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NORCROSS LANE, THORNTON CLEVELEY'S

DRAFT NOISE ASSESSMENT REPORT

FEBRUARY 2018

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NOISE ASSESSMENT REPORT

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ENERGY AND CLIMATE CHANGE
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MINERAL ESTATES AND QUARRYING
WASTE RESOURCE MANAGEMENT

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1 INTRODUCTION

- 1.1.1 By instruction dated 12th December 2017, Wardell Armstrong LLP was commissioned to undertake a noise assessment to support a Section 73 application to vary a planning condition for the proposed development at Norcross Lane, Thornton Cleveleys.
- 1.1.2 The proposed development site is located on the edge of Thornton Cleveleys and currently comprises open land, following the demolition of buildings on the site. To the north, the site is bordered by Clarke House with open land and White Carr Lane beyond. To the east, the site is bordered by open land with Amounderness Way and further open land beyond. To the south, the site is bordered by Norcross Lane, with an existing residential property and further open land beyond. To the west, the site is bordered by offices used by Veterans UK, with existing dwellings off Goldstone Drive and Sixfields beyond.
- 1.1.3 The application site comprises part of a larger area which benefits from outline approval (13/00200/OUTMAJ), granted in December 2015, for a range of uses including retail (A1/A2/A3/A4 and A5), commercial (B1) and residential (C3) uses.
- 1.1.4 A detailed planning application was submitted to Wyre Bough Council (WBC) for retail uses (A1, A3 and A5) and 354 associated car parking spaces. Planning permission was granted in December 2017 (17/00122/LMAJ), with the following conditions.
16. *'The rating levels for cumulative noise from all fixed plant and machinery and transportation sources (including delivery, waste collection, and customer vehicles) connected to the development hereby permitted shall not exceed the background noise level (LA90) at the nearest noise sensitive premises, as assessed in accordance with British Standard 4142:2014. Alternative levels and monitoring locations may be used subject to the prior written agreement of the Local Planning Authority'.*
17. *'The Maximum Instantaneous Noise Levels (LAFmax) from the development hereby permitted shall not exceed 60 dB(A) night-time (23.00-07.00) at the façade of the nearest noise sensitive premises. Alternative levels and monitoring locations may be used subject to the prior written agreement of the Local Planning Authority'.*
18. *'The development hereby permitted shall not be open to customers outside of the following times: 08.00 to 22.00 hours on any day'.*
19. *'No vehicle shall enter the development site for the purpose of making a delivery or a collection (including waste collections) between 2300 and 0630 hours, nor shall any collections or deliveries take place between these hours'.*

- 1.1.5 Following the granting of the planning permission, a Section 73 (S73) application (18/00065/LMAJ) to vary Condition 18 has been submitted. This noise assessment report has been prepared to support the S73 application.
- 1.1.6 The variation of Condition 18 will apply to Units 8 and 9 only, with the opening hours for the remainder of the units remaining in line with Condition 18. Units 8 and 9 are drive through take-away restaurants.
- 1.1.7 The proposed operating hours of Unit 8 are as follows:
 - 0600 to 0000 hours Monday to Saturday; and,
 - 0700 to 2300 hours Sunday and Bank Holidays.
- 1.1.8 The proposed operating hours of Unit 9 are as follows:
 - 0600 to 2130 hours Monday to Saturday; and,
 - 0700 to 2130 hours Sunday and Bank Holidays.
- 1.1.9 The client has provided a drawing showing the proposed locations and orientation of retail units on the proposed development site (Dwg: 14338-230 Rev A). This drawing has been used to calculate the likely noise impact from the extended operational hours at units 8 and 9 at existing sensitive receptors.

2 ASSESSMENT METHODOLOGY

2.1 Noise Survey

2.1.1 An unattended noise survey was carried out in November 2016 to support the detailed planning application (17/00122/LMAJ), to assess the noise levels at existing sensitive receptor locations. This information will be used to inform the assessment for the S73 application.

2.2 Assessment Methodology

2.2.1 An assessment is required to consider any potentially noise sensitive areas near to the site. The potential impacts of the future sources of noise, at existing sensitive receptor locations, in the vicinity of the proposed development have been assessed with reference to;

- National Planning Policy Framework, 2012; (NPPF);
- Planning Practice Guidance – Noise, 2014;
- Noise Policy Statement for England 2010; (NPSE);
- World Health Organisation Guidelines for Community Noise 1999 (WHO);
- British Standard 8233:2014 Guidance on sound insulation and noise reduction for buildings (BS8233);
- British Standard 4142:2014 Methods for Rating and assessing industrial and commercial sound (BS4142); and,
- Department of Transport's technical memorandum 'Calculation of Road Traffic Noise' 1988 (CRTN).

National Planning Policy Framework

2.2.2 In March 2012 the 'National Planning Policy Framework' (NPPF) was introduced as the current planning policy guidance within England. Paragraph 123 of the NPPF states:

'Planning policies and decisions should aim to:

- *avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;*
- *mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including through the use of conditions;*

- *recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established; and*
- *identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.'*

2.2.3 With regard to ‘adverse impacts’ the NPPF refers to the ‘Noise Policy Statement for England’ (NPSE), which defines three categories, as follows:

‘NOEL – No Observed Effect Level

- *This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.*

LOAEL – Lowest Observed Adverse Effect Level

- *This is the level above which adverse effects on health and quality of life can be detected.*

SOAEL – Significant Observed Adverse Effect Level

- *This is the level above which significant adverse effects on health and quality of life occur’.*

2.2.4 The first aim of the NPSE states that significant adverse effects on health and quality of life should be avoided. The second aim refers to the situation where the impact lies somewhere between LOAEL and SOAEL, and it requires that all reasonable steps are taken to mitigate and minimise the adverse effects of noise. However the requirement to mitigate and minimise the adverse effects of noise does not mean that such adverse effects cannot occur.

2.2.5 The Planning Practice Guidance (PPG) provides further detail about how the effect levels can be recognised. Above the NOEL noise becomes noticeable, however it has no adverse effect as it does not cause any change in behaviour or attitude. Once noise crosses the LOAEL threshold it begins to have an adverse effect and consideration needs to be given to mitigating and minimising those effects, taking account of the economic and social benefits being derived from the activity causing the noise. Increasing noise exposure further might cause the SOAEL threshold to be crossed. If the exposure is above this level the planning process should be used to avoid the effect occurring by use of appropriate mitigation such as by altering the design and layout. Such decisions must be made taking account of the economic and social benefit of the activity causing the noise, but it is undesirable for such exposure to be caused. At the highest extreme the situation should be prevented from occurring regardless of the benefits which might arise. Table 1 summarises the noise exposure hierarchy.

Table 1 National Planning Practice Guidance noise exposure hierarchy			
Perception	Examples of Outcomes	Increasing Effect Level	Action
Not noticeable	No Effect	No Observed Effect	No specific measures required
Noticeable and not intrusive	Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, eg turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, eg avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

2.2.6 The Noise Policy Statement for England refers to the World Health Organisation (WHO) when discussing noise impacts. The WHO Guidelines for Community Noise 1999 suggest guideline values for internal noise exposure which take into consideration the identified health effects and are set, based on the lowest effect levels for general populations. Guideline values for annoyance which relate to external noise exposure are set at 50 or 55 dB(A), representing day time levels below which a majority of the adult population will be protected from becoming moderately or seriously annoyed respectively.

2.2.7 The following guideline values are suggested by WHO:

- 35 dB $L_{Aeq\,(16\,hour)}$ during the day time in noise sensitive rooms
- 30 dB $L_{Aeq\,(8\,hour)}$ during the night time in bedrooms
- 45 dB $L_{Amax\,(fast)}$ during the night time in bedrooms
- 50 dB $L_{Aeq\,(16\,hour)}$ to protect majority of population from becoming moderately annoyed
- 55 dB $L_{Aeq\,(16\,hour)}$ to protect majority of population from becoming seriously annoyed

2.2.8 British Standard 8233 “Guidance on sound insulation and noise reduction for buildings” 2014 bases its advice on the WHO Guidelines. In addition, for internal noise levels it states;

“Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved.”

2.2.9 With regard to external noise, BS8233, 2014 states;

"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 guidance 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".

- 2.2.10 The PPG summarises the approach to be taken when assessing noise. It accepts that noise can override other planning concerns, but paragraph 002 of the noise guidance states:

"Neither the Noise Policy Statement for England nor the National Planning Policy Framework (which reflects the Noise Policy Statement) expects noise to be considered in isolation, separate from the economic, social and other environmental dimensions of proposed development".

British Standard 4142:2014 (BS4142), Method for rating and assessing industrial and commercial sound:

- 2.2.11 BS4142 is used to rate and assess sound of an industrial and/or commercial nature including:

- sound from industrial and manufacturing processes;
- sound from fixed installations which comprise mechanical and electrical plant and equipment;
- sound from the loading and unloading of goods and materials at industrial and/or commercial premises; and
- sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as that from forklift trucks, or that from train or ship movements on or around an industrial and/or commercial site.

