southdowns
environmental consultants

TRANT ENGINEERING LTD

NORTH MYMMS WATER TREATMENT WORKS, HERTFORDSHIRE

BS 4142 SOUND ASSESSMENT

FEBRUARY 2019

DRAFT REPORT

2297W-SEC-00001-01

www.southdowns.eu.com

TRANT ENGINEERING LTD

NORTH MYMMS WATER TREATMENT WORKS, HERTFORDSHIRE

BS 4142 SOUND ASSESSMENT

DOCUMENT REFERENCE: 2297W-SEC-00001-01

REVIEW AND AUTHORISATION			
Authored By Nathan Gregory	**Position** Senior Consultant	**Signature**	**Date** 12/02/19
Reviewed By Alex Mabey	**Position** Principal Consultant	**Signature**	**Date** 12/02/19
Checked By Matthew Tomes	**Position** Senior Consultant	**Signature**	**Date** 08/02/19
Approved By Patrick Williams	**Position** Director	**Signature**	**Date** 12/02/19

AMENDMENT HISTORY			
Issue	**Status**	**Description**	**Date**
01	Draft	Report for client comment	12/02/19

CONTENTS PAGE NO.

1. INTRODUCTION

1.1.1 Southdowns Environmental Consultants Ltd was commissioned in January 2019 by Trant Engineering Ltd (Trant) to undertake an assessment of sound levels arising from the operation of new water treatment plant at the North Mymms Water Treatment Works (WTW) located near Hatfield in Hertfordshire.

1.1.2 The sound assessment documented in this report has been prepared to accompany a planning application for the proposed operation of the new water treatment plant.

1.1.3 Sound levels predicted from the operation of the new water treatment plant have been assessed following the principles of British Standard BS 4142:2014 [1]. The resulting level differences derived from the assessment methodology have been assessed against a Noise Condition attached to an Outline Decision Notice (6/2015/2528/OUTLINE) [2] for the proposed plant installation at the WTW.

1.1.4 Nathan Gregory (MIOA) produced the assessment calculations and also authored this report. Matthew Tomes (MIOA) undertook the checking of the calculations, with the report reviewed by Alex Mabey (MIOA). Nathan is experienced in the assessment of sound following the methodology provided in BS 4142:2014, undertaking the calculations to produce the assessments, and checking the calculations of other assessments relating to industrial and commercial sound. Matthew Tomes has over 10 years of producing sound assessments including undertaking the measurements, calculations and authoring of reports. Alex Mabey also has over 10 years' experience of work in the field of environmental sound assessment and has worked on many different projects where assessment in accordance with the principles of BS 4142 was required.

1.1.5 The sound levels, guidance and assessment criteria are summarised in Section 2 of this report. The existing site is described in Section 3. The details of a previous baseline sound survey undertaken in the vicinity of the WTW site is described in Section 4, and the survey results are presented in Section 5. Details of the WTW plant sound modelling are presented in Section 6. The BS 4142 sound assessment is presented in Section 7 and the conclusions of the assessment are presented in Section 8. Figures and tables referred to in the report are presented in Appendix A and B respectively.

2. SOUND LEVELS AND CRITERIA

2.1 Sound Levels

2.1.1 Sound is measured on a logarithmic scale in decibels (dB) because of the ears' sensitivity to a wide range of pressure changes. The sound pressure level (SPL) of a signal is denoted by the symbol L_p and defined by the equation $L_p = 10 \log (p/p_o)^2$ where p is the root mean square pressure of the signal and p_o is the reference sound pressure (2×10^{-5} Pa).

2.1.2 The human auditory system is capable of detecting sounds over a frequency range of approximately 20 Hz to 20 kHz. Because the ear is most sensitive to sounds with frequencies between 1 and 5 kHz, an A-weighting network is used to reflect the differential sensitivity of human hearing to sounds of different frequency. The A-weighted sound pressure level, L_{pA}, is measured on a scale denoted by the metric dB(A).

2.1.3 The dB(A) level is commonly used for the measurement and assessment of environmental sound due to the relationship between the subjective impression of the auditory strength of a sound, otherwise known as loudness, and the A-weighted sound pressure level of that sound. A change in 3 dB is the minimum perceptible change in event sound levels under normal everyday listening conditions, whilst a 10 dB increase or decrease in the sound pressure level of a steady sound generally corresponds to a perceived doubling or halving of loudness.

2.1.4 An indication of the range of sound pressure levels commonly found in the unoccupied environment is given below:

Location	L_p dB(A)
Normal threshold of hearing	-10 to 20
Music halls and theatres	20 to 30
Living rooms and offices	30 to 50
Inside motor vehicles	50 to 70
Industrial premises	70 to 100
Burglar alarms at 1 m	100 to 110
Jet aircraft on take-off	110 to 130
Threshold of pain	130 to 140

2.1.5 The $L_{A90,T,}$ or background sound level, is defined by the A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T. This does not reflect the occurrence of transient and/or higher sound level events and is generally governed by continuous or semi-continuous sounds. Due to the varying acoustical environment, $L_{A90,\,T}$ is normally defined separately for day and night-time periods. Other percentiles are also sometimes used to describe the levels of ambient sound exceeded for different periods of time. The $L_{A50,T}$ and $L_{A10,T}$ sound levels denote the level of ambient sound exceeded for 50 and 10% of the time, T, respectively. The $L_{Amax,F}$ sound level denotes the maximum instantaneous sound level in any given period of time obtained using the 'Fast' time weighting.

2.1.6 The equivalent continuous sound pressure level is denoted by the symbol $L_{Aeq,T}$ and is defined as the value of the A-weighted sound pressure level of continuous steady sound that, within a specified time interval, has the same mean-squared sound pressure as a sound that varies with time. This average sound level is used in the UK for the measurement of sound from many sources (including industry, construction, railways and aircraft) and is widely used for the measurement of ambient sound, which comprises sound from all sources in the environment.

