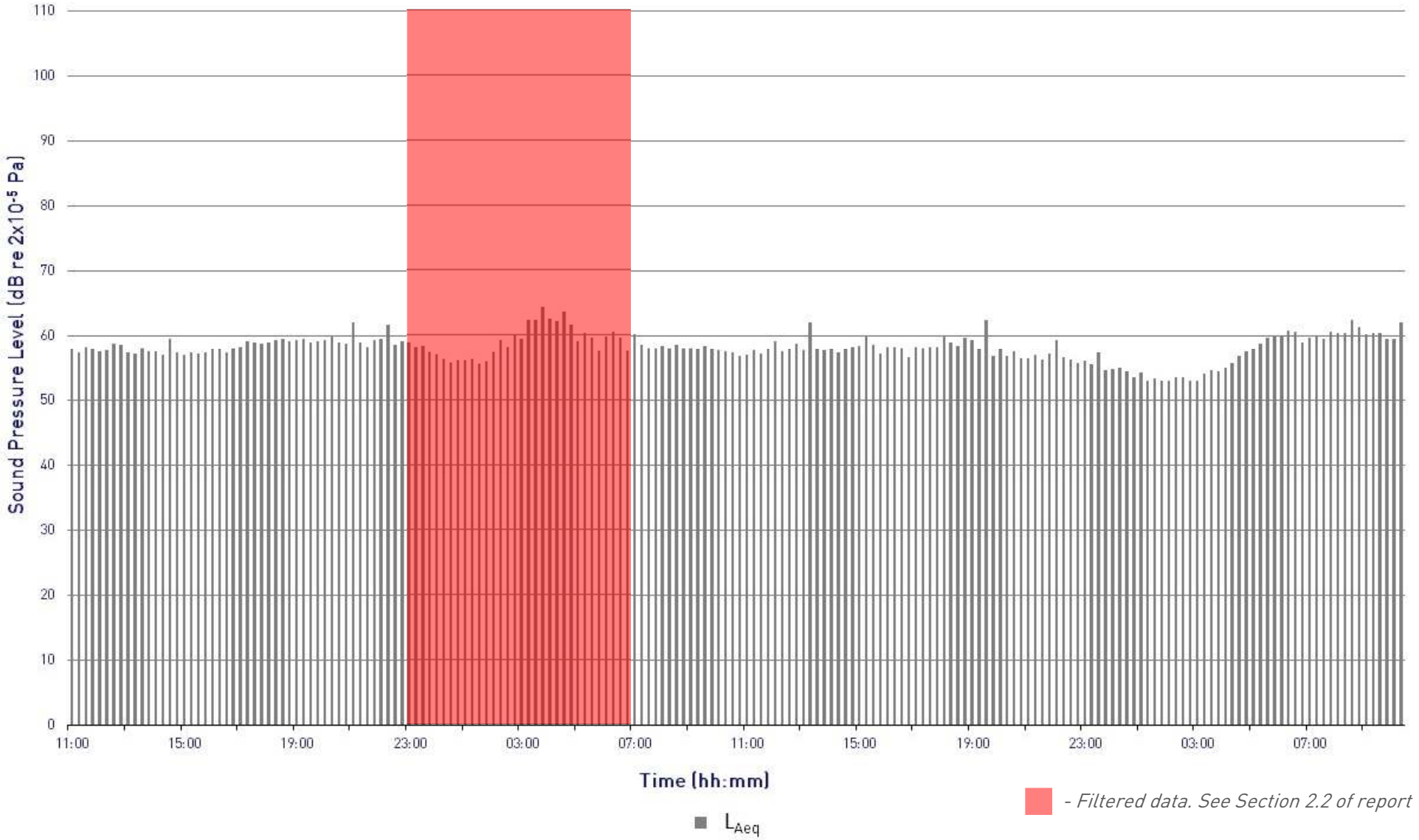
Appendix E – Graphs and Site Plans

Former Nestle Site

L_{Aeq} Time History

Measurement Position 1, Wednesday 17 January to Friday 19 January 2018

Graph 1



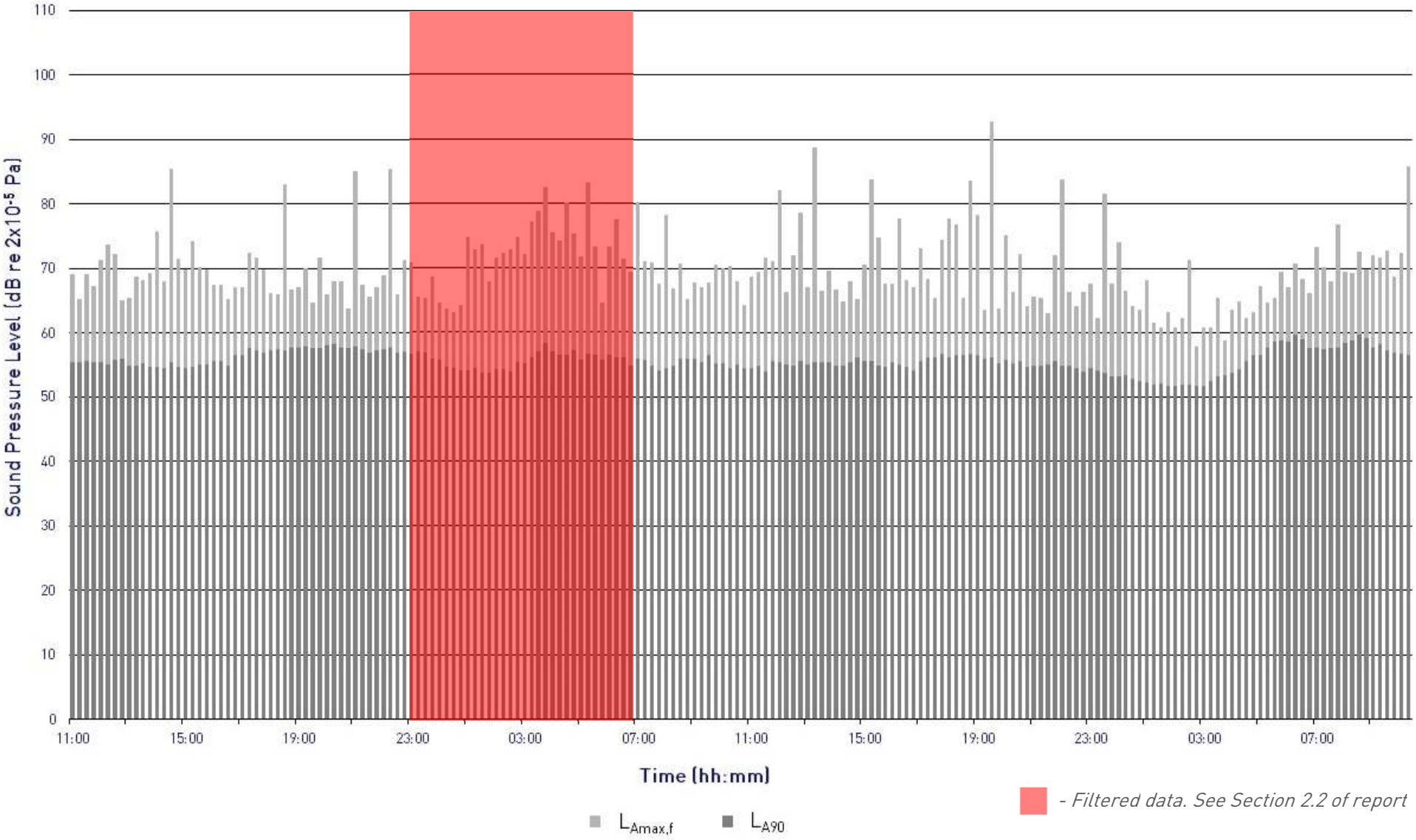
Former Nestle Site

$L_{Amax,f}$ and L_{A90} Time History

Measurement Position 1, Wednesday 17 January to Friday 19 January 2018

RBA ACOUSTICS

Graph 2



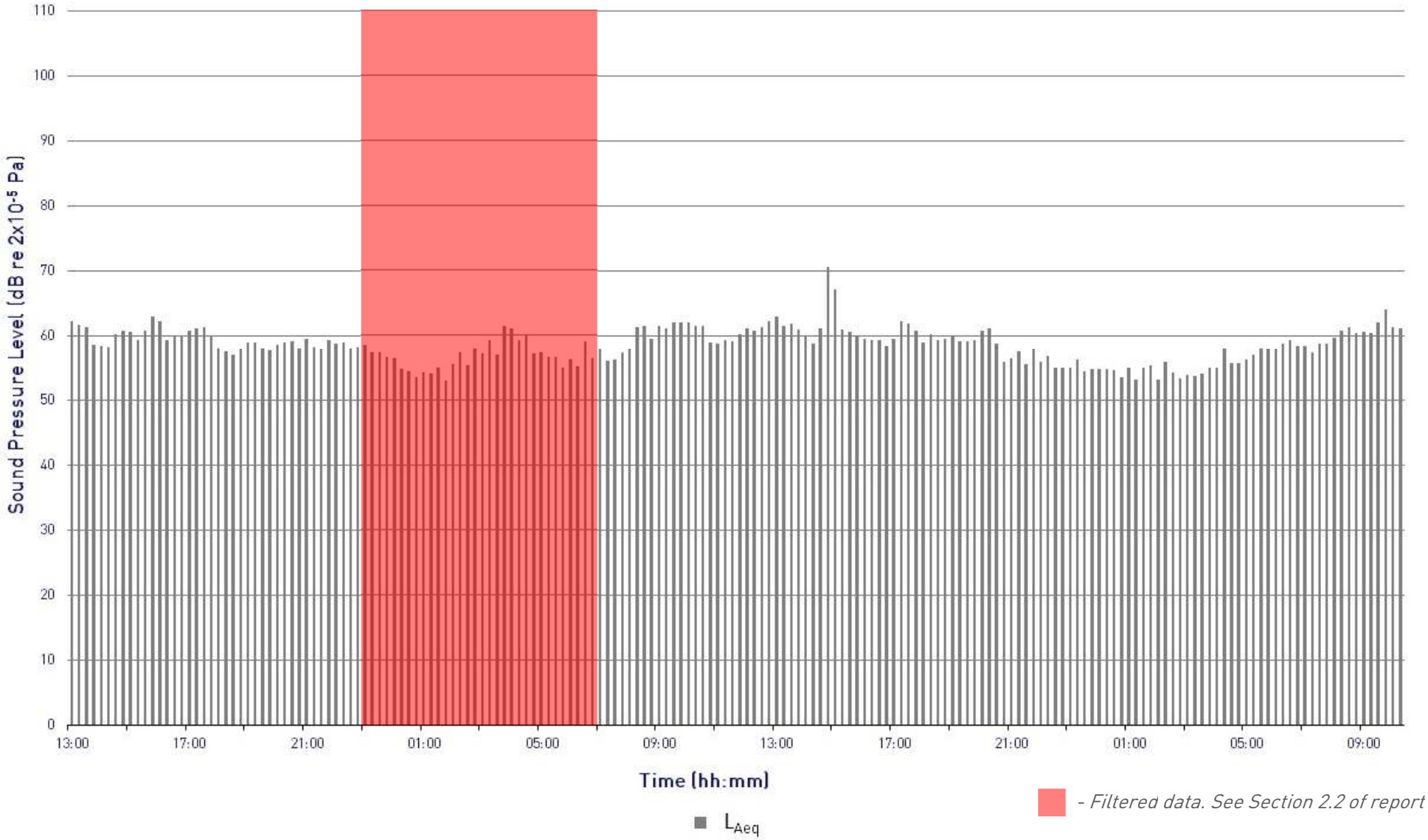