2.2.12 The standard is applicable to the determination of the following levels at outdoor locations:

- rating levels for sources of sound of an industrial and/or commercial nature; and
- ambient, background and residual sound levels, for the purposes of:
 - 1) Investigating complaints;
 - 2) Assessing sound from proposed, new, modified or additional source(s) of sound of an industrial and/or commercial nature; and
 - 3) Assessing sound at proposed new dwellings or premises used for residential purposes.

2.2.13 The purpose of the BS4142 assessment procedure is to assess the significance of sound of an industrial and/or commercial nature.

2.2.14 BS4142 refers to noise from the industrial source as the ‘specific noise’ and this is the term used in this report to refer to noise which is predicted to occur due to activities associated with the proposed commercial premises. The ‘specific noise’ levels, that have been used are detailed in Section 4 of this report.

2.2.15 BS4142 assesses the significance of impacts by comparing the specific noise level to the background noise level (L_{A90}). Section 4 provides details of the background noise survey undertaken.

2.2.16 Certain acoustic features can increase the significance of impacts over that expected from a simple comparison between the specific noise level and the background noise level. In particular BS4142 identifies that the absolute level of sound, the character, and the residual sound and the sensitivity of receptor should all be taken into consideration. BS4142 includes allowances for a rating penalty to be added if it is found that the specific noise source contains a tone, impulse and/or other characteristic, or is expected to be present. The specific noise level along with any applicable correction is referred to as the ‘rating level’.

2.2.17 The greater the increase between the rating level over the background noise level, the greater the magnitude of the impact. The assessment criteria given by BS4142 are as follows:

- A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context.

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

2.2.18 During the daytime, BS4142 requires that noise levels are assessed over 1-hour periods. However, during the night-time, noise levels are required to be assessed over 15-minute periods.

2.2.19 Where the initial estimate of the impact needs to be modified due to context, BS4142 states that all pertinent factors should be taken into consideration, including:

- The absolute level of sound;
- The character and level of the residual sound compared to the character and level of the specific sound; and
- The sensitivity of the receptor and whether dwellings or other premises used for residential purposes will already incorporate design measures that secure good internal and/or outdoor acoustic conditions.

Relationship between Planning Policy and BS4142

2.2.20 The three categories in NPPF can be related to the impact assessment categories in BS4142. The relationship between NPPF and BS4142 is shown in Table 2 below.

Table 2: Relationship between NPPF and BS4142		
Observed Effect Level	BS4142 magnitude of the impact	BS4142 Impact criteria
SOAEL	A difference of around +10dB or more	significant adverse impact
LOAEL	A difference of around +5dB	adverse impact
NOAEL	A difference of around +0dB	low impact

2.2.21 This relationship can be taken forward and used in this assessment to more easily determine the impact of noise from the development at existing sensitive receptors in terms of planning policy.

2.3 Existing Sensitive Receptors

- 2.3.1 The following existing receptors have been identified as those potentially affected by noise from Units 8 and 9 during the proposed extended hours.
- 2.3.2 Other receptors may be affected by noise from the development, however the noise impact will be equal to or less than at the receptors identified. The existing sensitive receptors identified are shown on Drawing LE13636-001 and in Table 3 below;

Table 3: Existing Noise Sensitive Receptor Locations

Receptor	Address	Receptor Type	Bearing from Site	Distance from the proposed site boundary to the receptor
ESR1	23 Brescot Way FY5 3QA	Residential	West	70m
ESR2	22 Prenton Gardens, FY5 3RR	Residential	West	80m
ESR3	Norcross Cottage, Norcross Lane, FY5 3DE	Offices	South East	20m
ESR4	Norcross Hall Farm, Norcross Lane, FY5 3DE	Residential	South East	20m

- 2.3.3 ESR3 is both vacant, and a commercial premises, therefore, noise at this premises will only be considered during the daytime (i.e. 0700-0800 hours only).

3 NOISE SURVEY

- 3.1.1 On the 22nd, 23rd 24th, and 25th November 2016, Wardell Armstrong LLP carried out a noise survey at the proposed development site.
- 3.1.2 Unattended noise measurements were taken at two monitoring locations, which are considered to be representative of existing sensitive receptors near to the south eastern and western parts of the site.
- 3.1.3 The monitoring locations are as follows, and are shown on Drawing Number LE13636-001:
- Monitoring Location 1 (ML1): In the western part of the proposed development site. This location was chosen to be representative of existing sensitive receptors ESR1.
 - Monitoring Location 2 (ML2): In the south-eastern part of the proposed development site. This location was chosen to be representative of existing sensitive receptors ESR2, ESR3 and ESR4.
- 3.1.4 Unattended noise monitoring was carried out between 2109 hours on 22nd November and 1306 hours on 23rd November 2016 at ML1, and between 1356 hours on 23rd November and 1117 hours on 25th November at ML2.
- 3.1.5 The noise measurements were made using Class 1, integrating sound level meters. The microphones were mounted vertically on tripods 1.2m above the ground. The sound level meters were calibrated to a reference level of 94dB at 1kHz both before, and on completion of, the noise survey. No drift of more than 0.5dB in the calibration was noted during the survey.
- 3.1.6 On the 22nd November, the weather conditions during the survey were as follows:
- Low wind up to 3m/s;
 - Damp ground; and,
 - Temperature approximately +7°C.
- 3.1.7 On the 23rd November, the weather conditions during the survey were as follows:
- Low wind up to 5m/s;
 - Dry ground;
 - Temperature ranged between approximately +2 and +7°C; and,
 - Partly cloudy.

3.1.8 On the 24th November, the weather conditions during the survey were as follows:

- Low wind up to 5m/s;
- Dry ground;
- Temperature ranged between approximately +0 and +7°C; and,
- Clear Sky.

3.1.9 On the 25th November, the weather conditions during the survey were as follows:

- Low wind up to 5m/s;
- Dry ground;
- Temperature ranged between approximately +0 and +7°C; and,
- Clear Sky

3.1.10 For the purpose of this assessment daytime hours are taken to be 0700 to 2300 hours and night-time hours to be 2300 to 0700 hours.

3.1.11 A-weighted¹ L_{eq}^2 noise levels were measured to comply with the requirements of WHO and BS8233. A-weighted L_{90}^3 and L_{10}^4 noise levels, together with the maximum and minimum sound pressure levels, were also measured to provide additional information. The measured noise levels are set out in full in Appendix A.

UNCERTAINTY

3.1.12 To reduce measurement uncertainty the following steps have been taken:

- The background noise measurement locations were selected to be representative of the background noise level at the closest receptors to Units 8 and 9. In accordance with guidance the sound level meters were mounted vertically on tripods 1.2m above the ground. The monitoring locations were also more than 3.5 metres from any other reflecting surfaces;
- The background noise measurements were undertaken during dry and calm/low wind speed weather conditions;
- The daytime background noise monitoring was undertaken during what is considered to be a representative period of the daytime;
- The daytime background noise monitoring was undertaken over 1 hour periods in accordance with the reference period required by BS4142;
- The night time background noise monitoring was undertaken during what is considered to be a representative period of the night time;

- The night time background noise monitoring was undertaken over 15 minute periods in accordance with the reference period required by BS4142;
- The results of each measurement period are reported to the nearest 0.1dB; and
- Noise measurements were made using Class 1, integrating sound level meters.

¹ A' Weighting	An electronic filter in a sound level meter which mimics the human ear's response to sounds at different frequencies under defined conditions
² L _{Eq}	Equivalent continuous noise level; the steady sound pressure which contains an equivalent quantity of sound energy as the time-varying sound pressure levels.
³ L ₉₀	The noise level which is exceeded for 90% of the measurement period.
⁴ L ₁₀	The noise level which is exceeded for 10% of the measurement period.

4 PROPOSED SOURCES OF NOISE AND DETAILS OF NOISE MODELLING

4.1 Introduction

- 4.1.1 The operational activities associated with Units 8 and 9 have the potential to generate noise which may have an impact at the existing sensitive receptors identified.
- 4.1.2 To determine the noise likely cumulative impact of the noise to be generated by activities at Units 8 and 9 and the remainder of the proposed commercial and retail development, noise predictions have been carried out using SoundPLAN (Version 8.0) computer noise modelling software.