2.1.7 Community responses to environmental sound sources are dependent on both acoustic and non-acoustic factors. The acoustic factors include absolute sound level, changes to, or exceedances of, background and residual sound levels, as well as the characteristic features, time, duration and intermittency of the sound. Noise is defined as unwanted sound.

2.2 National Noise Policy and Planning Policy Framework

Noise Policy Statement for England (NPSE)

2.2.1 The Noise Policy Statement for England (March 2010) [3], sets out the long term vision of Government noise policy.

2.2.2 The vision of the NPSE is to 'Promote good health and a good quality of life through the effective management and control of noise within the context of Government policy on sustainable development'. This vision is supported by three key aims:

- avoid significant adverse impacts on health and quality of life;
- mitigate and reduce to a minimum other adverse impacts on health and quality of life; and
- where possible, contribute to the improvement of health and quality of life.

2.2.3 The NPSE applies to most forms of noise, including environmental noise, neighbour noise and neighbourhood noise, but not occupational noise in the workplace.

2.2.4 The NPSE has adopted the following concepts to help consider whether noise is likely to have a 'significant adverse' or 'adverse' impact on health and quality of life:

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 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.

2.2.5 The NPSE goes on to state that:

"it is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times. It is acknowledged that further research is required to increase our

understanding of what may constitute a significant adverse impact on health and quality of life from noise. However, not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available."

National Planning Policy Framework

2.2.6 The Government's National Planning Policy Framework (NPPF) came into force in March 2012 [4], with a revision of the document published in July 2018 [5]. The NPPF sets out the Government's planning policy for England and how it should be applied. The NPPF replaced a number of planning policy guidance documents, including the now archived Planning Policy Guidance 24: Planning and Noise.

2.2.7 The NPPF defines the Government's planning policy for England and sets out the framework within which local authorities should prepare their local and neighbourhood plans, reflecting the needs and priorities of their communities.

2.2.8 The main references to noise in the NPPF are found in paragraphs 170 and 180, where it states that:

"170. Planning policies and decisions should contribute to and enhance the natural and local environment by:

…

e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans …

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

a) *mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;*
b) *identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason …"*

Planning Practice Guidance - Noise

2.2.9 Planning Practice Guidance (PPG) on noise [6] was issued in March 2014. This web-based guidance advises local planning authorities to take into account the acoustic environment, and in doing so consider the following:

- whether or not a significant adverse effect is occurring or likely to occur;
- whether or not an adverse effect is occurring or likely to occur; and
- whether or not a good standard of amenity can be achieved.

2.2.10 The PPG includes examples of how to recognise when noise could be a concern and provides example outcomes to which the Observed Effect Levels can apply. The PPG noise exposure hierarchy is presented in Table 2.1, based on the likely average response, along with example outcomes.

2.2.11 While it is acknowledged that planning and nuisance regimes are separate entities, the hierarchy table does provide useful information regarding how the concept of SOAELs and LOAELs, introduced through the NPSE, could be applied and does allow for subjective observations to be considered in the context of potential effect levels. The presence of an "Effect Level" does not infer whether a nuisance is or is not present.

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, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a 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, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
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

TABLE 2.1: PLANNING PRACTICE GUIDANCE NOISE EXPOSURE HIERARCHY

2.2.12 The PPG guidance states that "*if external amenity spaces are an intrinsic part of the overall design, the acoustic environment of those spaces should be considered so that they can be enjoyed as intended*." Furthermore the guidance goes on to so say "*Although the existence of a garden or balcony is generally desirable, the intended benefits will be reduced with increasing noise exposure and could be such that significant adverse effects occur.*"

2.3 Local Authority Sound Criteria

2.3.1 The North Mymms WTW site falls within the administrative area of Welwyn Hatfield Borough Council (WHBC).

2.3.2 The Welwyn Hatfield District Plan [7] has policies for the protection of local communities from the potential negative impacts of noise through the requirement that proposals should ensure there is no significant adverse impact on the local acoustic environment.

2.3.3 In relation to commercial developments, the District Plan states that the council will "*seek to ensure that new development with a potential for causing noise nuisance is sited away from noise-sensitive land uses, both existing and known proposed developments.*"

2.3.4 In response to an Outline Planning Application (6/2015/2528/OUTLINE) submitted by Affinity Water Ltd in December 2015 relating to the installation and operation of additional WTW plant, WHBC attached the following noise related planning condition to the development:

> *"No above ground development construction shall commence on site until an acoustic report has been submitted to and approved in writing by the Local Planning Authority detailing the noise from plant and equipment to be installed at the premises showing that noise emissions will be 10dB (LAeq) below the background noise level (LA90) at the nearest residential properties (using the methodology outlined in BS142:2014) [sic]. The scheme shall be completed in accordance with the approved details before any part of the accommodation hereby approved is occupied and maintained thereafter in accordance with the approved details.*
>
> *REASON: To protect the living conditions and amenity of the residents and other nearby residential properties from noise disturbance in accordance with Policy R19 of the Welwyn Hatfield District Plan 2005."*

2.4 British Standard BS 4142:2014

2.4.1 Guidance on the rating and assessing of sound of an industrial and/or commercial nature is contained in British Standard BS 4142:2014 'Methods for rating and assessing industrial and commercial sound'.

2.4.2 The standard states that:

"This standard is applicable to the determination of the following levels at outdoor locations:

a) rating levels for sources of sound of an industrial and/or commercial nature; and

b) 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.”

2.4.3 The determination of sound amounting to a nuisance is beyond the scope of BS 4142:2014.

2.4.4 The significance of sound of an industrial and/or commercial nature depends upon the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs.

2.4.5 Typically, the greater the difference between rating level and background sound level, the greater the magnitude of the impact. BS 4142 provides the following guidance when assessing the difference in the rating level and background sound assessment level:

- a difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context;
- a difference of around +5 dB is likely to be an indication of an adverse impact, depending on context; and
- the lower the rating level is relative to the measured background sound level, the less likely it is that the specific 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.