Former Nestle Site

L_{Aeq} Time History

Measurement Position 2, Wednesday 17 January to Friday 19 January 2018

RBA ACOUSTICS

Graph 3



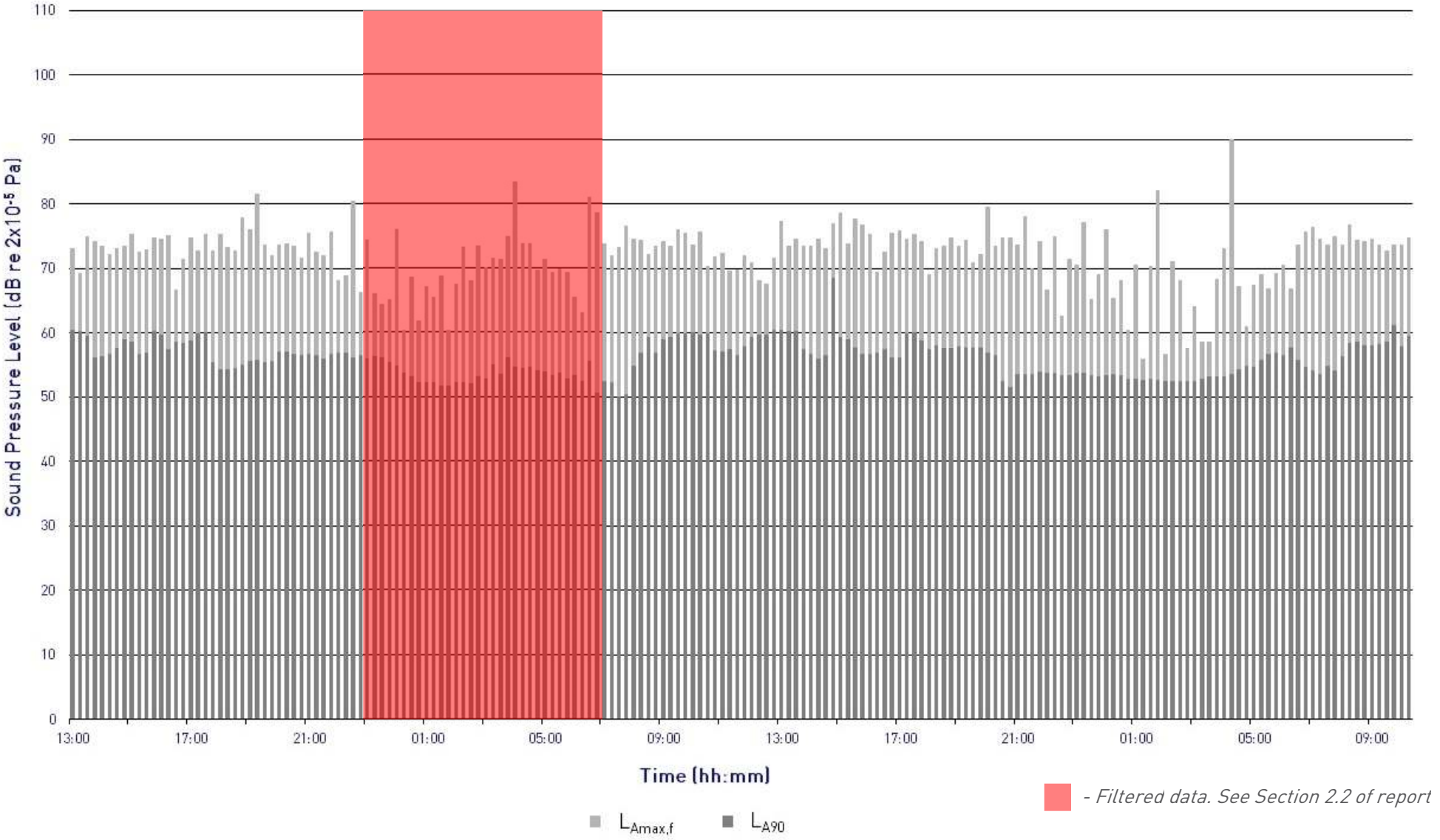
Former Nestle Site

$L_{Amax,f}$ and L_{A90} Time History

Measurement Position 2, Wednesday 17 January to Friday 19 January 2018

RBA ACOUSTICS

Graph 4



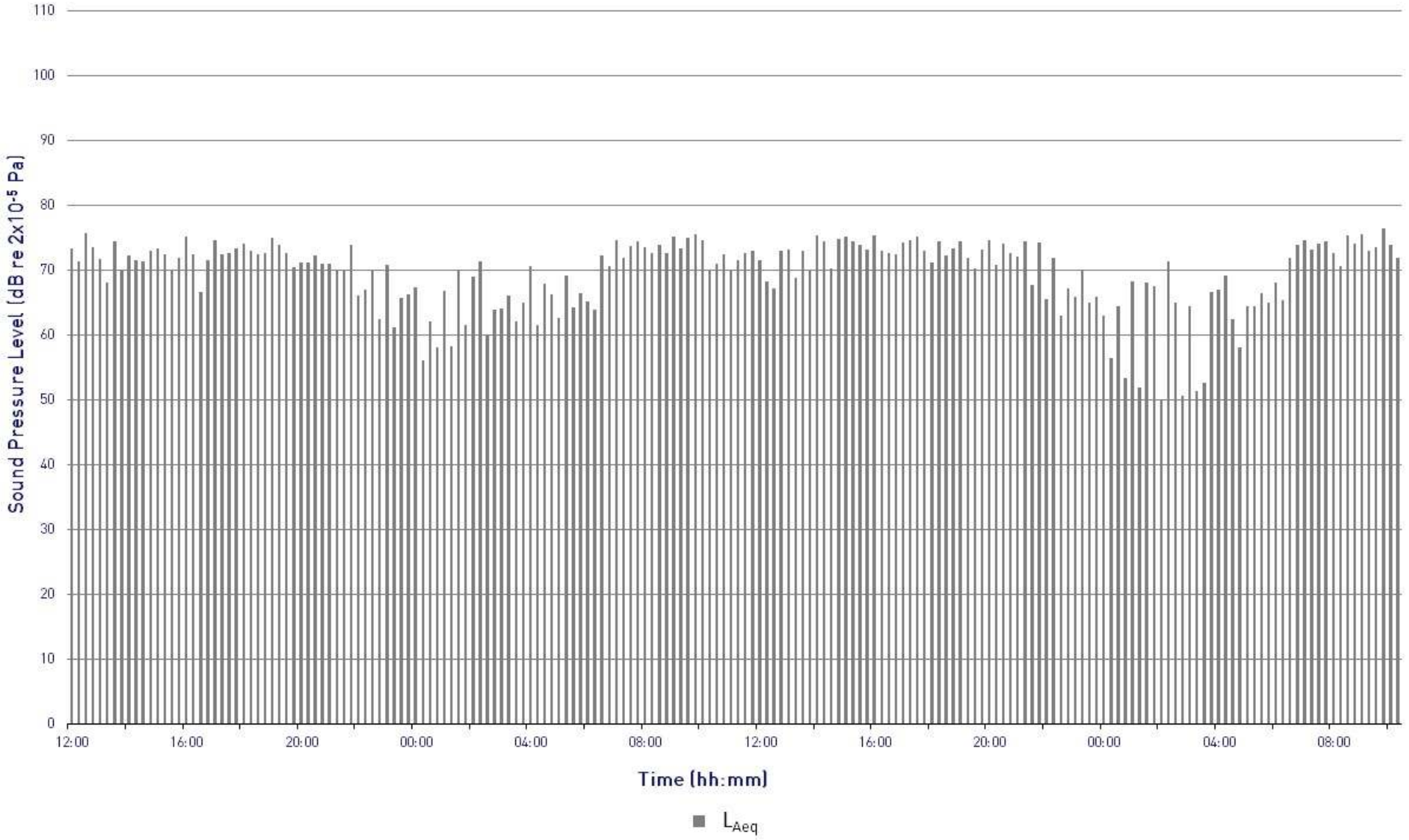
Former Nestle Site

L_{Aeq} Time History