4.2 Details of Modelling Data

Operational Activities Associated with the Proposed Commercial and Retail Development

- 4.2.1 Details of the activities at Units 8 and 9 and the remainder of the proposed site, have been used to calculate likely levels of noise at the existing sensitive receptors.
- 4.2.2 From the information submitted with the planning application, it is understood that the operational hours of the retail development will be between 0800 hours and 2200 hours Monday to Sunday, and this activity is currently permitted. Deliveries will take place between 0630 hours and 2300 hours, and any proposed plant will operate 24 hours per day.
- 4.2.3 Drawing 14338-230 Rev A shows the location of the proposed retail units, associated delivery areas, location of fixed plant and carparking areas. This layout has been used within the noise model, to calculate the noise levels at the sensitive receptors, identified in Table 3.
- 4.2.4 The following assumptions have been made when carrying out the noise predictions for the extended hours:
- A total of 4 HGVs will enter and leave the site per hour during the daytime (0700-2300 hours), and night-time (0630-0700). All vehicles will gain access and leave via Norcross Lane.
 - Three potential routes, taken by the HGVs, have each been included within the noise model. These include deliveries to Units 1 through 6, deliveries to Units 7a, 7b and 7c, and deliveries to Units 8 and 9.

- A maximum noise level for each delivery to each unit has been modelled using WA archive noise data, the 3rd octave measured data has been included within the noise model.
- Noise from each delivery has been placed at a height of 1.5m above ground level.
- Noise levels from any fixed plant are based on the noise level limits set in the Noise Assessment Report (LE13436-001) prepared by Wardell Armstrong, dated January 2017. A noise level limit of 60dB(A) has been used for Unit 9.
- Noise from customer vehicles accessing the proposed development site via Norcross Lane, has been modelled using traffic data provided by Bryan G Hall, received December 2016.
- Noise from the carpark areas, including noise from trollies, is based upon 330 car parking spaces, using the 'car park' module in SoundPLAN.
- It has been assumed that 60 vehicles per hour will access the drive through facilities at Units 8 and 9 during the daytime and 30 vehicles during the night-time (0600-0700 hours, and 2300-0000 hours).
- The noise model includes the fences shown on Drawing 14338-231.

4.2.5 Each item of equipment and process has been included in the noise model at the approximate location and height at which it is likely to operate. The arrangement of the noise sources is shown on Figure 1.

Calculation of noise from vehicle movements

4.2.6 The HGV used in the noise model is described in Table 4 below.

Table 4: Details of the Equipment used in the Noise Model				
Item	Noise Level		Speed (kph)	
	Data Location Table	Noise Level (SWL/dB(A))		
1	Road Lorry (Full)	BS5228 - Table C6.21	108	32

On-Site Mitigation

4.2.7 It is understood that boundary treatment is included in to the development proposals. These have been included within the noise model, and are located as follows;

- To the east of Units 7a, 7b and 7c, around the external area to the rear of the units. The barrier is 1.8m in height; and,

- In the south eastern part of the site, around the drive thru associated with Unit 9. The barrier is 1.8m in height.

5 NOISE IMPACT ASSESSMENT

5.1 Introduction

- 5.1.1 An assessment is required to support a variation of Condition 18 of the decision notice 17/00122/LMAJ, which restricts operating times for the proposed development.
- 5.1.2 To determine the noise likely to be generated by the proposed activities at the site, noise predictions have been carried out using SoundPLAN (Version 8.0) computer modelling software, using the assumptions and data, which is detailed in Section 4 of this report.

5.2 Assessment of Noise from On-site Activities

- 5.2.1 In accordance with the Noise Assessment Report prepared by Wardell Armstrong (dated January 2017), and BS4142, noise penalties have been applied to the noise sources where applicable.
- 5.2.2 A 2dB penalty for tonal noise has been applied to the noise from the fixed plant, and, a 6dB penalty for impulsive sound has been applied to the noise from deliveries.
- 5.2.3 The calculated daytime and night-time specific noise level includes a contribution of the noise from each of the sources associated with the proposed retail and commercial development.
- 5.2.4 The calculated noise level at the nearest façade of each existing sensitive receptor has been calculated using SoundPLAN 8.0.
- 5.2.5 The model has calculated the noise level at the façade of the existing sensitive receptors, therefore, a 3dB façade correction has been added to the measured background noise level.

5.3 BS4142 Assessment to Vary Condition 18

- 5.3.1 Condition 18 states;

'The development hereby permitted shall not be open to customers outside of the following times: 08.00 to 22.00 hours on any day'.

- 5.3.2 However, the S73 variation proposes that;

- The proposed operating hours of Unit 8 are as follows:
 - 0600 to 0000 hours Monday to Saturday; and,
 - 0700 to 2300 hours Sunday and Bank Holidays.

- The proposed operating hours of Unit 9 are as follows:

- 0600 to 2130 hours Monday to Saturday; and,
 - 0700 to 2130 hours Sunday and Bank Holidays.

5.3.3 Therefore, a BS4142 assessment has been undertaken to support the variation of condition 18, so that the extended operational hours between 0600 and 0800, and 2200 and 0000 hours may be permitted.

5.3.4 ***Selection of Background Noise***

5.3.5 Section 8 of BS4142 provides guidance on the selection of the background sound to be used in the assessment. BS4142 states that the background sound levels used for the assessment should be representative of the period being assessed (i.e. daytime or night-time periods), and that there is no “single” background sound level.

5.3.6 Therefore, some assessment of the measured noise levels is required to select the most appropriate and representative background sound level. An assessment has been carried out based upon the measured noise levels during the daytime period.

5.3.7 For the purposes of this assessment, the measured background noise level from ML1 and ML2, is considered representative of the background noise level at sensitive receptors.

5.3.8 The background noise levels, used in the BS4142 assessment are the L_{A90} levels measured at ML1 between 22nd and 23rd November 2016, and ML2 between 23rd and 24th November 2016. The daytime levels have been measured over 1 hour reference periods. For the daytime periods being assessed (2200-2300 hours, and 0700-0800 hours), the 1 hour measured background noise levels have been used in the assessment.

5.3.9 For the night-time periods, the background noise levels have been averaged over the period being assessed (2300-0000, and 0600-0700).

2200 to 2300 hours

5.3.10 The measured background noise level for the period 2200 to 2300 hours is 48dB $L_{A90,1Hour}$ at ML1 and 50dB $L_{A90,1Hour}$ at ML2. This includes a facade correction of 3dB as the assessment has been undertaken at the façade of the existing sensitive receptors.

2300-0000 hours

- 5.3.11 The measured background noise level for the period 2300 to 0000 hours is 47dB $L_{A90,15min}$ at ML1 and 46dB $L_{A90,15min}$ at ML2. This includes a facade correction of 3dB as the assessment has been undertaken at the façade of the existing sensitive receptors.

0600-0700

- 5.3.12 The measured background noise level for the period 0600 to 0700 hours is 56dB $L_{A90,15min}$ at ML1 and 58dB $L_{A90,15min}$ at ML2. This includes a facade correction of 3dB as the assessment has been undertaken at the façade of the existing sensitive receptors.

0700-0800 hours

- 5.3.13 The measured background noise level for the period 0700 to 0800 hours is 57dB $L_{A90,1hour}$ at ML1 and 61dB $L_{A90,1hour}$ at ML2. This includes a facade correction of 3dB as the assessment has been undertaken at the façade of the existing sensitive receptors.

BS4142: 2014 Assessment for the Proposed Commercial Premises

Specific Noise Levels

- 5.3.14 As discussed in Section 4, the proposed noise sources have been modelled using SoundPLAN 8.0.

- 5.3.15 In accordance with the Noise Assessment Report prepared by Wardell Armstrong (dated January 2017), and BS4142, noise penalties have been applied to the noise sources where applicable.

- 5.3.16 A 2dB penalty for tonal noise has been applied to the noise from the fixed plant, and, a 6dB penalty for impulsive sound has been applied to the noise from deliveries.

- 5.3.17 In accordance with BS4142, the calculated noise rating level for the noise sources associated with the proposed retail and commercial premises, has been compared with the corresponding measured background noise level during the daytime and night-time. The assessment has been carried out for each receptor during the daytime and night-time periods. The result of the assessment is shown in Tables 5 and 6.

Table 5: BS4142 Assessment During the Daytime (Figures in dB(A))

	2200-2300				0700-0800			
	ESR1	ESR2	ESR3	ESR4	ESR1	ESR2	ESR3	ESR4
Cumulative Rating Noise Level	36	39	50	49	37	39	50	50
Selected Background Noise Level	48	50	50	50	57	61	61	61
Noise Impact	-12	-11	0	-1	-20	-22	-11	-11

5.3.18 The cumulative rating level will be equal to or below the measured background noise level at all ESRs during the daytime periods under consideration. Therefore, noise from the development will cause a **low impact** at ESR's during the extended hours of operation during the daytime period.