2.4.6 Certain acoustic features can increase the significance of the impact over that expected from a basic comparison between specific sound level and the background sound level. These features include tonality and impulsivity, as well as additional characteristics and intermittency of the sound.

2.4.7 Where appropriate, a rating penalty for sound based on a subjective assessment of its characteristics should be established. In other circumstances an objective appraisal of tonal and/or impulsive characteristics may be appropriate.

2.4.8 Although BS 4142:2014 was derived from previous editions of the standard, many aspects have been introduced, or developed, since the previous edition. As such, differences may exist in the results obtained through the application of this standard compared to its predecessors. These differences may be attributable, in part, to changes in the assessment of acoustical features, differences in establishing representative background sound levels, and/or the application of context to the results.

3. SITE DESCRIPTION AND PROPOSED WTW OPERATIONS

3.1 Site Description

3.1.1 The North Mymms WTW is located to the east of Warrengate Road in North Mymms, as indicated on Figure A1 of Appendix A.

3.1.2 Affinity Water is the operator of the WTW.

3.1.3 The WTW treats water from 4 no. borehole sources located in North Mymms, Essendon, Roestock and Tyttenhanger, and has a design capacity of 36 mega-litres per day (Ml/d).

3.1.4 The existing WTW plant that was present onsite when the baseline noise survey was carried out consisted of a number of water treatment tanks and high lift pumps for chlorination, disinfection and filtration purposes. This plant is understood to operate on a 24/7 basis.

3.1.5 The nearest noise sensitive receptors to the WTW site are two residential, semi-detached dwellings located on the access road to the WTW site. Other residential properties are located c.200 m away to the north-west and c.350 m to the south-west on Warrengate Road.

3.1.6 Approximately 420 m to the west of the WTW site is the A1(M) motorway. To the east of the site is farmland and woodland. A railway line operated by Great Northern is located c.900 m to the east of the WTW site. Beyond the railway line is Brookmans Park village.

3.1.7 There are a number of small earth bunds on the WTW site which provide some screening between certain existing WTW equipment and the nearest residential properties.

3.2 Proposed WTW Site Operations

3.2.1 The new plant to be installed on site is understood to comprise the following noise generating equipment:

- 2 no. Contact tank mixers;
- 1 no. Coagulation tank mixer;
- 1 no. Flocculation tank mixer;
- 1no. Actiflo settling tank scraper;
- 2 no. Actiflo recycle pumps;
- 1 no Air compressor*;
- 2 no. PAC converyors;
- 2 no. PAC Eductor*;
- 1 no. Actisand conveyor*;
- 1 no. Actisand educator*;
- 1 no. Actisand big bag loader;
- 1 no. Lamella coagulation tank mixer;
- 1 no. Lamella flocculation tank mixer;
- 1 no. Lamella thickener scraper;
- 2 no. Lamella sludge pumps;
- 1 no. Sludge balancing tank mixing pump;
- 2 no. Centrifuge feed pumps;

- 1 no. Centrifuge*; and
- 2 no. Polymer makeup kits*.

3.2.2 A number of items of plant are to be housed within a single acoustic enclosure. These items of plant are indicted in the above list with an asterisk. The locations of individual items of plant are identified on Figure A2 of Appendix A.

3.2.3 North/south elevations of the proposed acoustic enclosure and external plant are presented in Figure A3 of Appendix A, with the east/west elevations presented in Figure A4 of Appendix A.

4. BASELINE SOUND SURVEY

4.1 Sound Survey

4.1.1 A baseline sound survey was undertaken at North Mymms WTW in March 2016. The survey comprised of unattended continuous sound monitoring over a 6 day period and attended sound monitoring during a weekday night-time period. Details of the sound monitoring are presented in the following sub-sections.

4.1.2 The baseline survey was carried out as part of a sound assessment of a previous design proposal for the upgrade of the WTW site. This sound assessment was reported in reference [8]. However, the plant was not installed. Due to this and the lack of significant development in the area, it is assumed that the noise climate has not significantly changed since the previous baseline survey was carried out. As such, the results of the survey are still considered to be representative of the baseline background sound environment in the vicinity of North Mymms WTW.

4.2 Attended Sound Monitoring

4.2.1 Attended short-term sound measurements were obtained at monitoring locations ST1 and ST2 shown on Figure A1 of Appendix A. These measurements were obtained between 00:02 hrs and 02:43 hrs on Thursday 24th March 2016.

4.2.2 The sound measurements at both locations were made in free-field conditions with the microphone positioned 1.5 m above local ground.

4.2.3 The sound level meter was set to measure sound pressure levels with the ‘Fast’ time weighting and A-weighting frequency network applied to the sound pressure level measurements.

4.2.4 The sound level meter was calibrated before and after the survey period using a Rion NC-74 Class 1 Acoustic Calibrator to generate a calibration level of 94.0 dB at 1 kHz.

4.2.5 The sample measurements undertaken at each location were obtained over 15-minute periods with each 15-minute measurement comprising three consecutive 5-minute periods, from which a cumulative 15-minute level was derived.

4.3 Unattended Sound Monitoring

4.3.1 Continuous unattended sound monitoring was undertaken between Friday 18th and Thursday 24th March 2016. The sound monitoring equipment was located on the western boundary of the WTW site, approximately 5 m from the garden of No. 71 Warrengate Road, the closest residential property to the WTW site. The microphone was positioned c.1.5 m above local ground in free-field conditions. This unattended sound monitoring location is labelled as LT1 on Figure A1 of Appendix A.

4.3.2 The sound measurements were undertaken using a Rion NL-32 precision integrating sound level meter fitted with a weatherproof windshield. The sound level meter was powered by gel cell batteries and stored inside a weatherproof security box.

4.3.3 Consecutive 15-minute measurements of sound indices which included $L_{Amax,F}$, $L_{Aeq,15min}$, and $L_{A90,15min}$ sound levels were measured over the six day monitoring period.