Measurement Position 3, Wednesday 17 January to Friday 19 January 2018

RBA ACOUSTICS

Graph 5



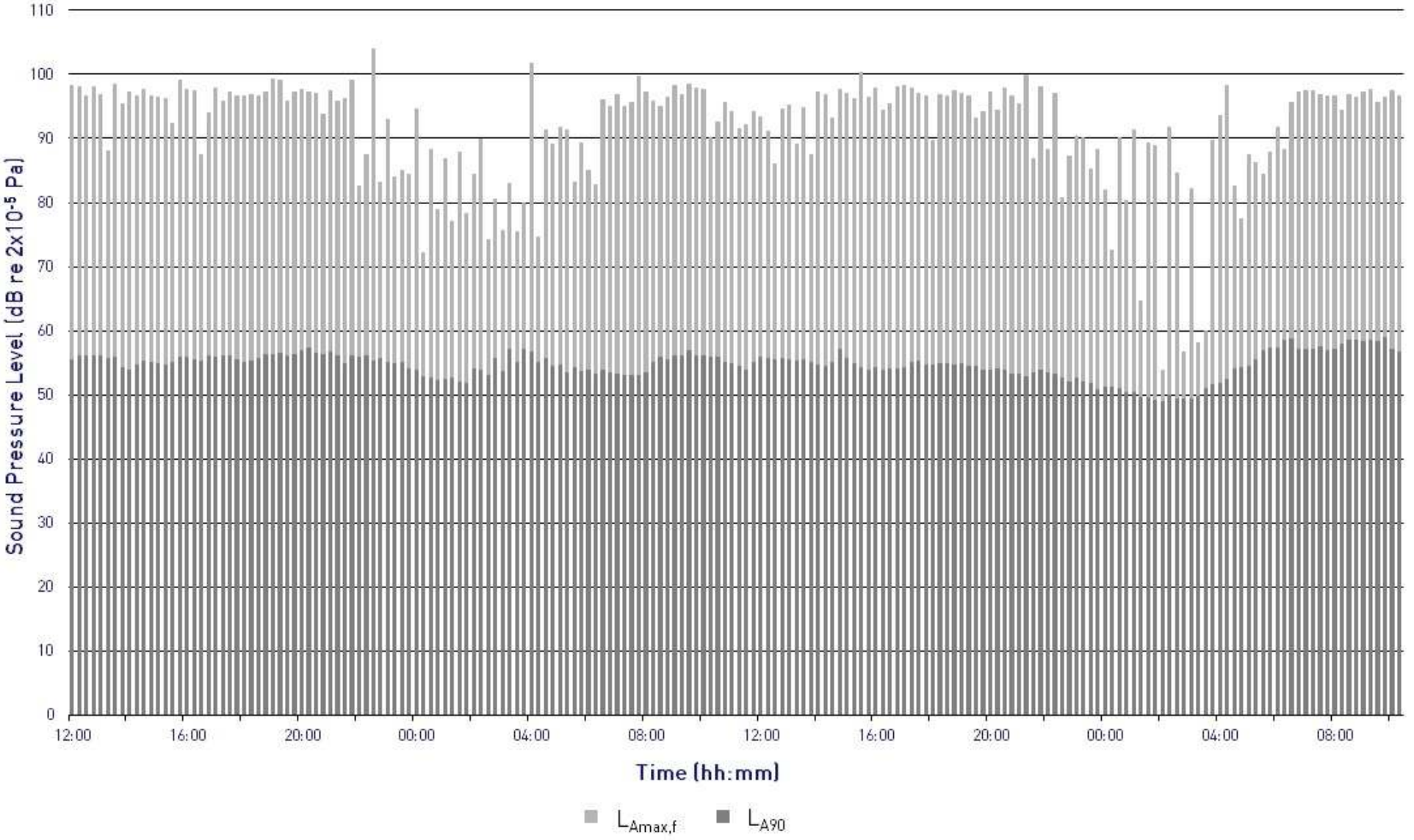
Former Nestle Site

$L_{Amax,f}$ and L_{A90} Time History

Measurement Position 3, Wednesday 17 January to Friday 19 January 2018

RBA ACOUSTICS

Graph 6

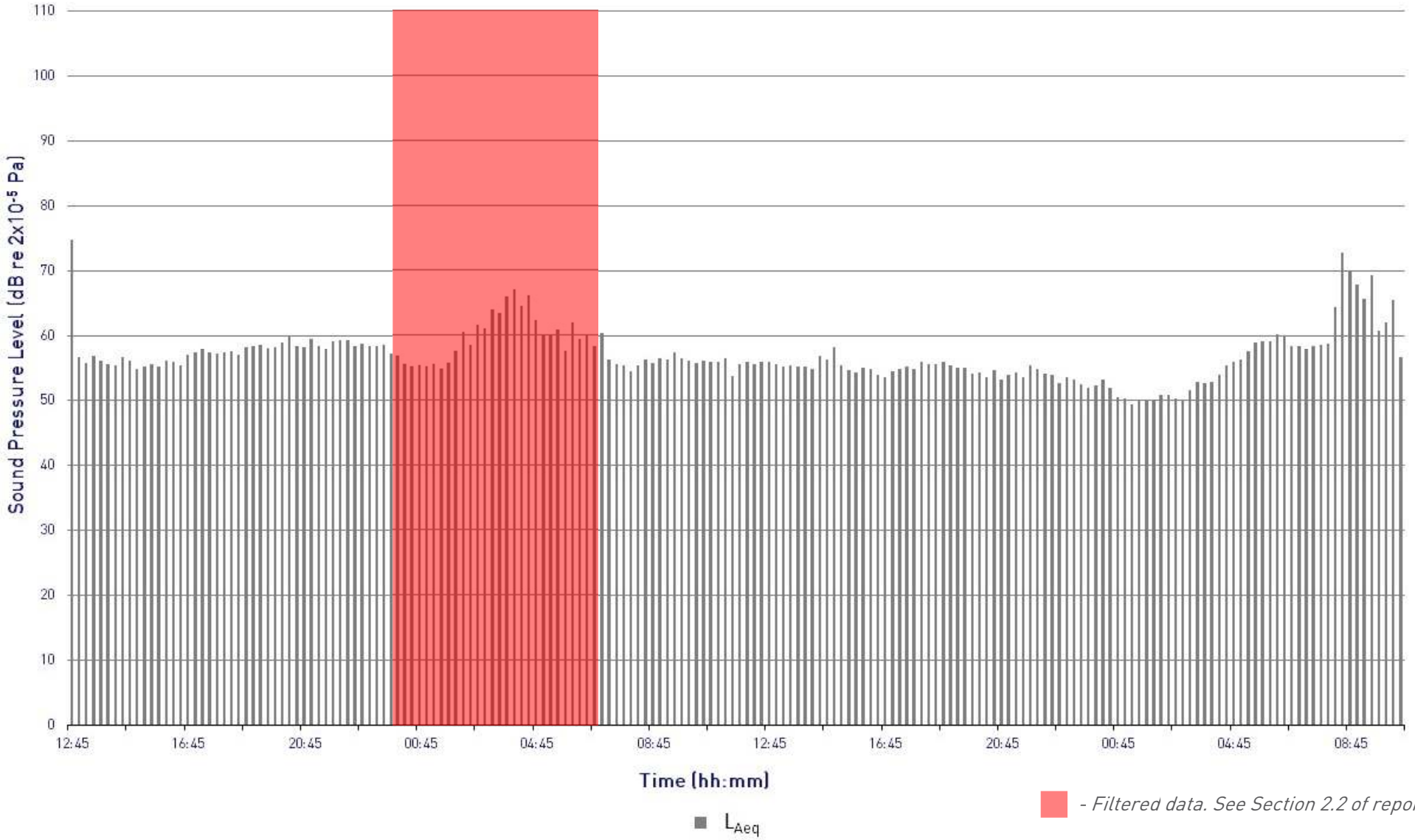


Former Nestle Site

L_{Aeq} Time History

Measurement Position 4, Wednesday 17 January to Friday 19 January 2018

Graph 7