Table 6: BS4142 Assessment During the Night-time (Figures in dB(A))

	2300-0000				0600-0700			
	ESR1	ESR2	ESR3	ESR4	ESR1	ESR2	ESR3	ESR4
Cumulative Rating Noise Level	33	36			51	35	38	53
Selected Background Noise Level (incl. façade correction)	47	46			46	56	58	58
Noise Impact	-14	-10			+5	-21	-20	-5

5.3.19 The cumulative rating level will be above the measured background noise level at ESR4 between 2300 and 0000 hours and below the measured background noise level at ESR1 and ESR2. The cumulative rating level will be below the measured background noise level at all ESRs between 0600 and 0700 hours.

- 5.3.20 Noise from the development will cause a **low impact** at ESR1, ESR2, ESR3, ESR4 during the proposed hours of operation, with the exception of 2300-0000 hours at ESR4, where there is a potential for an adverse impact to be felt.
- 5.3.21 It is recommended that mitigation be put in place to attenuate noise levels from the retail and commercial development and therefore reduce the impact at ESR4.

6 NOISE ATTENUATION SCHEME

- 6.1.1 Mitigation measures are required to reduce the impact from noise from the retail and commercial development at ESR's.
- 6.1.2 It is recommended that a barrier, 1.8m in height is located around the drive thru area at Unit 8. A BS4142 assessment has been carried out with the proposed barrier in place. The result of the assessment is shown in Tables 7 and 8.

Table 7: BS4142 Assessment During the Daytime with the Proposed Barrier at Unit 8 (Figures in dB(A))								
	2200-2300				0700-0800			
	ESR1	ESR2	ESR3	ESR4	ESR1	ESR2	ESR3	ESR4
Cumulative Rating Noise Level	37	39	49	49	36	39	49	49
Selected Background Noise Level	48	50	50	50	57	61	61	61
Noise Impact	-11	-11	-1	-1	-21	-22	-12	-12

- 6.1.3 The cumulative rating level will be below the measured background noise level at all ESRs during the daytime periods. Therefore, noise from the development will cause a **low impact** at ESR's during the extended hours of operation during the daytime period, depending on context.

Table 8: BS4142 Assessment During the Night-time with the Proposed Barrier at Unit 8 (Figures in dB(A))

	2300-0000			0600-0700			
	ESR1	ESR2		ESR4	ESR1	ESR2	ESR4
Cumulative Rating Noise Level	33	40	Not considered at night	50	35	41	51
Selected Background Noise Level (incl. façade correction)	47	46		46	56	58	58
Noise Impact	-14	-6		+4	-21	-17	-7

- 6.1.4 The cumulative rating level will be above the measured background noise level at ESR3 and ESR4 between 2300 and 0000 hours and below the measured background noise level at ESR 1 and ER2. The cumulative rating level will be below the measured background noise level at all ESRs between 0600 and 0700 hours.
- 6.1.5 Noise from the development will cause a **low impact** at ESR1, ESR2, ESR3, ESR4 during the proposed hours of operation, with the exception of 2300 and 0000 hours at ESR4, where there is a potential for an adverse impact to be felt.
- 6.1.6 The mitigation is not providing a significant reduction to the noise impact at ESR4. Higher barriers have been tested in the noise model and have shown not to provide any real benefit at ESR4.

BS4142 Context Assessment

- 6.1.7 BS4142:2014 States; “The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound sources exceeds the background sound level and the context in which the sound occurs”.
- 6.1.8 The first requirement of this statement has been determined within the noise impact assessment section above. To determine the context in which the proposed industrial sound will reside, three factors must be considered, these are;
- The absolute level of sound;

- The character and level of the residual sound compared to the character and level of the specific sound; and,
- The sensitivity of the receptor.

Absolute level of Sound

- 6.1.9 The impact of a given difference between rating level and background noise level will depend upon whether the residual sound level is low or high.
- 6.1.10 The residual noise level at the site is high during the daytime and night-time periods. The proposed development is located adjacent to a busy road, which has a significant flow of traffic during the daytime.

Character and Level of Residual Sound Compared with the Specific Sound

- 6.1.11 The predicted specific noise from the proposed commercial and retail development is low. The development is located next to a busy single carriageway road, and there is a busy single carriageway road to the east of the proposed development site. Furthermore, there is an existing industrial premises located to the north of the proposed development site. These sources of noise give a high residual noise level at ESR4.
- 6.1.12 Onsite observations indicate that HGV's currently access the existing industrial premises to the north of the proposed development site at the times in question. Therefore, existing sensitive receptors currently experience noise from HGV movements.
- 6.1.13 The existing noise environment contains low to mid frequency noise. Noise from fixed plant and the carpark areas also contains low to mid frequency noise, and does not contain any distinguishable features. As such the character of the noise from the proposed retail development is not of a significantly different character to other noise sources in the vicinity of the sensitive receptors. Therefore the impact is less significant.

Sensitivity of Receptor

- 6.1.14 The sensitivity of the receptor changes throughout the day, with the night-time and evening periods being more sensitive due to the occupants' need for quiet for rest and relaxation.
- 6.1.15 It is understood that ESR3 is permitted for use as an office. It is therefore not considered to be a sensitive receptor during the night-time period.

6.1.16 The existing sensitive receptors will have a medium sensitivity to noise, however there is no option to mitigate the sound at the receptor.

Summary of the Site Context

6.1.17 A BS4142 assessment has been undertaken to assess the potential noise impact from the proposed retail and commercial development.

6.1.18 The absolute level of noise from the proposed commercial and retail development is low, and it is unlikely that noise from the proposed commercial and retail development will be distinguishable from the existing noise environment.

6.1.19 The context assessment has highlighted that noise from the proposed retail and commercial development will cause a **low impact** at existing sensitive receptors, and will and will not cause any change in behaviour or attitude, therefore resulting in a 'No Observed Adverse Effect' (NOAEL).

6.2 Comparison with Planning Condition 16

6.2.1 Condition 16 of the planning decision notice requests that;

'The rating levels for cumulative noise from all fixed plant and machinery and transportation sources (including delivery, waste collection, and customer vehicles) connected to the development hereby permitted shall not exceed the background noise level (LA90) at the nearest noise sensitive premises, as assessed in accordance with British Standard 4142:2014. Alternative levels and monitoring locations may be used subject to the prior written agreement of the Local Planning Authority'.

6.2.2 The assessment of noise at ESR4, between 2300 and 0000 hours demonstrates that the rating level slightly exceeds the background sound level, and would therefore not be in strict compliance with Condition 16. However, the condition states, that *'Alternative levels and monitoring locations may be used subject to the prior written agreement of the Local Planning Authority'*.

6.2.3 In this case we suggest that '*alternative levels*' are used, and that noise at ESR4, is considered to be acceptable for the following reasons;

- The main source of noise from the development site, is road traffic on development roads, and at the drive-through of Unit 8. Which has the same character as noise from existing road traffic on Norcross Lane, which is closer to ESR4 than the development site. Therefore, the character of the noise will remain the same.

- The existing ambient noise level at the site between 2300 and 0000hours is around 54dB(A), and the calculated noise from the site is 50dB(A), during the same time period. Therefore, noise from the development site will be lower than the existing ambient noise level, and will be partially masked by existing road traffic noise.
- The excess of the rating level over the background sound level occurs for a period of 1 hour only between 2300 and 0000 hours. Noise during all other times meets the planning condition requirement.
- During the period between 2300 and 0000, residents of dwellings will typically be indoors. When the sound from the development site is considered internally, the mitigation provided by the facades of the buildings should be considered in accordance with BS4142. Internal noise levels are unlikely to be affected by noise from the activities at Units 8 and 9.

6.2.4 Therefore, we propose that noise from the development site during the proposed extended hours is acceptable.

7 CONCLUSIONS

- 7.1.1 Wardell Armstrong has carried out a further noise assessment for the proposed commercial and retail premises located at Norcross Lane, Thornton-in-Cleveleys, Lancashire.
- 7.1.2 This assessment follows granting of the detailed planning application for retail uses (A1, A3 and A5) and 354 associated car parking spaces in December 2017 (17/00122/LMAJ), with conditions.
- 7.1.3 This noise assessment report has been prepared to support a Section 73 application to vary Condition 18, which restricts operational hours of the site to between 0800 and 2200 hours.
- 7.1.4 The proposals are to extend the operational hours of the following units to;
- Unit 8;
 - 0600 to 0000 hours Monday to Saturday; and,
 - 0700 to 2300 hours Sunday and Bank Holidays.
 - Unit 9;
 - 0600 to 2130 hours Monday to Saturday; and,
 - 0700 to 2130 hours Sunday and Bank Holidays.
- 7.1.5 To establish baseline noise levels an unattended noise survey has been carried out. This report assesses the results of the noise surveys carried out in accordance with current guidance and includes recommendations for noise mitigation as appropriate.
- 7.1.6 Details of the likely sources of noise at the proposed commercial development are not available at the time of writing. Therefore, a noise limit for the mechanical plant has been set to minimise the impact of noise from the development.
- 7.1.7 Careful selection of the plant and mitigation measures may be required to reduce noise emissions to achieve the suggested noise limits.
- 7.1.8 Noise modelling of the proposed development site has been undertaken, and includes a consideration of noise from;
- Delivery by HGV;
 - Fixed plant;
 - Customer vehicles on site access roads, and drive-throughs; and,

- The car park area.