4.4 Weather Conditions

4.4.1 Weather conditions during the attended monitoring on Thursday 24th March 2016 were dry with scattered clouds and negligible wind. Air temperatures were around 10 °C and relative humidity was around 63 %.

4.4.2 A log of the weather during the unattended monitoring period has been obtained from an internet source and is summarised in Table B1 of Appendix B.

5. SOUND SURVEY RESULTS

5.1 Attended Sound Survey Results

5.1.1 The results of the attended measurements are tabulated in Table B2 of Appendix B and summarised below in Table 5.1.

Monitoring Location	Measurement Start Time	Dur. (mins)	Measured Sound Levels, dB re. 2 x 10^{-5} Pa.		
			$L_{Amax,F}$	$L_{Aeq,T}$	$L_{A90,T}$
ST1	00:02	15	63.9	45.3	43.3
	01:35	15	60.5	42.6	40.5
	02:11	15	57.7	43.3	40.8
ST2	00:27	15	55.8	45.8	44.2
	01:53	15	62.3	45.8	43.8
	02:28	15	63.9	45.8	44.1

TABLE 5.1: SUMMARY OF SHORT-TERM ATTENDED SOUND MEASUREMENT RESULTS – THURSDAY 24TH MARCH

5.1.2 Observations made during the attended sound survey indicated that the ambient $L_{Aeq,T}$ and background $L_{A90,T}$ sound levels were primarily governed by road traffic on the A1 motorway. Sound from the existing WTW plant was audible at the attended monitoring locations, along with occasional sound from farm animals in the surrounding farmland.

5.2 Unattended Sound Survey Results

5.2.1 The results of the unattended sound survey are presented graphically on Figure A5 of Appendix A, tabulated in Table B3 of Appendix B and summarised in Table 5.2. Daytime $L_{Aeq,16hr}$ and night-time $L_{Aeq,8hr}$ ambient sound levels presented in table 5.2 have been calculated using logarithmic averaging, whilst mean $L_{Amax,F}$ and $L_{A90,T}$ sound levels have been calculated using arithmetic averaging. The range of 15-minute values over which each average value has been calculated is shown in parenthesis.

Day of Meas.	Date	Measured Sound Levels, dB re. 2 x 10^{-5} Pa.					
		Day Time (07:00 - 23:00 hrs)			Night-Time (23:00 - 07:00 hrs)		
		$L_{Amax,F}$	$L_{Aeq,16hr}$	$L_{A90,T}$	$L_{Amax,F}$	$L_{Aeq,8hr}$	$L_{A90,T}$
Friday	18-Mar-16	64 (51-83)	50 (45-55)	46 (43-51)	71 (45-71)	45 (40-51)	40 (37-45)
Saturday	19-Mar-16	82 (50-82)	49 (43-53)	45 (40-48)	74 (44-74)	44 (36-50)	39 (34-43)
Sunday	20-Mar-16	85 (51-85)	49 (45-56)	45 (42-47)	75 (45-75)	47 (40-52)	43 (37-50)
Monday	21-Mar-16	83 (56-83)	53 (50-56)	50 (47-52)	90 (54-90)	53 (48-59)	48 (43-56)
Tuesday	22-Mar-16	80 (56-80)	52 (47-57)	47 (42-56)	71 (51-71)	49 (45-53)	45 (41-51)
Wednesday	23-Mar-16	85 (51-85)	50 (46-60)	46 (44-52)	85 (51-85)	49 (45-60)	46 (44-52)
Average Values		*80 (64-85)*	*50 (49-53)*	*46 (45-50)*	*78 (71-90)*	*48 (44-53)*	*43 (39-48)*

TABLE 5.2: SUMMARY OF FREE-FIELD UNATTENDED CONTINUOUS SOUND MONITORING RESULTS AT LT1

Note: The range of 15 minute levels measured during the period are shown in parenthesis

5.2.2 The results of the unattended sound monitoring show that during the daytime periods ambient $L_{Aeq,16hr}$ sound levels ranged between 49 and 53 dB, with a mean level of 50 dB $L_{Aeq,16hr}$ obtained.

5.2.3 Mean background sound levels measured during the daytime periods ranged between 45 and 50 dB $L_{A90,T}$. The overall mean 16 hour daytime background sound level measured over the 6 day monitoring period was 46 dB $L_{A90,T}$.

5.2.4 During the night-time periods, $L_{Aeq,8hr}$ sound levels ranged between 44 and 53 dB $L_{Aeq,8hr}$ with an overall mean value of 48 dB $L_{Aeq,8hr}$.

5.2.5 Mean background sound levels during the night-time periods ranged between 39 and 48 dB $L_{A90,T}$ with an overall mean value of 43 dB $L_{A90,T}$ obtained over the 6 day monitoring period.

5.3 Derivation of Background Sound Assessment Levels

5.3.1 The results of continuous unattended sound monitoring at LT1 provide an indication of the diurnal variation in sound levels over the survey period, while the short-term attended sound measurements provide an indication of the variation in sound levels between the receptor locations and the WTW site.

5.3.2 Statistical analysis of the background $L_{A90,T}$ sound levels is presented in Figure A6 of Appendix A. From an inspection of this statistical analysis and a comparison of the attended and unattended $L_{A90,T}$ sound data, the background $L_{A90,T}$ sound levels presented below in Table 5.3 have been derived for the assessment of the the new WTW plant, using the principles of BS 4142.

Location	**Background Sound Levels, dB re. 2 x 10^{-5} Pa.**	
	Daytime	**Night-time**
	$L_{A90,T}$	**$L_{A90,T}$**
LTN1/ST1	46	41
ST2	49	44

TABLE 5.3: BACKGROUND SOUND ASSESSMENT LEVELS

6. SOUND MODELLING

6.1 Sound Model Calculations

6.1.1 A sound model has been constructed to calculate the propagation of sound away from the North Mymms WTW site and the sound levels likely to affect nearby receptors.