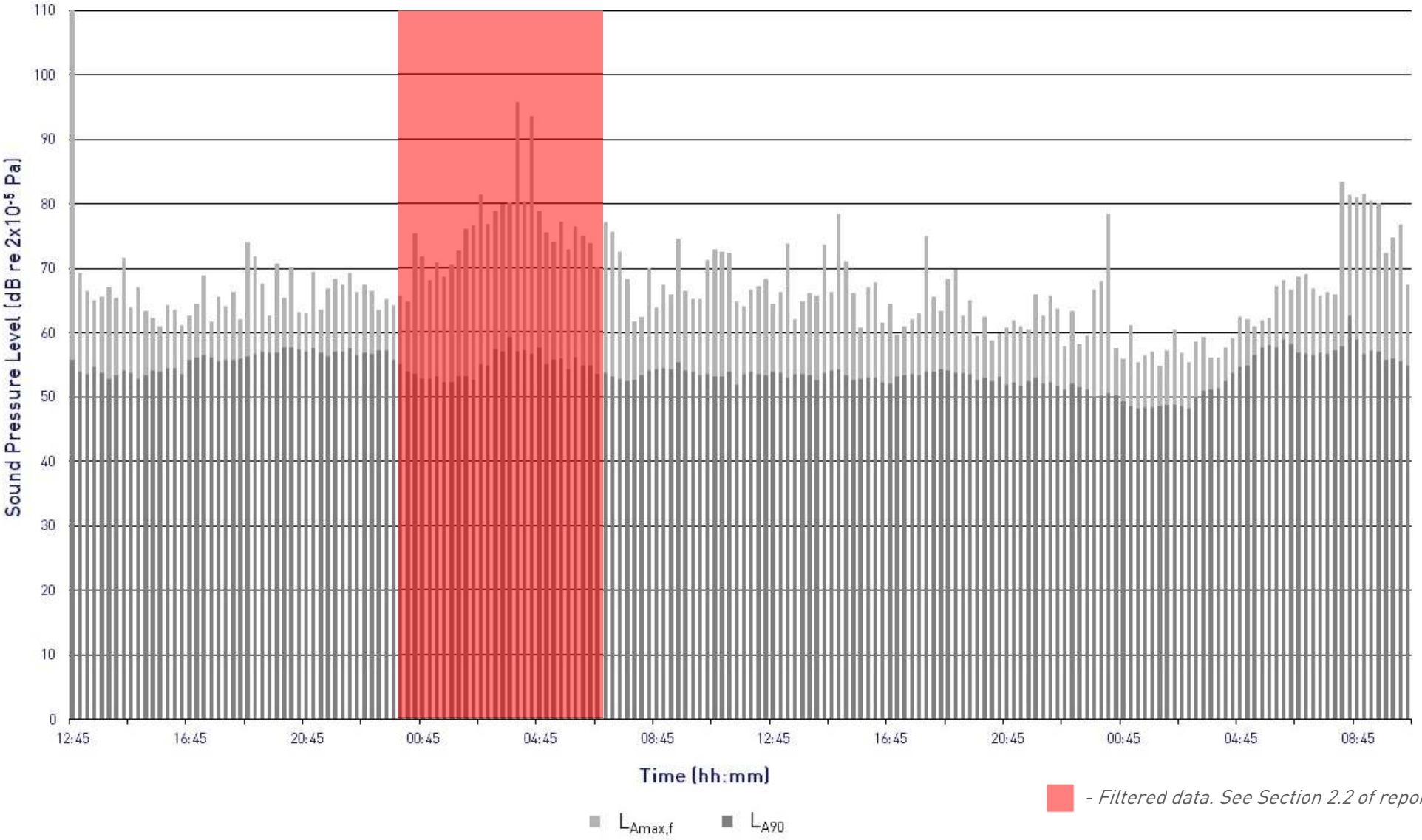
Former Nestle Site

$L_{Amax,f}$ and L_{A90} Time History

Measurement Position 4, Wednesday 17 January to Friday 19 January 2018

RBA ACOUSTICS

Graph 8

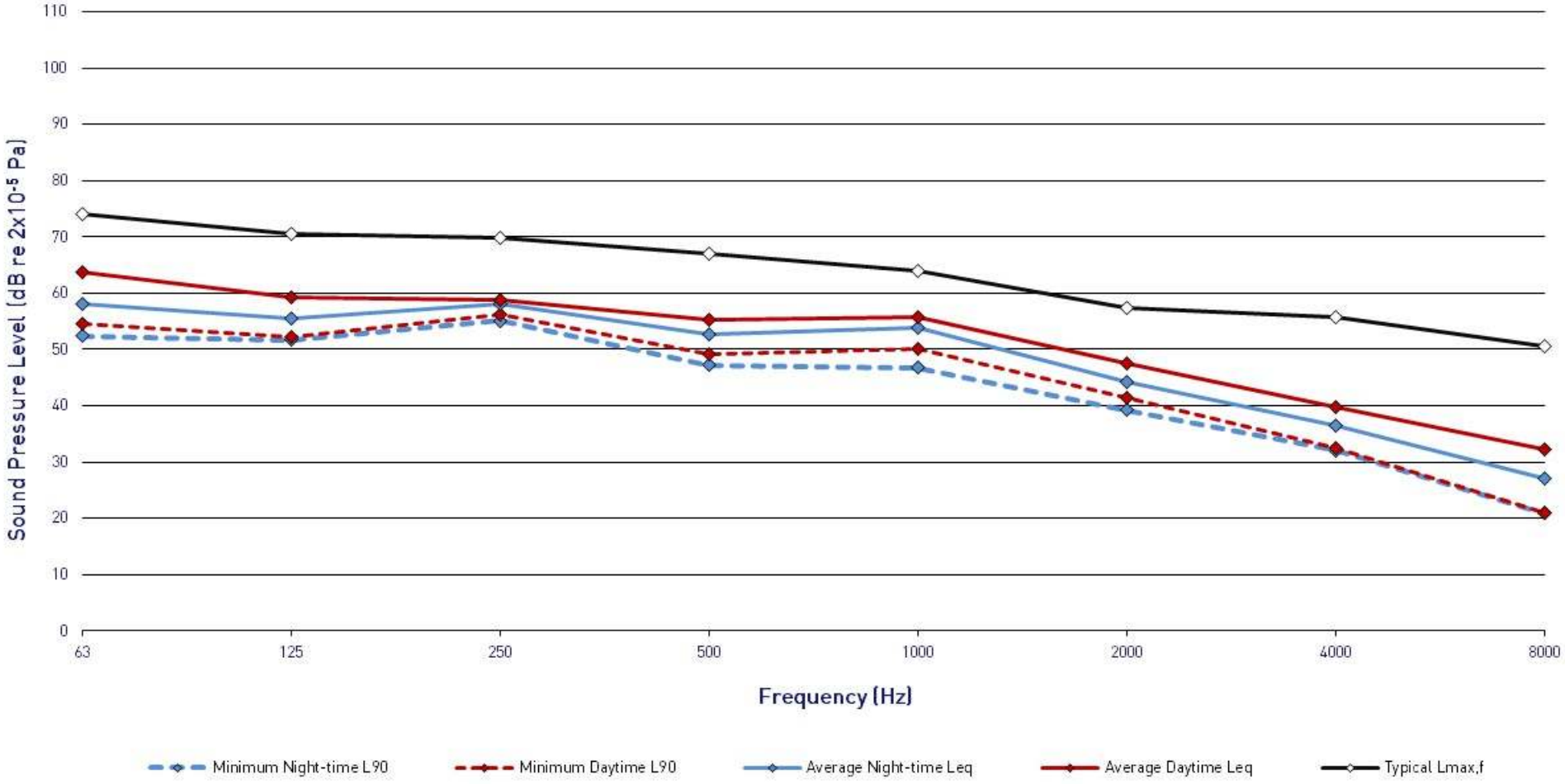


Former Nestle Site

Spectral Noise Levels

Measurement Position 1, Wednesday 17 January to Friday 19 January 2018

Graph 9

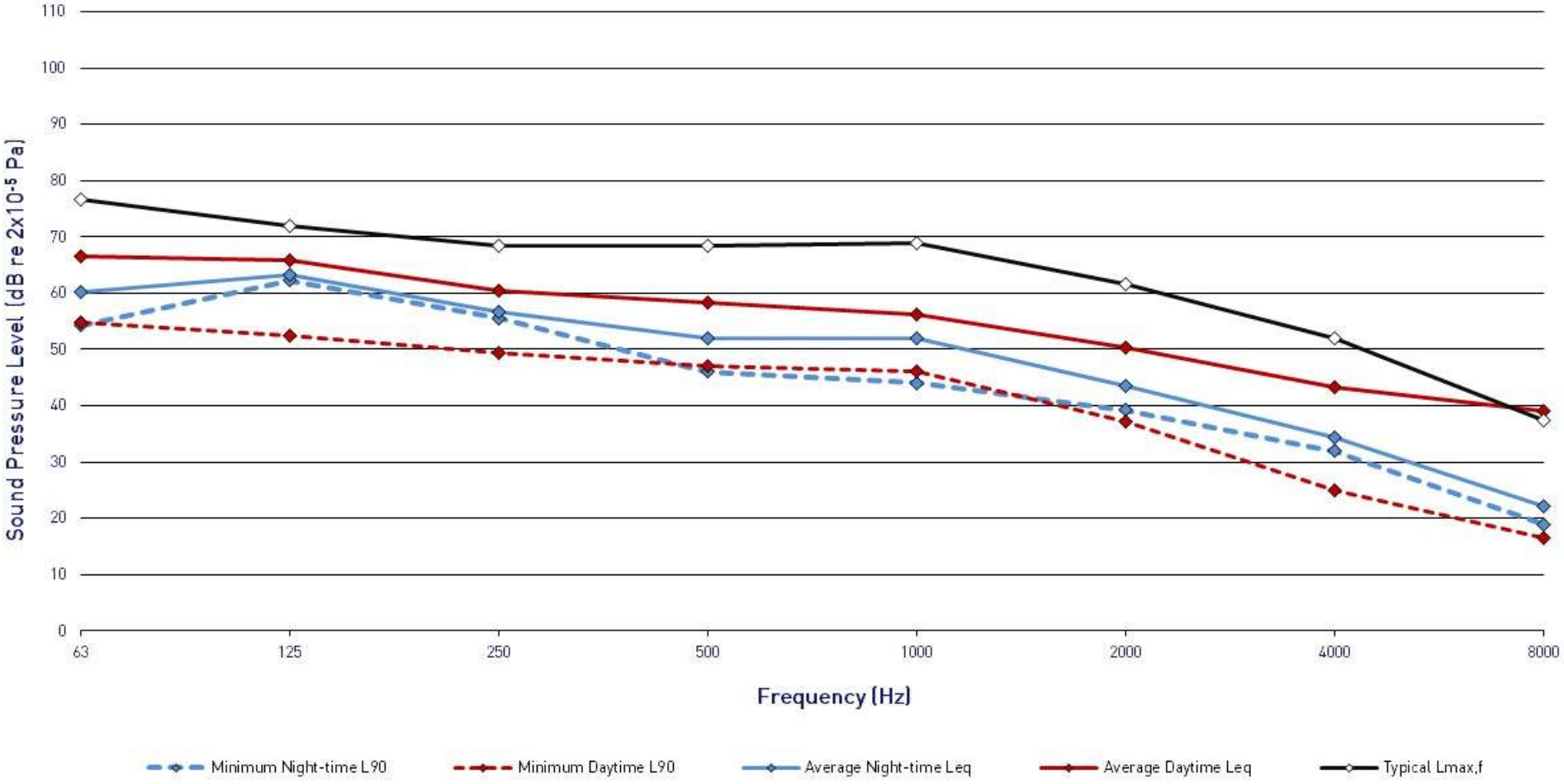


Former Nestle Site

Spectral Noise Levels