- 7.1.9 An assessment has been carried out in accordance with British Standard 4142: 2014 Methods for rating and assessing industrial and commercial sound; (BS4142) for noise from mechanical plant, deliveries and vehicle movements within the carpark areas.
- 7.1.10 In accordance with BS4142, the noise will cause a **low impact** at existing sensitive receptors, when considering site context.
- 7.1.11 Noise from the development slightly exceeds the background sound level, and is therefore, not strictly in accordance with Condition 16 of the decision notice attached to the planning approval. However, Condition 16 allows some flexibility, including the use of alternative levels to be agreed, and consequently as part of this submission. For the reasons discussed in this assessment the extended operating hours will not cause an unacceptable noise impact at nearby sensitive receptors.

APPENDICES

Appendix A Noise Monitoring Results

Appendix A
Noise Monitoring Results

ML1 – To the north west of the site, near to existing receptors off Goldstone Drive and Sixfields						
Time	L _{Aeq} (dB)	L _A min (dB)	L _A max (dB)	L _{A90} (dB)	L _{A10} (dB)	Comments
22/11/2106 - Daytime						
2200-2300	49.6	41.9	60.6	45	52.4	
22/11/2016 – 23/11/2106– Night-time						
2300-2315	49	42.7	61.5	44.5	51.9	
2315-2330	47.6	41.7	60.1	44	50.2	
2330-2345	46.8	42.2	60.5	44	48.7	
2345-0000	47.6	42.2	64.6	43.8	49.9	
0000-0015	46.8	42.7	58.4	43.7	49.2	
0015-0030	45.6	42.6	55	43.7	47.2	
0030-0045	44.9	41.3	52	42.6	46.8	
0045-0100	45.4	41	56.6	42.2	46.6	
0100-0115	48.1	42.7	59	43.7	51.5	
0115-0130	48	42.5	64	43.4	49.2	
0130-0145	46.3	42.5	56.3	44	48.2	
0145-0200	45.6	41.2	59.8	43	46.6	
0200-0215	45.1	41.5	54.3	43	46.6	
0215-0230	46.1	41.2	57.4	43.1	48.1	
0230-0245	46.1	40.3	57.3	42.9	48.4	
0245-0300	46.8	41.6	58.6	43.2	49.6	
0300-0315	46.1	40.8	57.3	43.1	48.4	
0315-0330	46.6	40.8	60.9	42.9	48.5	
0330-0345	46.9	41.5	58.1	43	49.8	
0345-0400	47.8	41.9	62.7	44.2	50.5	
0400-0415	48.3	42	58.6	44.1	51.4	
0415-0430	48	42.3	61.3	44.3	50.8	
0430-0445	48.8	41.7	61.5	44.1	51.8	
0445-0500	51.1	43.8	63.9	46.7	53.7	
0500-0515	51.9	44.1	61.2	47.9	54.1	
0515-0530	52.4	46.7	61.8	48.3	54.7	
0530-0545	53.1	46.5	60.5	49	55.4	
0545-0600	53.8	47.2	62.7	51.1	55.5	
0600-0615	55.2	49.5	62	52.5	56.9	
0615-0630	55.4	50.3	63.3	52.8	56.9	
0630-0645	55.8	51.2	70.3	53.8	57.1	
0645-0700	56.6	51.9	71	54	57.9	
23/11/2016 - Daytime						
0700-0800	56.2	50.5	66.3	53.6	57.7	
0800-0900	55.9	52.1	65.1	54.1	57.2	
0900-1000	55.4	48.5	71.8	52.5	56.8	
1000-1100	54.7	48.3	73.6	51.9	56.2	
1100-1200	54.2	48.6	66.7	51.9	55.8	
1200-1300	53.9	48.7	67.4	51.7	55.3	

ML2 – In the south eastern part of the site, approximately 15m from Norcross Lane						
Time	L _{Aeq} (dB)	L _A min (dB)	L _A max (dB)	L _{A90} (dB)	L _{A10} (dB)	Comments
23/11/2106 - Daytime						
1400-1500	62.3	48.9	80.8	53.9	65.4	
1500-1600	64.8	52.3	94.7	56.6	65.9	

1600-1700	62.3	51.4	80.7	56.4	65.1
1700-1800	63.2	52.3	80.9	57.4	65.8
1800-1900	62.8	51.2	80.4	56.7	65.4
1900-2000	65	50.8	92.5	55.1	65.3
2000-2100	60.5	48.2	77.1	53	64.2
2100-2200	59.1	44.7	70.4	49.6	63.4
2200-2300	57.5	43	75.2	47.3	61.9

23/11/2016 – 24/11/2106– Night-time

2300-2315	54.7	41.2	68.5	44.3	58.6
2315-2330	54.7	39.3	69.6	43	59.2
2330-2345	53.7	37.1	70.3	40.9	57.3
2345-0000	53	37.5	67.6	42	56.6
0000-0015	53.3	38.5	69.1	41.7	55.3
0015-0030	53.3	35.7	70.9	40.7	55
0030-0045	52.3	32.7	73.3	39.7	53.2
0045-0100	52.7	32.3	71.2	38.6	54.7
0100-0115	50.5	31	72.5	34.5	51.2
0115-0130	57.7	31.9	85.1	35	49.5
0130-0145	48.2	27.6	69.5	31.4	48.7
0145-0200	48.5	30.6	70.7	33.6	49.7
0200-0215	42.6	29.6	64.5	31.6	43.6
0215-0230	52.4	29.2	71	32.1	53.3
0230-0245	49.7	28.8	68.4	31.6	51.1
0245-0300	49.7	29.8	72.9	32.4	48.1
0300-0315	46.3	28.5	67.9	29.9	47
0315-0330	49	31.5	69	33.9	51.3
0330-0345	50.5	31.2	70.2	35	53.1
0345-0400	48.4	30.3	69	33.3	49.6
0400-0415	50.8	31.3	72.9	35.2	52.5
0415-0430	52.8	33.7	72.2	39.8	54.6
0430-0445	53.5	36.8	72.3	41.1	55.9
0445-0500	54.1	34.3	70.7	39.6	57.1
0500-0515	54.4	40.7	70.7	44.6	56.9
0515-0530	56.5	40.8	72.4	44.9	60.7
0530-0545	58.6	45.7	70.7	48.2	63.4
0545-0600	59.2	45.5	71.6	50.7	63.5
0600-0615	60.2	48.3	72.3	52.1	64.8
0615-0630	61.1	50.6	71.2	53.8	65.3
0630-0645	62.5	51.6	72.7	55.9	66.1
0645-0700	63.4	55.4	77.4	57.1	66.5

24/11/2016 - Daytime

0700-0800	63.9	53.6	75	58.3	66.7
0800-0900	63.3	53.1	71.9	57.3	66.2
0900-1000	63	46.2	82.5	55.6	65.9
1000-1100	62.5	45.9	75.3	52	65.9
1100-1200	63	47	90.3	52	65.8
1200-1300	62.8	46.4	80.3	52.1	65.9
1300-1400	62.2	47.2	73.2	52.2	65.6
1400-1500	63.2	47.3	88.9	54.1	65.7
1500-1600	65.4	49.3	95.3	56.4	65.8
1600-1700	62.7	49.1	80.2	55.3	65.6
1700-1800	62.8	51.4	82.8	56.7	65.2
1800-1900	62.8	53.1	73.1	57.3	65.4
1900-2000	62	50.6	74.3	55.3	65.2
2000-2100	61.4	49.8	87.4	53.6	64.6
2100-2200	62.2	46.3	93.1	51.4	64
2200-2300	57.9	42.8	75.5	48.7	62.3