6.1.2 The sound modelling has been undertaken using SoundPLAN. SoundPLAN is a propriety software package which allows the calculation of sound levels using acoustical ray-tracing techniques through implementing the prediction procedure as defined in ISO 9613-2: 1996 [9]. ISO 9613-2 provides a general method of calculation for calculating the attenuation of sound during propagation outdoors. The environmental sound propagation from source to receiver position is calculated based upon the following acoustic algorithm:

$$\boldsymbol{L_{fT}(DW) = L_w + D_c - A}$$

where:

Lft(DW)	=	equivalent continuous downwind octave-band sound pressure level at a receiver location, representing a worse case assessment;
Lw	=	octave-band sound power level of the sound source, where available, otherwise overall dB(A) level used;
Dc	=	directivity correction;
A	=	octave-band attenuation that occurs during propagation from the sound source to the receiver. $A = A_{div} + A_{atm} + A_{gr} + A_{bar} + A_{misc}$;
Adiv	=	attenuation due to geometrical divergence;
Aatm	=	attenuation due to atmospheric absorption;
Agr	=	attenuation due to the ground effect;
Abar	=	attenuation due to a barrier; and
Amisc	=	attenuation due to miscellaneous other effects.

6.2 Model Assumptions

6.2.1 Principal features of the surrounding area included in the modelling such as buildings and other intervening structures have been based on Ordinance Survey mapping, site plans, and supplemented with onsite observations. Residential building heights have been calculated based on the observed number of floors, with the assumption of 2.4 m in height per floor level. Site building heights have been estimated from the site visits and using Google/Bing images.

6.2.2 The topography of on-site bunds has been modelled according to ground contours shown on the site plans provided by Black and Veatch. The topography of the surrounding area has been modelled as flat ground, with areas of hard and soft ground.

6.2.3 Calculation receptors have been selected to represent the nearest residential properties to the WTW site. The calculation receptors are labelled as R1 to R5 on Figure A7 of Appendix A. Daytime sound levels have been predicted at each receptor at a free-field location, at 1.5 m above local ground and any floor repeats, with the maximum used for the assessment. Night-time sound levels have been predicted 1 m from the façade of the residential properties, at 1st floor height.

6.3 Modelled Sound Sources

6.3.1 Reference sound levels for the new WTW plant to be installed onsite have been provided by Trant and these are presented below in Table 6.1.

New WTW Plant	Sound Pressure Level @ 1 m, dB (A)	No. of Plant	Internal / External	Modelled Height of Source (m)
Contact Tank Mixer	≤ 80 dBA	2	External	5.5 *
Coagulation Tank Mixer	≤ 80 dBA	1	External	5.5 *
Flocculation Tank Mixer	≤ 80 dBA	1	External	5.5 *
Actiflo Settling Tank Scraper	≤ 80 dBA	1	External	3.5
Actiflo Recycle Pump	≤ 80 dBA	2	External	1.0
Air Compressor	≤ 80 dBA	1	Internal	1.5
PAC Conveyor	≤ 80 dBA	2	External	4.5
PAC Eductor	≤ 80 dBA	2	Internal	1.5
Actisand Conveyor	≤ 80 dBA	1	Internal	1.5
Actisand Eductor	≤ 80 dBA	1	Internal	1.5
Actisand Big Bag Loader	≤ 80 dBA	1	Internal	1.5
Lamella Coagulation Tank Mixer	≤ 80 dBA	1	External	6.6 *
Lamella Flocculation Tank Mixer	≤ 80 dBA	1	External	6.6 *
Lamella Thickener Scraper	≤ 80 dBA	1	External	6.6 *
Lamella Sludge Pump	≤ 80 dBA	2	External	1.0
Sludge Balancing Tank Mixing Pump	72 dBA (+/- 2 dBA)	1	External	1.0
Centrifuge Feed Pump	≤ 80 dBA	2	External	1.0
Centrifuge	≤ 80 dBA (+/- 2 dBA)	1	Internal	2.5
Polymer Makeup Kit	≤ 72 dBA	2	Internal	1.5

TABLE 6.1: WATER TREATMENT PLANT REFERENCE SOURCE-TERM LEVELS

*Note: * indicates a noise source positioned above a structure. for each of these, the noise source is assumed 0.5m above the top of the structure.*

6.3.2 To consider a worse case operating scenario for sound assessment purposes, it has been assumed that each item of plant will operate continuously at full capacity during the day and night-time assessment periods.

6.3.3 Where a plant sound pressure level has been specified as "≤", the highest value has been assumed as a worse case. In addition, where a "+/-" range has been specified, the maximum potential difference has been applied to the stated value, again to present a worse-case scenario.

6.3.4 Frequency data from Southdowns' database of water treatment plant sound levels have been used to derive 1/3 octave band frequency spectrum for each item of plant onsite. These 1/3 octave band spectra are presented in Table B4 of Appendix B.

Internal Noise Sources

6.3.5 All internal noise sources have been modelled within a single structure, which covers the northern half of the area to be developed, as shown on Figure A2 of Appendix A.

6.3.6 This structure has been included in the SoundPLAN model. Transmission losses of the facades have been derived from published data for specific materials following analysis of the elevation plans provided. The materials assumed in the model are concrete floor; brick walls up to 1.12m; and KS1000 cladding on the remainder of the walls and roof. Assumed transmission losses and absorption coefficient values for these materials are presented in Tables B5 and B6 of Appendix B, respectively.

7. SOUND ASSESSMENT

7.1 Assessment Receptors

7.1.1 The calculation receptors identified for this assessment are listed below in Table 7.1 and shown in Figure A7 of Appendix A.

Receptor ID	Receptor Address	Type
R1	Warrengate Road (I)	Residential
R2	Warrengate Road (II)	Residential
R3	Abdale Lane	Residential
R4	No. 71 Waterworks House (East)	Residential
R5	No. 73 Waterworks House (West)	Residential

TABLE 7.1: RECEPTOR LOCATIONS

7.2 BS 4142 Assessment

7.2.1 The method for predicting the significance of sound of an industrial and/or commercial nature in accordance with the principles of BS 4142:2014 is based on a comparison of the plant's Rating Level ($L_{Ar,T}$) with the background $L_{A90,T}$ assessment sound level at a residential receptor location.