Measurement Position 2, Wednesday 17 January to Friday 19 January 2018

Graph 10

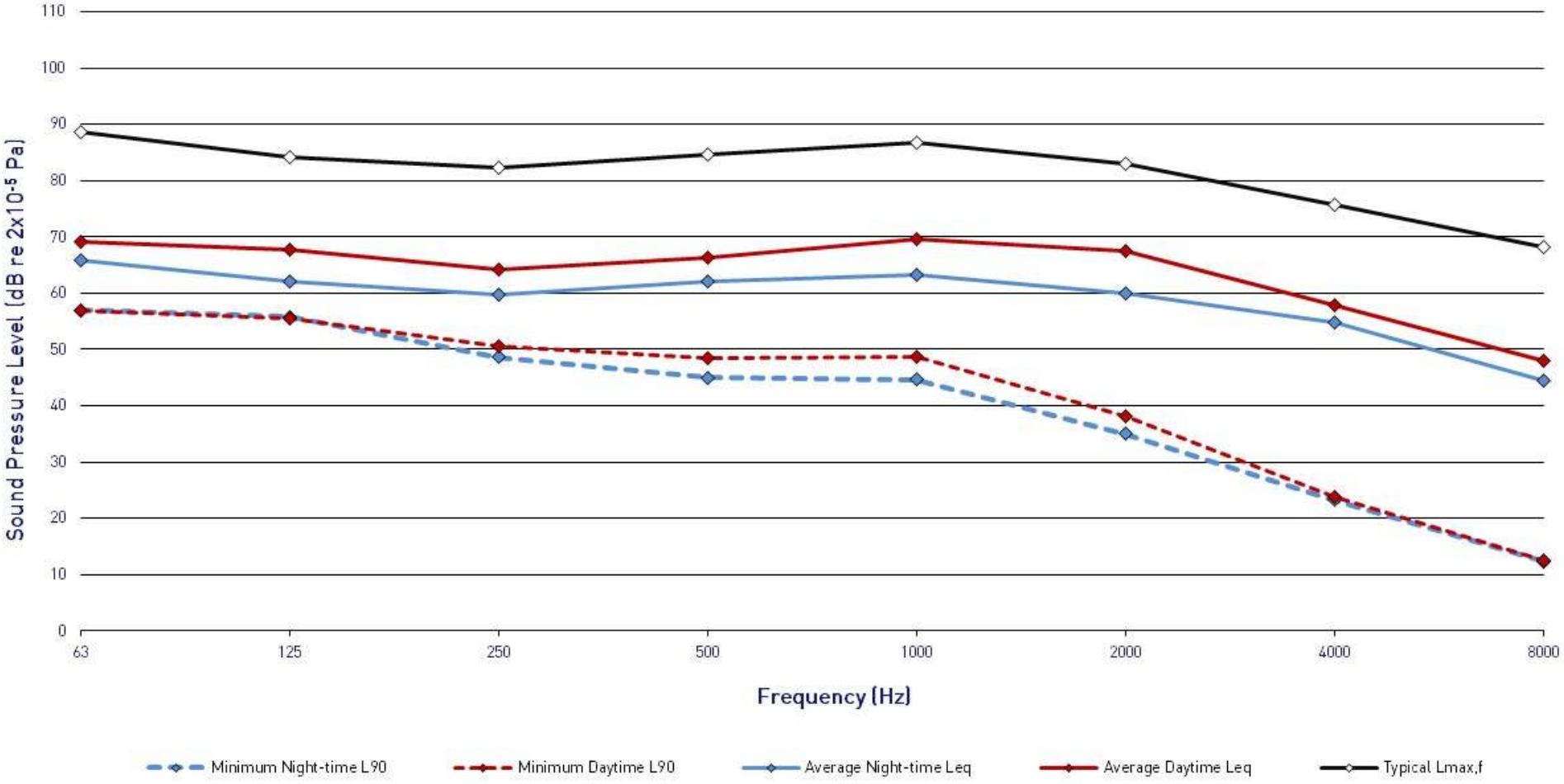


Former Nestle Site

Spectral Noise Levels

Measurement Position 3, Wednesday 17 January to Friday 19 January 2018

Graph 11

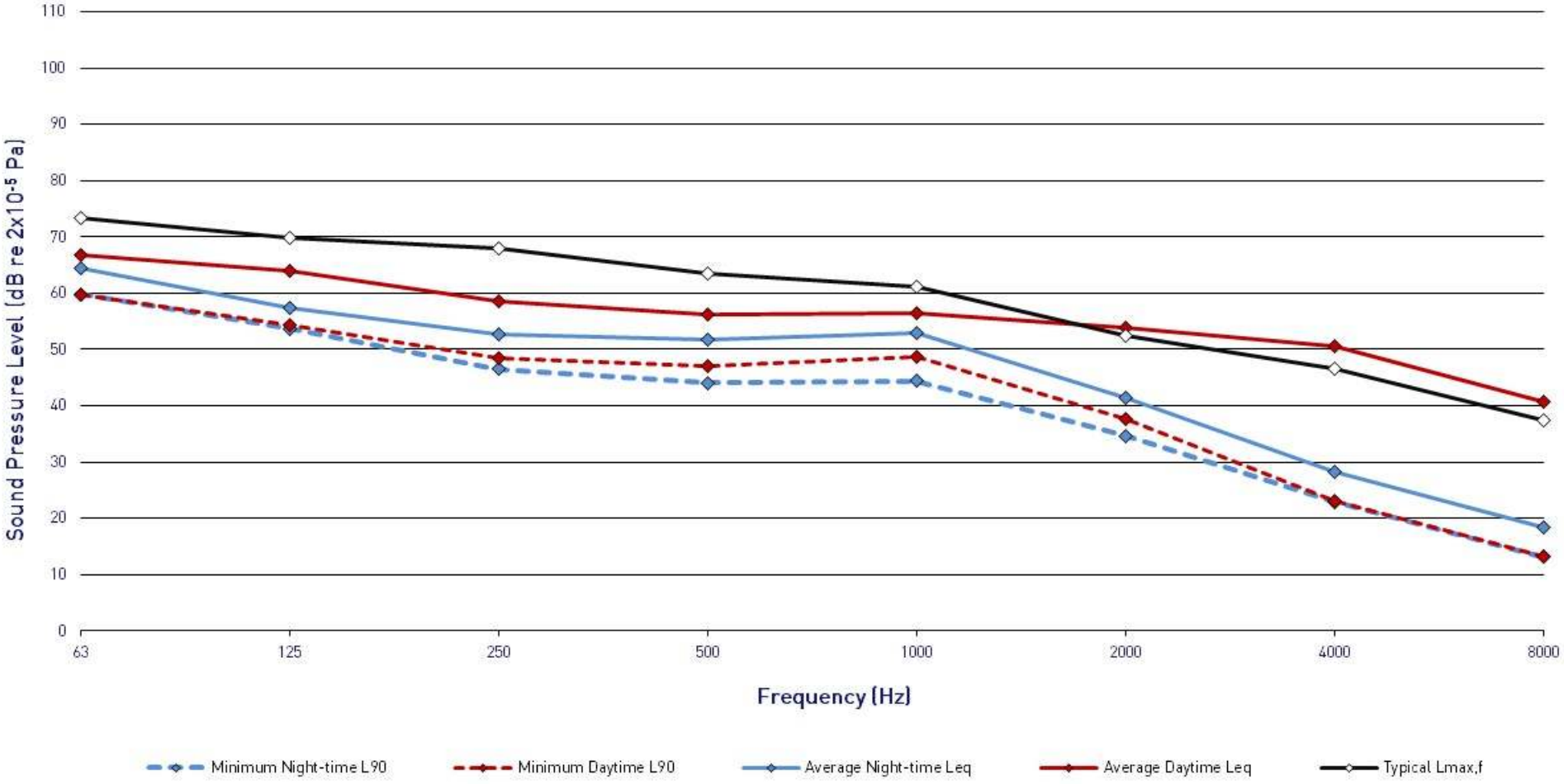


Former Nestle Site

Spectral Noise Levels

Measurement Position 4, Wednesday 17 January to Friday 19 January 2018

Graph 12



Former Nestle Factory, Hayes