24/11/2016 – 25/11/2016 Night-time

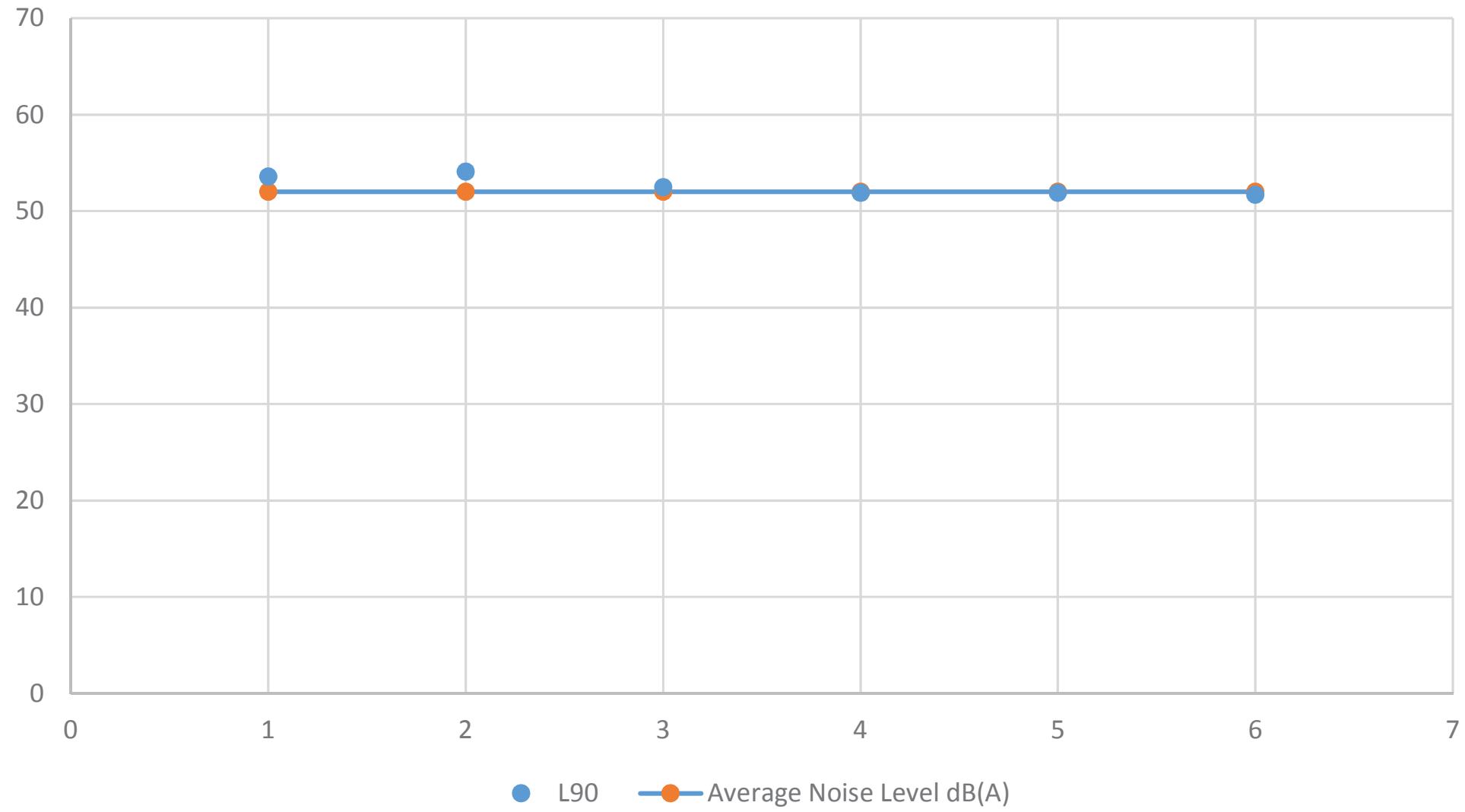
2300-2315	56.5	41	72.9	46.2	61.1
2315-2330	56.5	42	68.7	46	61.3
2330-2345	54.3	37	70	42.1	57.3
2345-0000	55.4	38.9	72	43.3	59.6
0000-0015	53	37.2	72.6	41.1	53.9
0015-0030	52.5	35.4	69	39.4	54.8
0030-0045	51.9	35	71.7	40.3	54.5
0045-0100	53	34	70.4	38.8	55.7
0100-0115	50.3	31.6	71.2	37	50.3
0115-0130	55.2	31.5	78.1	36.4	52.5
0130-0145	49.3	29	67.7	33.2	50
0145-0200	48.4	28.6	67.6	30.9	49.9
0200-0215	50.2	32	70	36.6	50.9
0215-0230	57.4	27.6	81	33.3	50.6
0230-0245	59.8	30	86	32.4	50.3
0245-0300	51.1	27	72.3	28.8	52.5
0300-0315	46.8	28	67	29.6	48.5
0315-0330	44.8	29.9	59.4	31.8	48.6
0330-0345	49.9	32.1	70.2	37.5	52.5
0345-0400	49.1	32.3	69	35.7	51.6
0400-0415	48.7	29.4	67.5	33.7	50.8
0415-0430	48.2	31	68.9	36.1	49.7
0430-0445	53.7	32.3	71.8	40.2	55.6
0445-0500	53.2	35.1	69.5	39.7	55.3
0500-0515	56.2	35.4	70.5	41.9	59.8
0515-0530	56.7	39	73.5	44.2	60.3
0530-0545	58.4	45.7	71.7	48.8	62.8
0545-0600	59.3	48.1	71.4	51.5	63.6
0600-0615	59.5	48.6	70.8	51.7	63.8
0615-0630	61.1	47.2	70.7	52.8	65.3
0630-0645	61.8	52.2	72.4	55	65.7
0645-0700	63.4	52.9	76.3	56.9	66.6

25/11/2016 Daytime

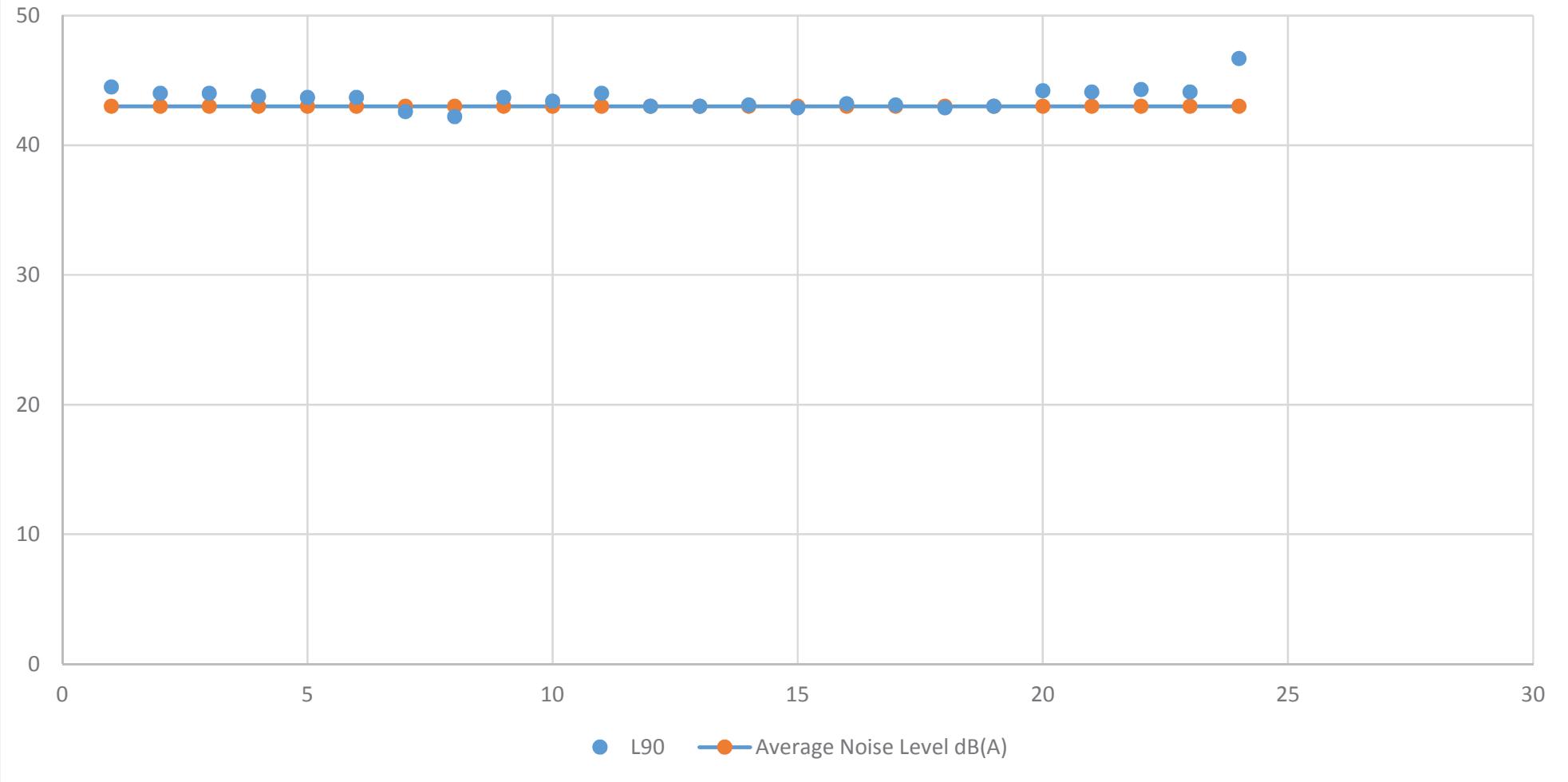
0700-0800	64	54.8	76.7	58.7	66.7
0800-0900	63.9	52.8	78.7	58	66.6
0900-1000	63.6	51.6	77	56.8	66.5
1000-1100	62.4	48.6	76.5	54	65.7