<u>Background Sound Levels</u>

7.2.2 The $L_{A90,T}$ background sound level is the sound level exceeded for 90 % of the time in the absence of any sound from the specific source of interest. Background $L_{A90,T}$ sound levels presented in Table 5.3 have been used for assessing the WTW plant sound levels.

<u>Rating Levels</u>

7.2.3 Section 9 of BS 4142 refers to the application of acoustic feature corrections to take into consideration the presence of any tonality, impulsivity, intermittency and/or any other distinguishable characteristics that are present in the specific sound's character at the assessment location. The resulting sound level is called the rating level, $L_{Ar,T}$ and is used for means of assessing the specific sound.

7.2.4 Analysis of the model output shows that the new sources are not expected to be tonal and due to the nature of operation will not be intermittent or impulsive. An acoustic correction of +3 dB has been applied to the specific predicted sound levels in order to account for the potential presence of sound characteristics which are not represented by tonality, impulsivity or intermittency.

<u>BS 4142 Assessment</u>

7.2.5 The predicted WTW plant rating levels at the receptor locations are presented in Tables 7.2 and 7.3 for the daytime and night-time periods, respectively.

Rep. ID	Address	Faç.	WTW Plant Sound Level, dB $L_{Aeq,1hr}$ [1]	WTW Rating Level, dB $L_{Ar,1hr}$	Background Sound Assessment Level, dB $L_{A90,1hr}$	Level Difference (Rating Level minus Background)
R1	Warrengate Road	NE	36	39	49	-10
R2	Warrengate Road	NE	33	36	49	-13
R3	Abdale Lane	E	32	35	49	-14
R4	No. 71 Warrengate Road	E	45	48	46	+2
R5	No. 73 Warrengate Road	N	42	45	46	-1

TABLE 7.2: DAYTIME BS 4142 SOUND ASSESSMENT

Rep. ID	Address	Faç.	WTW Plant Sound Level, dB $L_{Aeq,15min}$ [1]	WTW Rating Level, dB $L_{Ar,15min}$	Background Sound Assessment Level, dB $L_{A90,15min}$	Level Difference (Rating Level minus Background)
R1	Warrengate Road	NE	36	39	44	-5
R2	Warrengate Road	NE	33	36	44	-8
R3	Abdale Lane	E	32	35	44	-9
R4	No. 71 Warrengate Road	E	45	48	41	+7
R5	No. 73 Warrengate Road	N	42	45	41	+4

TABLE 7.3: NIGHT-TIME BS 4142 SOUND ASSESSMENT

7.2.6 According to BS 4142, where the Rating Level does not exceed the background sound level then this provides an indication of a specific sound source having a low sound impact, depending on the context. As such, it is considered that at R1 to R3 sound levels from the operation of the new WTW plant are expected to be of low impact. However, rating levels at R4 and R5 are expected to be above the background sound level and therefore, an adverse impact is possible.

7.2.7 WHBC's criterion requires operational sound levels ($L_{Aeq,T}$) to be at least 10 dB below the existing background $L_{A90,T}$ sound levels. Tables 7.4 and 7.5 below compare predicted operational sound levels to the background levels in order to assess against this criteria.

Rep. ID	Address	Faç.	WTW Plant Sound Level, dB $L_{Aeq,1hr}$ [1]	Background Sound Assessment Level, dB $L_{A90,1hr}$	Level Difference (Sound Level minus Background)	WHBC Noise Criteria Achieved?
R1	Warrengate Road	NE	36	49	-13	✔
R2	Warrengate Road	NE	33	49	-16	✔
R3	Abdale Lane	E	32	49	-17	✔
R4	No. 71 Warrengate Road	E	45	46	-1	✕
R5	No. 73 Warrengate Road	N	42	46	-4	✕

TABLE 7.4: DAYTIME LOCAL AUTHORITY CRITERION ASSESSMENT

Rec. ID	Address	Faç.	WTW Plant Sound Level, dB $L_{Aeq,15min}$ [1]	Background Sound Assessment Level, dB $L_{A90,15min}$	Level Difference (Sound Level minus Background)	WHBC Sound Criteria Achieved?
R1	Warrengate Road	NE	36	44	-9	✕
R2	Warrengate Road	NE	33	44	-11	✔
R3	Abdale Lane	E	32	44	-12	✔
R4	No. 71 Warrengate Road	N	45	41	+4	✕
R5	No. 73 Warrengate Road	N	42	41	+1	✕

TABLE 7.5: NIGHT-TIME LOCAL AUTHORITY CRITERION ASSESSMENT

7.2.8 The results of the daytime assessment show a level difference of -1 dB is predicted at R4 - No. 71 Warrengate Road, with a level difference of -4 dB predicted at R5 – No. 73 Warrengate Road. At the other receptors the WTW plant sound levels are predicted to fall 10 dB or more below the background sound assessment level.

7.2.9 The results of the night-time assessment show a level difference of +4 dB at R4 - 71 Warrengate Road and a level difference of +1 dB at R5 - 73 Warrengate Road. At the other receptors the WTW plant sound levels are predicted to fall between -9 and -12 dB below the background sound levels.

7.2.10 WHBC's noise criterion of 10 dB below the background sound level is therefore predicted to be exceeded by up to 9 dB during the daytime assessment period and by up to 14 dB during the night-time assessment period.

<u>Context</u>

7.2.11 When considering the significance of an impact BS 4142 advises that the context of the impact should be taken into account. The context of the impact should consider factors such as: the absolute level of sound; the character and level of the residual sound compared to the character and level of the specific sound; 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.

7.2.12 The results of the sound measurements indicate that during daytime periods, the ambient sound levels averaged 50 dB $L_{Aeq,16hr}$. The predicted operational sound levels are at least 5 dB below this pre-existing ambient sound level.