Existing Site Plan Detailing Measurement Positions

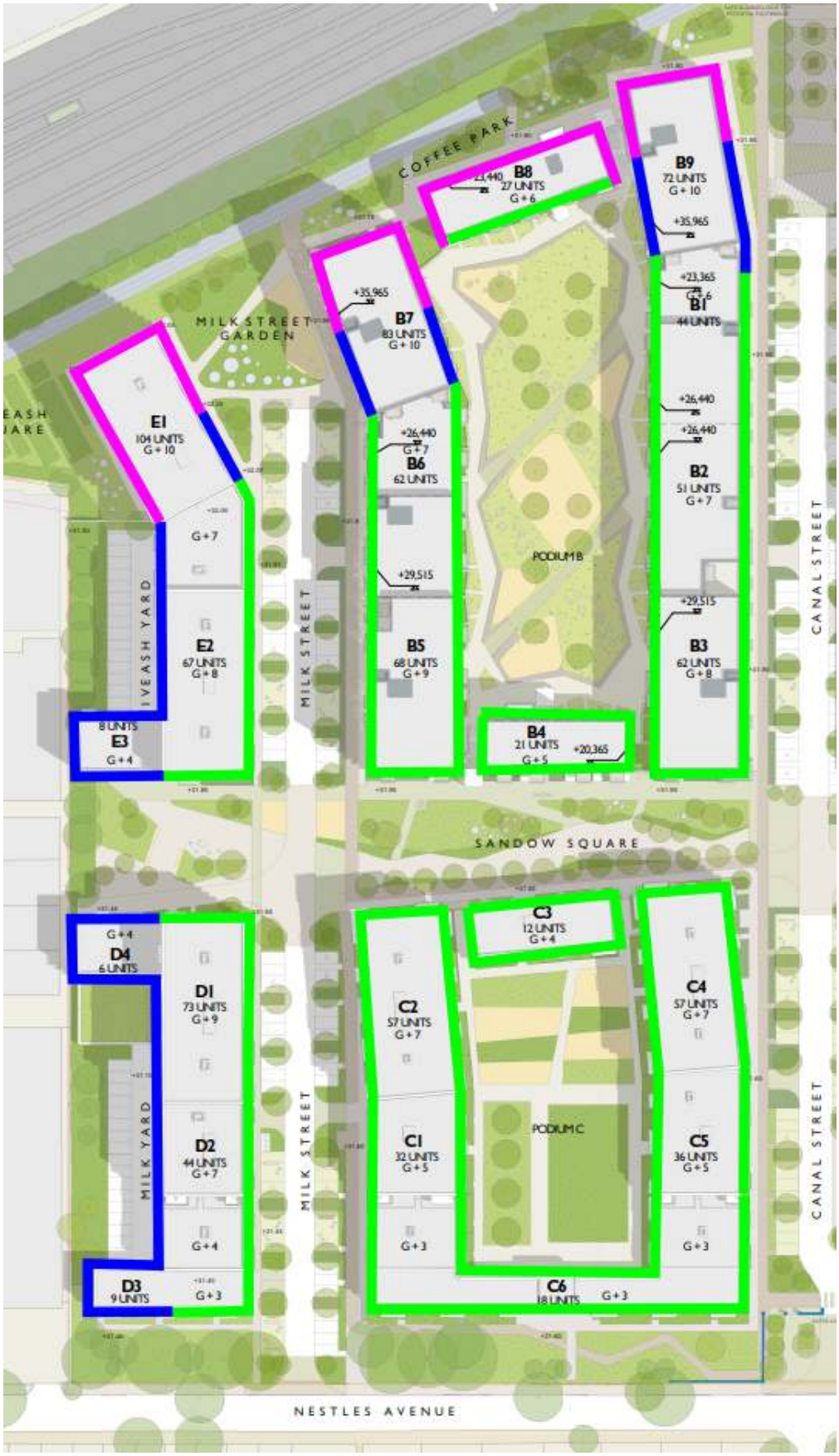
Project 8231

Figure 1

17 October 2019

Not to Scale

RBA ACOUSTICS



Key:	
Zone 1:	
Zone 2:	
Zone 3:	
Zone 4:	

Former Nestle Factory, Hayes

Glazing Zones for Blocks B, C, D and E

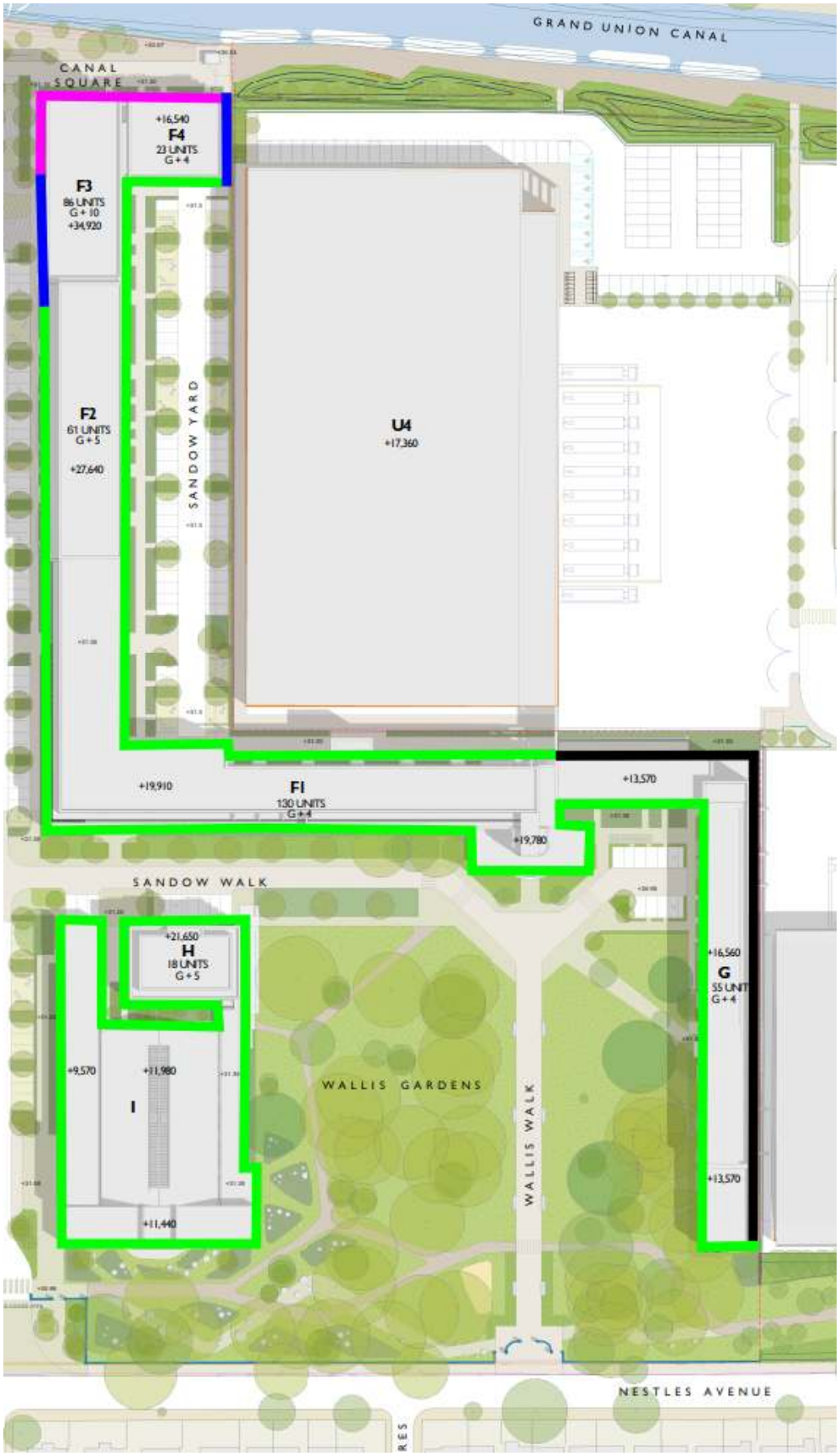
Project 8231

Figure 2

17 October 2019

Not to Scale

RBA ACOUSTICS



Key:	
Zone 1:	
Zone 2:	
Zone 3:	
Zone 4:	