Appendix B Analysis of Measured Background Noise Levels

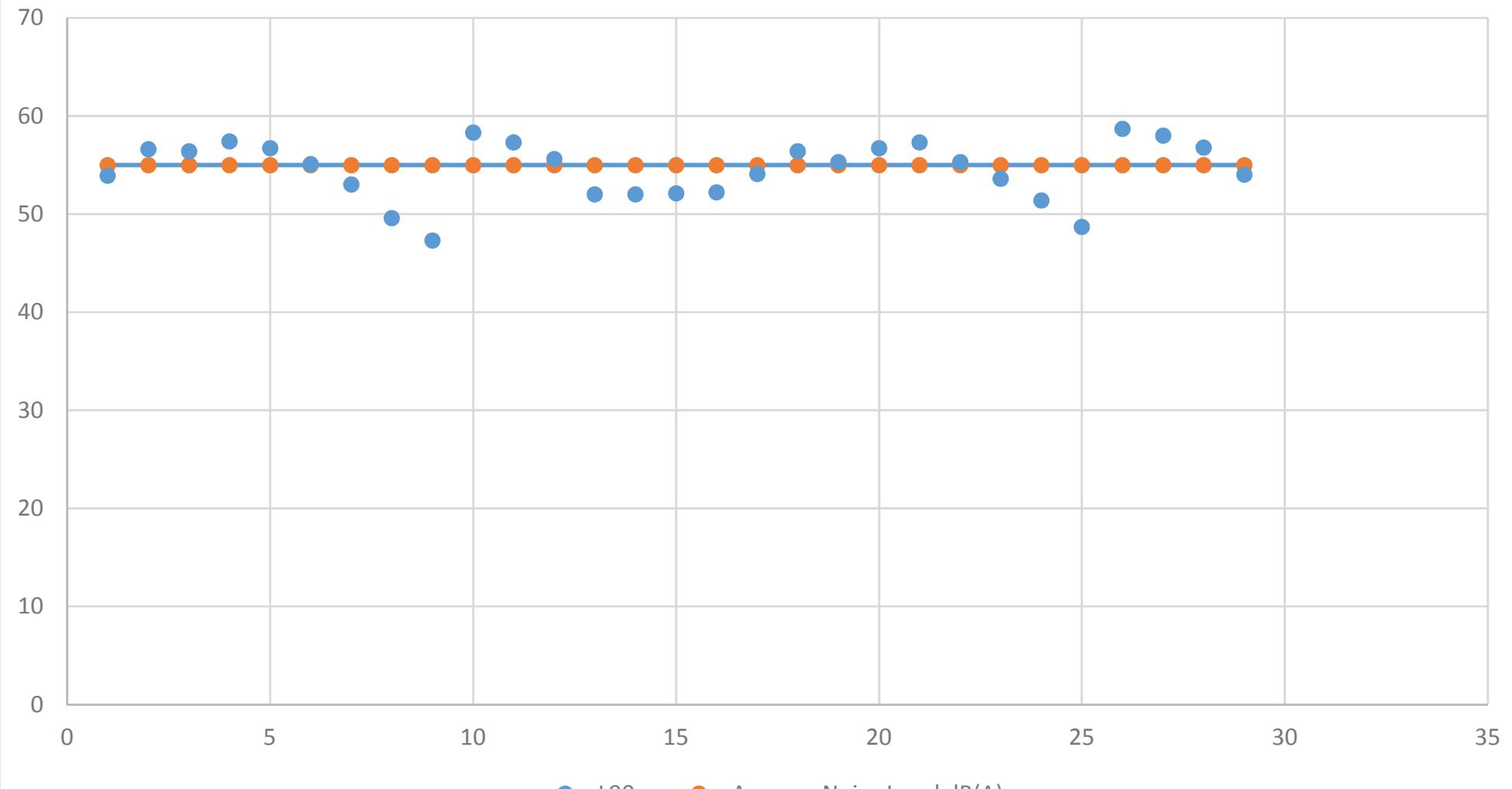
ML1 - Daytime Background Noise Levels



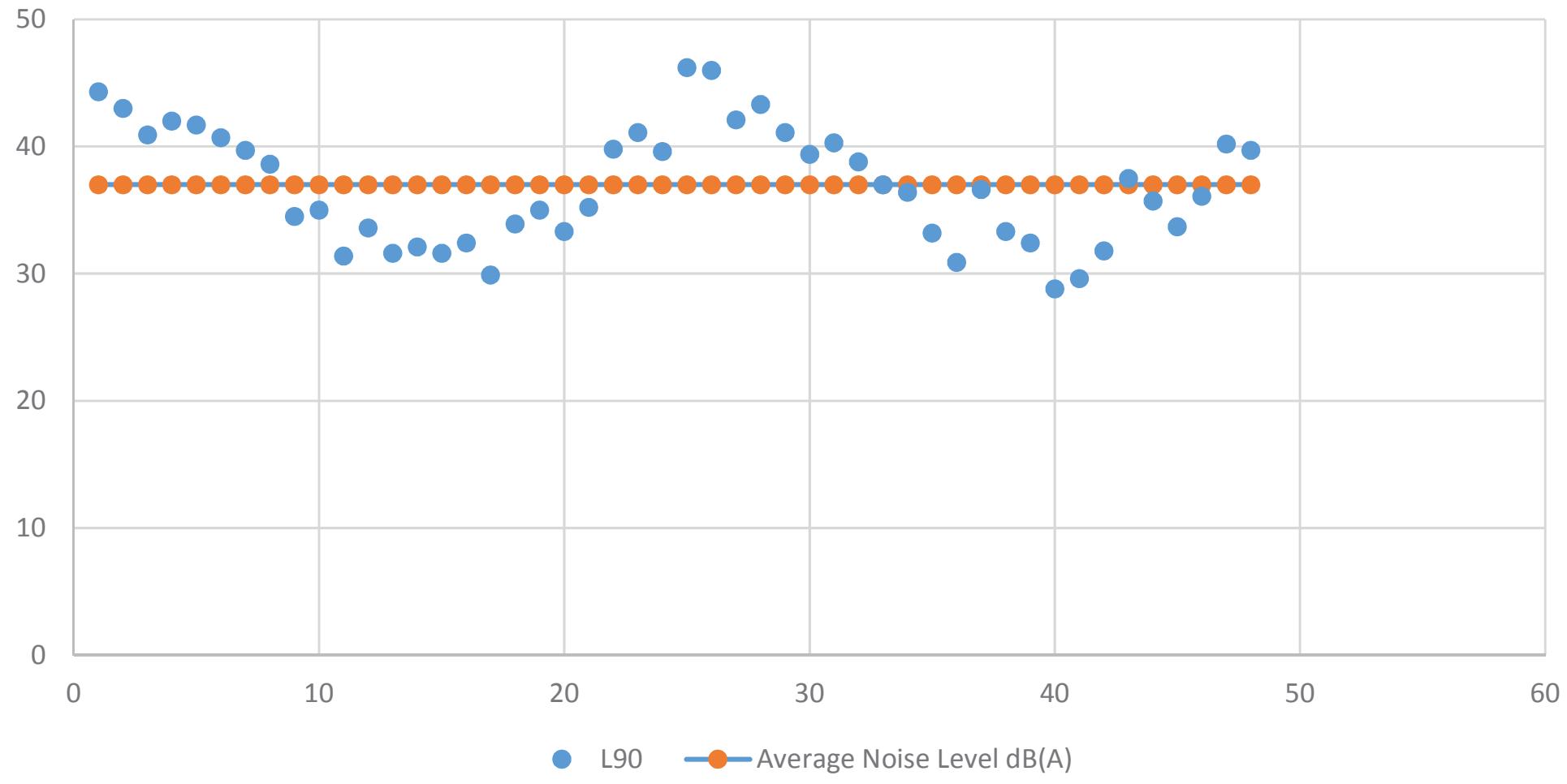
ML1 - Night-time Background Noise Levels