7.2.13 During night-time periods the ambient sound levels averaged 48 dB $L_{Aeq,8hr}$. The calculated WTW plant specific $L_{Aeq,T}$ sound levels of 32 to 45 dB are below the average night-time ambient sound level by at least 3 dB.

Internal Noise Levels

7.2.14 In order to provide further context, calculations have been undertaken to predict the level of new WTW plant noise levels within habitable rooms of the nearby sensitive receptors.

7.2.15 In order to predict the internal levels, standard façade reductions have been applied to the calculated model results. BS 8233:2014 [10] Guidance on Sound Insulation and Noise Reduction for Buildings indicates that where window glazing and/or trickle ventilators are considered to be the weakest façade element, an approximate insulation of 33 dB R_w may be assumed for insulating glass units, assuming suitable sound attenuating trickle ventilators are used. If partially open windows are relied upon to provide background ventilation, then any insulation would be reduced to approximately 15 dB.

7.2.16 Internal noise levels due to the operation of the new WTW plant have been estimated inside habitable rooms of nearby sensitive receptors and are presented below in Table 7.4.

Receptor ID	Address	Façade	Plant Noise Level, dB $L_{Aeq,T}$	Predicted Internal Noise Level, dB $L_{Aeq,T}$	
				Window Open	Window Closed
R1	Warrengate Road (I)	NE	36	21	<20
R2	Warrengate Road (II)	SE	33	<20	<20
R3	Abdale Lane	E	32	<20	<20
R4	Waterworks House (East)	E	45	30	<20
R5	Waterworks House (West)	N	42	27	<20

TABLE 7.6: PREDICTED INTERNAL RECEPTOR NOISE LEVELS DUE TO NEW WTW PLANT

7.2.17 The results in Table 7.6 indicate that internal noise levels at receptors R1 to R3 are expected to be below 25 dB $L_{Aeq,T}$ and are therefore considered to be of low significance. Internal noise levels with windows open are calculated to be 30 dB $L_{Aeq,T}$ at R4 and 27 dB $L_{Aeq,T}$ at R5. It is likely that this level of specific WTW noise will be audible during night-time with windows open and, when combined with the existing ambient noise levels, will exceed the internal noise guidelines specified in BS 8233.

7.3 Mitigation

7.3.1 Options to mitigate the WTW plant sound onsite include the installation of acoustic enclosures and/or localised screening around the items of new plant that are to be housed external to the enclosure.

7.3.2 Analysis of the model results shows that breakout sound from the sources housed within the enclosure is negligible when compared to the levels generated by the external sources.

7.3.3 The dominant new sound sources are primarily located at height and include the following:

- 2 no. contact tank mixers;
- coagulation tank mixer;
- flocculation tank mixer;
- lamella coagulation tank mixer;
- lamella flocculation tank mixer; and
- lamella thickener scraper.

7.3.4 A method to reduce the impact from these items of plant would be to install 2 no. noise barriers along the eastern edge of the top of the tanks, in the position where a hand rail is proposed, as indicated in the plan view on Figure A8 of Appendix A and in the elevation view on Figure A9 of Appendix A.

Mitigation Assessment

7.3.5 Two 2m noise barriers as described above have been included in the sound propagation model with the resulting sound levels summarised below in Tables 7.5 and 7.6 for the daytime and night-time periods, respectively.

Rep. ID	Address	Faç.	WTW Plant Sound Level, dB $L_{Aeq,1hr}$ [1]	Background Sound Assessment Level, dB $L_{A90,1hr}$	Level Difference (Sound Level minus Background)	WHBC Noise Criteria Achieved?
R1	Warrengate Road	NE	29	49	-20	✔
R2	Warrengate Road	NE	26	49	-23	✔
R3	Abdale Lane	E	25	49	-24	✔
R4	No. 71 Warrengate Road	E	35	46	-11	✔
R5	No. 73 Warrengate Road	N	33	46	-13	✔

TABLE 7.7: MITIGATED DAYTIME BS 4142 SOUND ASSESSMENT

Rec. ID	Address	Faç.	WTW Plant Sound Level, dB $L_{Aeq,15min}$ [1]	Background Sound Assessment Level, dB $L_{A90,15min}$	Level Difference (Sound Level minus Background)	WHBC Noise Criteria Achieved?
R1	Warrengate Road	NE	29	44	-15	✔
R2	Warrengate Road	NE	26	44	-18	✔
R3	Abdale Lane	E	25	44	-19	✔
R4	No. 71 Warrengate Road	N	35	41	-6	✕
R5	No. 73 Warrengate Road	N	33	41	-8	✕

TABLE 7.8: MITIGATED NIGHT-TIME BS 4142 NOISE ASSESSMENT

7.3.6 The results of the mitigated daytime assessment show that the WTW plant sound levels are predicted to fall 10 dB or more below the background assessment level.

7.3.7 The results of the night-time assessment show a level difference of -6 dB at R4 - 71 Warrengate Road and a level difference of -8 dB at R5 - 73 Warrengate Road. At the other receptors the WTW plant noise levels are predicted to fall 10 dB or more below the background noise assessment level.

7.3.8 WHBC's noise criterion of 10 dB below the background noise level is therefore achieved during daytime periods. However, the criterion is still predicted to be exceeded by up to 4 dB during the night-time assessment period following the installation of the recommended noise barriers.

Context

7.3.9 The predicted daytime mitigated operational sound levels are at least 15 dB below the pre-existing measured ambient sound level of 50 dB $L_{Aeq,16hr}$. In addition, the night-time mitigated operational sound levels are at least 13 dB below the pre-existing measured ambient sound level of 48 dB $L_{Aeq,8hr}$.

Mitigated Internal Noise Levels

7.3.10 Internal noise levels due to the operation of the new WTW plant, assuming the inclusion of the 2m noise barriers, have been estimated inside habitable rooms of nearby sensitive receptors and are presented below in Table 7.9.