Former Nestle Factory, Hayes

Glazing Zones for Blocks F, G, H and I

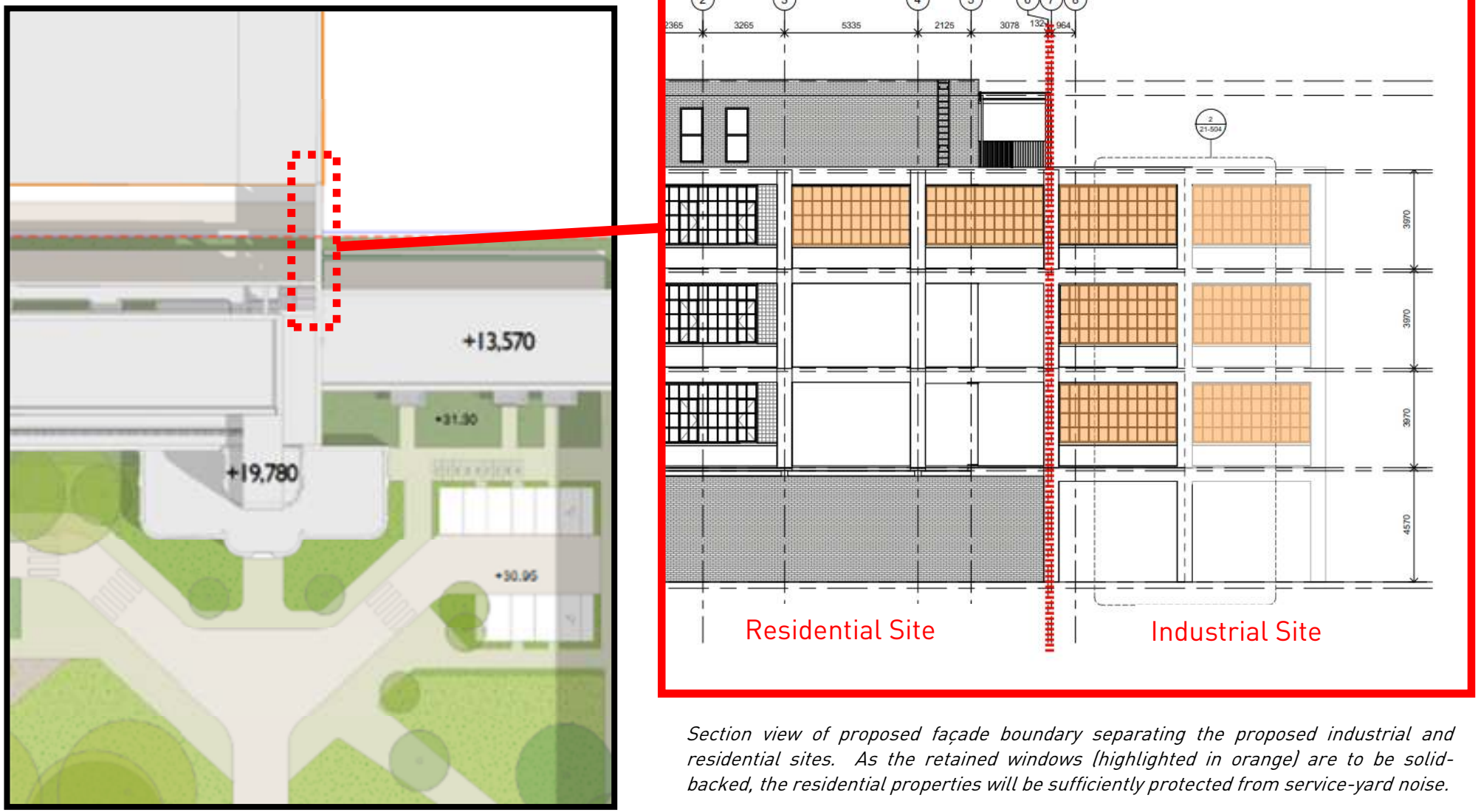
Project 8231

Figure 3

17 October 2019

Not to Scale

RBA ACOUSTICS



Section view of proposed façade boundary separating the proposed industrial and residential sites. As the retained windows (highlighted in orange) are to be solid-backed, the residential properties will be sufficiently protected from service-yard noise.

Former Nestle Factory, Hayes

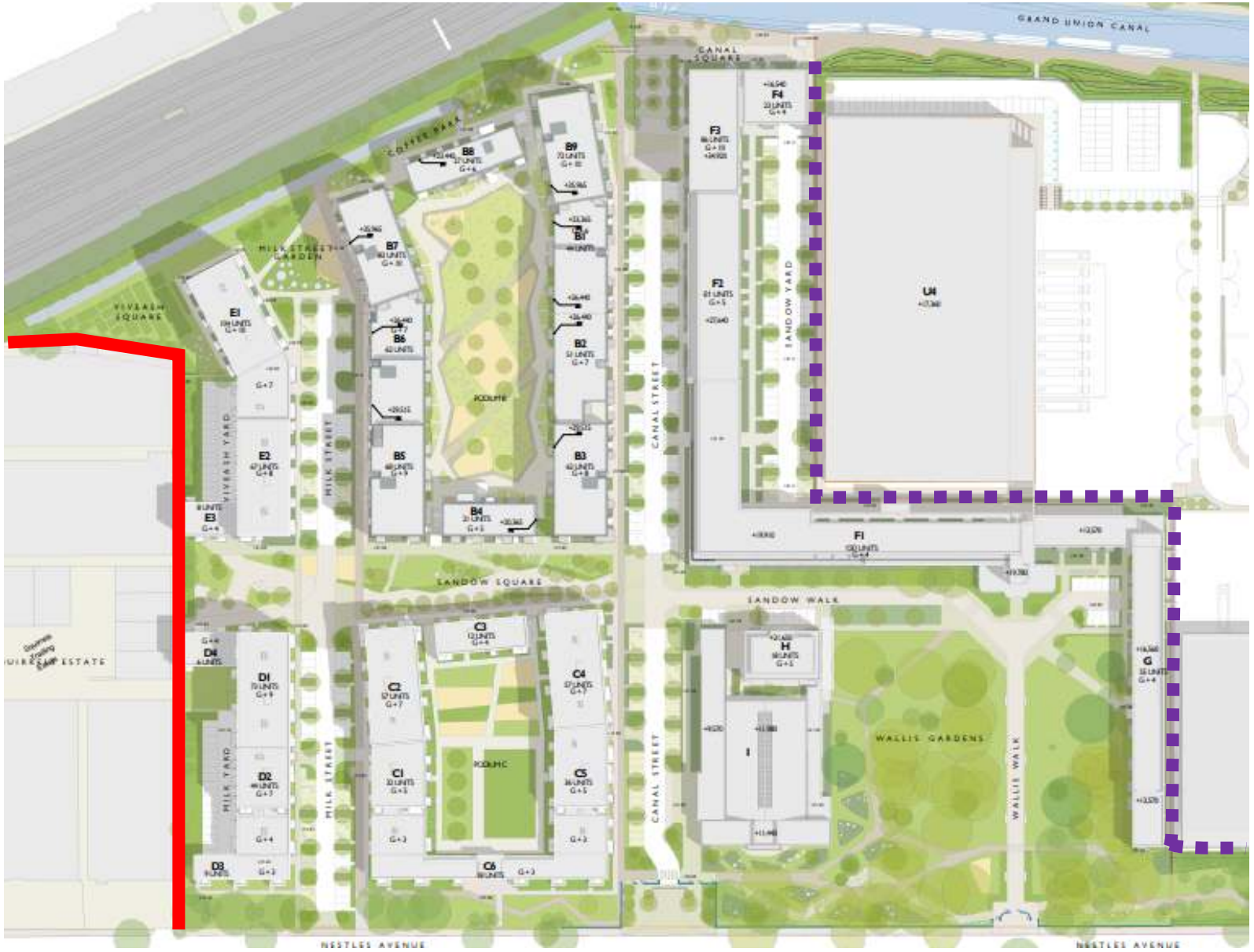
Section and Plan Drawings Showing Extent of Retained Façade Located Between Block F1 & G and Unit 4

Figure 4

17 October 2019

Not to Scale

RBA ACOUSTICS



Key:

Imperforate acoustic barrier:

Timber fence:

Former Nestle Factory, Hayes

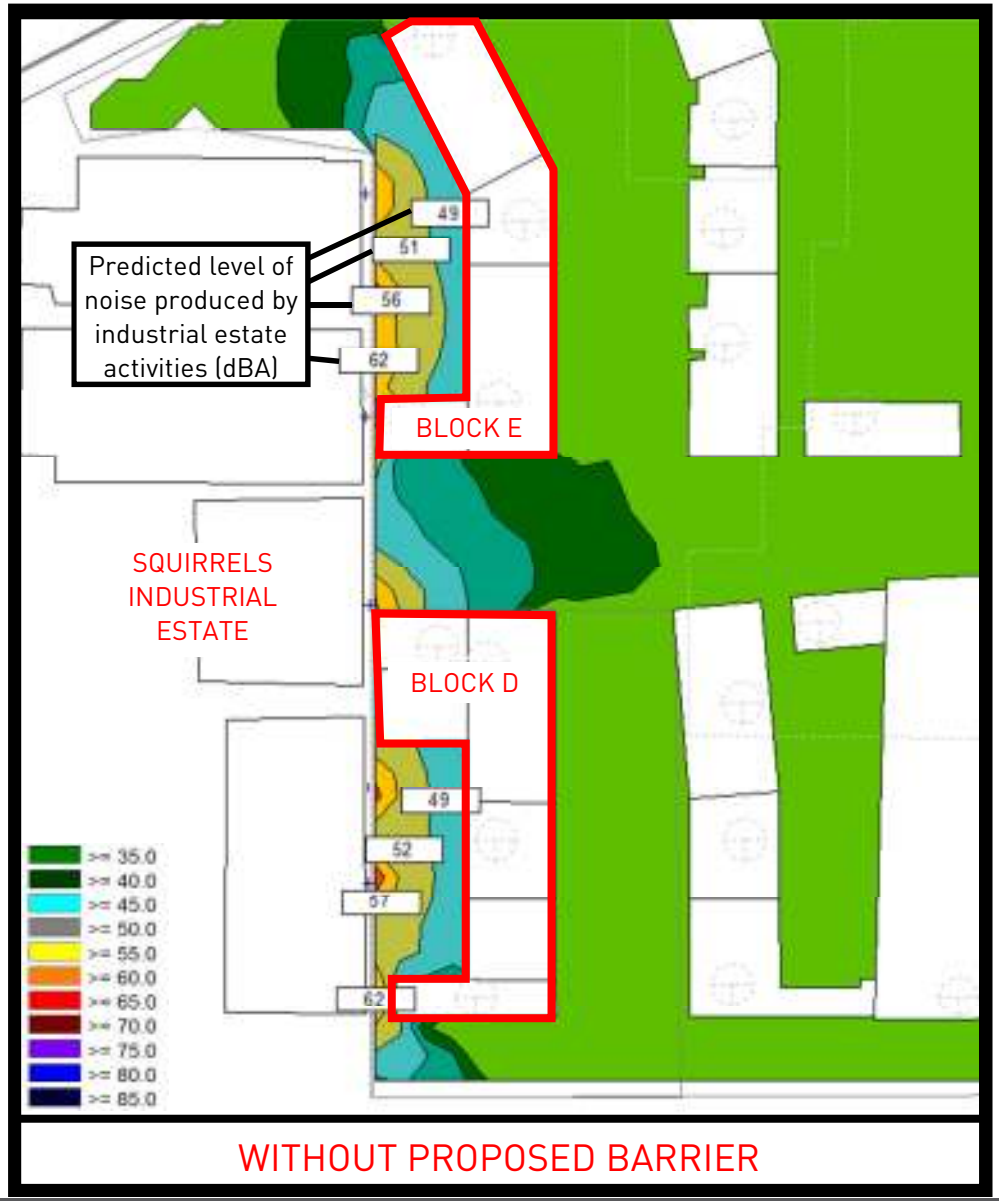
Extent of Proposed Site Fences

Figure 5

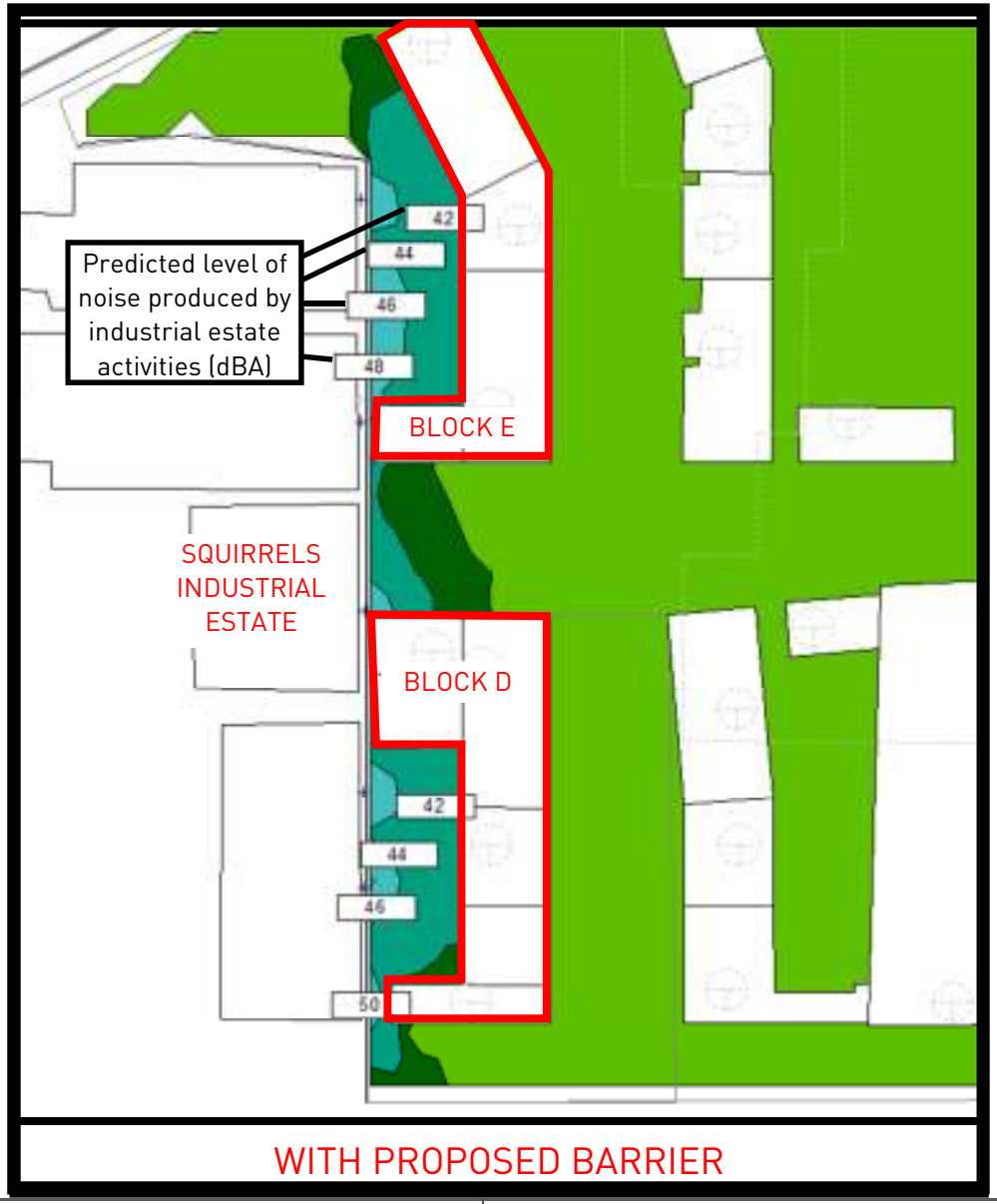
17 October 2019

Not to Scale

RBA ACOUSTICS



WITHOUT PROPOSED BARRIER



WITH PROPOSED BARRIER

Former Nestle Factory, Hayes

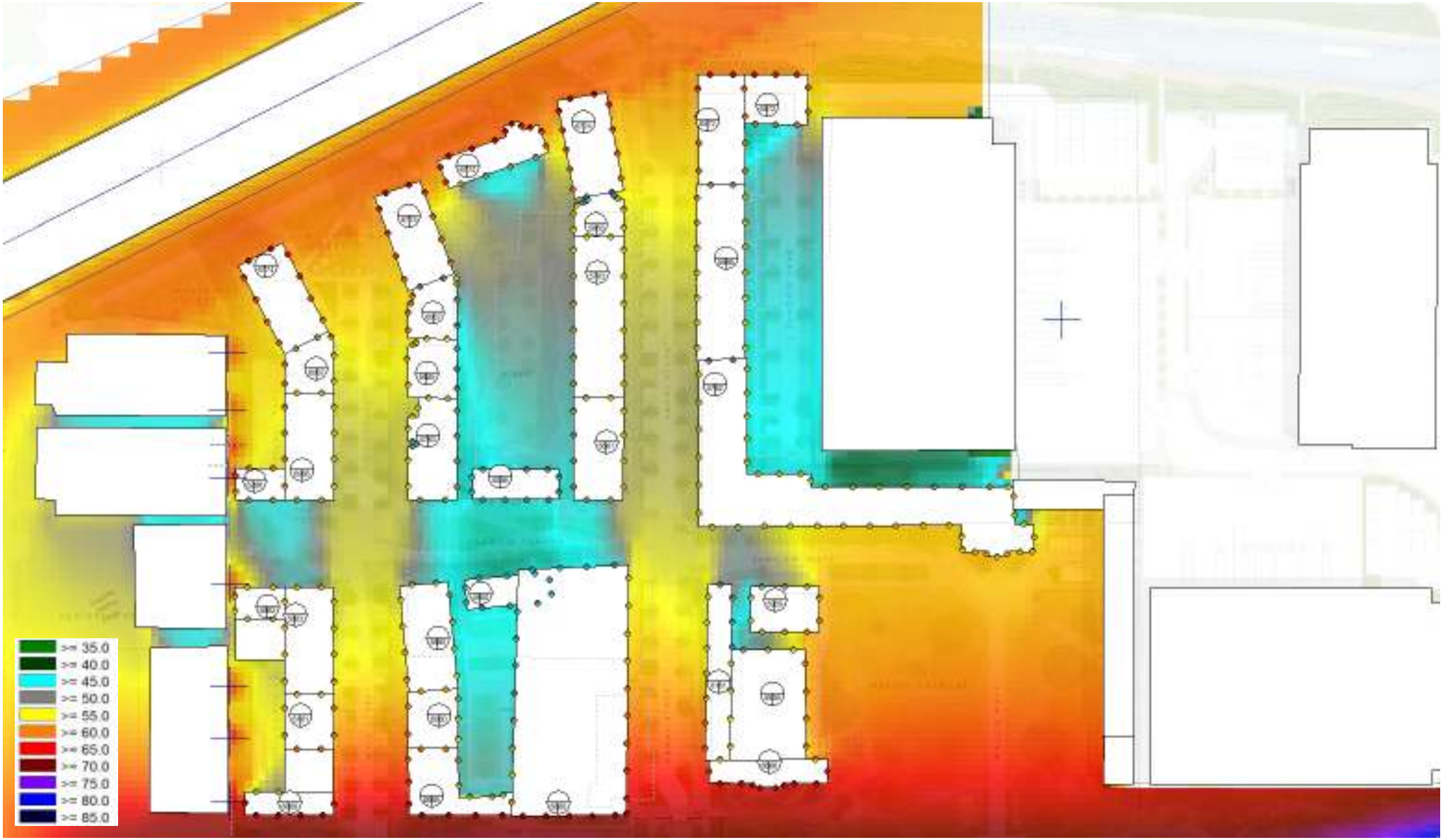
Environmental Noise Model showing the Assessment of the Imperforate Barrier along the Western Site Boundary

Figure 6

17 October 2019

Not to Scale

RBA ACOUSTICS



Former Nestle Factory, Hayes

Environmental Noise Model Showing Daytime Noise Levels Produced by Existing Noise Sources

Figure 7

17 October 2019

Not to Scale

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