ML2 - Daytime Background Noise Levels

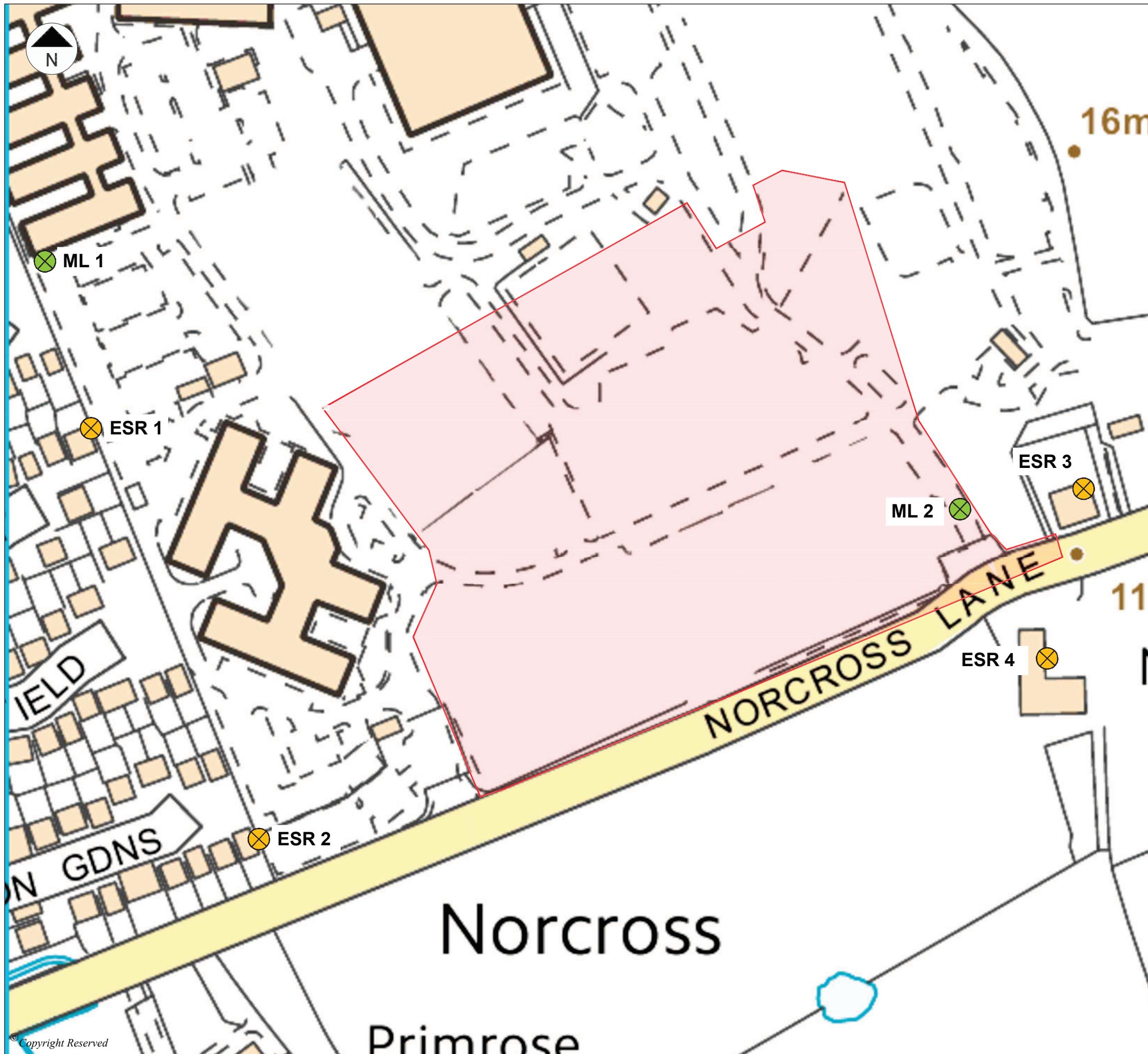


ML2 Night-time Background Noise Levels



DRAWINGS

LE13636-001 Noise Monitoring and Existing Sensitive Receptor Locations



DO NOT SCALE FROM THIS DRAWING

- | | |
|---|--------------------------------------|
| <u>REFERENCE</u> | |
| — | SITE BOUNDARY |
| ○ X | EXISTING SENSITIVE RECEPTOR LOCATION |
| ○ X | NOISE MONITORING RECEPTOR LOCATION |

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D
	Kier Property				

CLIENT Kier Property

PROJECT Norcross Lane,
Thornton-Cleveleys

DRAWING TITLE Noise Monitoring and Existing
Sensitive Receptor Locations

DRG No. LE13636-001 REV A

DRG SIZE A3 SCALE NTS DATE 01/12/16

DRAWN BY PG CHECKED BY LE APPROVED BY CMD

■ LEIGH TEL 0194 226 0101 WEB: WWW.WARDELL-ARMSTRONG.COM

BIRMINGHAM CARDIFF CARLISLE CROYDON

EDINBURGH GLASGOW LONDON MANCHESTER

NEWCASTLE UPON TYNE SHEFFIELD STOKE ON TRENT TAUNTON

FIGURES

Figure 1 Arrangement of the Noise Model

Norcross Lane 2nd App
LE13636

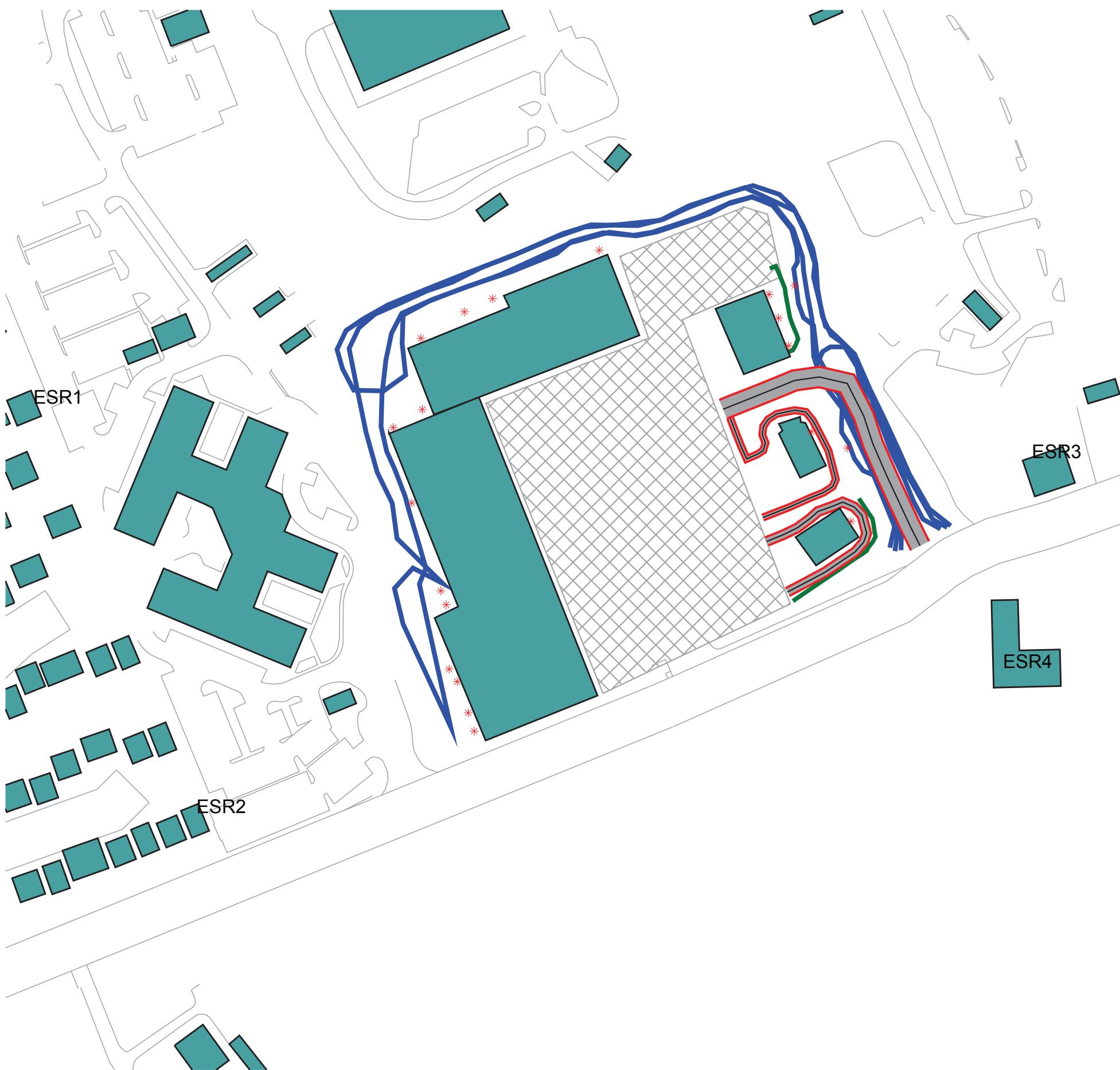
Figure 1
Arrangement of Model

Drawn By: R Calvert

Checked By: R Calvert

Approved By: Mark Dawson

09/02/2018



Signs and symbols

- ▲ Existing NSR
- Existing Buildings
- Road axis
- Emission line
- Site Boundary
- Surface
- ▨ Parking lot
- * Point source
- Wall

Length scale 1:1500

0 20 40 60 m

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