Receptor ID	Address	Façade	Plant Noise Level, dB $L_{Aeq,15min}$	Predicted Internal Noise Level, dB $L_{Aeq,T}$	
				Window Open	Window Closed
R1	Warrengate Road (I)	NE	29	<20	<20
R2	Warrengate Road (II)	SE	26	<20	<20
R3	Abdale Lane	E	25	<20	<20
R4	Waterworks House (East)	E	35	<20	<20
R5	Waterworks House (West)	N	33	<20	<20

TABLE 7.9: PREDICTED INTERNAL RECEPTOR NOISE LEVELS DUE TO NEW WTW PLANT – MITIGATED

7.3.11 The results in Table 7.9 indicate that, providing the noise barriers are installed as indicated, internal noise levels due to the operation of the new WTW plant are expected to be below 20 dB $L_{Aeq,T}$ within all sensitive receptors and are therefore considered to be of low significance.

Further mitigation

7.3.12 In order to achieve the Local Authority's criterion of 10 dB below the background sound level, it would be necessary to reduce the cumulative operational sound level to 31 dB $L_{Aeq,T}$, a reduction of 4 dB from the mitigated sound levels presented in Table 7.8 would be required.

7.3.13 Further analysis of the dominant items of plant has shown that it would be possible to reduce operational sound levels to 31 dB $L_{Aeq,T}$ by providing acoustic enclosures around the dominant 8 no. items of plant. In order to achieve this overall value, each enclosure will need to achieve a sound reduction of at least 10 dB. The items of plant that will require enclosures to achieve the target sound level are detailed below (items are listed in order of dominance at the closest receptor):

- Flocculation Tank Mixer;
- Coagulation Tank Mixer;
- Lamella Coagulation Tank ;
- Actiflo Recycle Pump no. 1;
- Actiflo Recycle Pump no. 2;
- Contact Tank Mixer no.1;
- Lamella Sludge Pump no. 2; and
- Contact Tank Mixer no.2.

7.3.14 As indicated above, providing enclosures around these items of plant reduces the calculated operational sound levels to below the Local Authority criterion. Alternatively, if the source level of the above items of plant could be reduced by 10 dB (to ≤ 70 dB(A) sound pressure level at 1m) through the selection of quieter plant, enclosures may not be required.

7.4 Uncertainty

7.4.1 Uncertainty in the measurements and calculations needs to be taken into account when assessing the validity of these conclusions. There is uncertainty regarding the specific sound sources, background sound level and calculations including:

- source heights have been assumed from inspection of site plans and vertical sections of items of plant;
- the reference noise data which has been used to model the new WTW has been based on estimated worse case noise levels made by the equipment supplier;
- the frequency energy in the WTW plant noise has been based on noise levels measured of similar WTW plant on other water treatment/supply sites; and
- rounding to integer values has been used in the derivation of the background sound levels and model calculations, to avoid an impression of precision to decimal places.

8. CONCLUSIONS

8.1.1 A noise assessment has been undertaken of the operation of proposed water treatment plant at North Mymms Water Treatment Works.

8.1.2 A baseline noise survey consisting of unattended and attended noise monitoring which was undertaken in 2016 in the vicinity of the WTW site and the results of this survey have been used to establish existing ambient ($L_{Aeq,T}$) and background ($L_{A90,T}$) noise levels outside the nearest residential receptors to the WTW site.

8.1.3 The main source of noise observed in the vicinity of the WTW site was road traffic on the A1 motorway. Noise from existing WTW plant was audible at the noise survey monitoring locations.

8.1.4 An assessment of the proposed new WTW plant has been undertaken using the principles of BS 4142:2014. Cumulative WTW plant emissions have been calculated and compared with day and night-time background sound assessment levels.

8.1.5 The results of the BS 4142 sound assessment indicate that unmitigated new WTW plant sound levels exceed the background level by up to 2 dB during the daytime assessment period and by up to 7 dB during the night-time assessment period.

8.1.6 Welwyn Hatfield Borough Council has specified a Condition that specific $L_{Aeq,T}$ noise levels from the new plant are required to be 10 dB or more below the current background level. A comparison between the specific new WTW plant sound level and the background level has shown that the Local Authority's criterion is calculated to be exceeded by up to 9 dB during the daytime assessment period and by up to 14 dB during the night-time assessment period.

8.1.7 Options to mitigate the WTW plant noise onsite include the installation of acoustic enclosures and/or localised screening around the plant. Calculations have been undertaken to investigate the effect of positioning 2m noise barriers close to the most dominant plant.

8.1.8 The results of the mitigation calculations, assuming 2m noise barriers only, have shown a compliance with the Local Authority's criterion during daytime operation and a reduced level during night-time, which exceeds the criterion by up to 4 dB.

8.1.9 Comparisons have shown that these predicted mitigated noise levels are at least 15 dB below the pre-existing daytime ambient $L_{Aeq,16hr}$ sound level and at least 13 dB below the pre-existing night-time ambient $L_{Aeq,8hr}$ sound level.

8.1.10 With the 2m barriers installed, noise levels inside sensitive receptors due to the operation of the new plant are expected to fall below 20 dB $L_{Aeq,T}$, whether windows are open or closed and are therefore considered to be of low significance.

8.1.11 Further mitigation has been considered in the form of enclosures around the remaining dominant plant, following the inclusion of the 2m noise barrier. The combination of these mitigation measures is expected to reduce operational plant noise levels to at least 10 dB below the background level, and therefore comply with the Local Authority's criterion.

8.1.12 It is recommended that further calculations are undertaken once more concise source term data is available. This will enable the determination of both noise barriers and acoustic enclosures are required in order to comply with the Local Authority's day and night-time criteria. This will also enable the tailoring of specific mitigation measures to the dominant items of plant.

9. REFERENCES

1. British Standards Institution (BSI). BS 4142:2014 Methods for rating and assessing industrial and commercial sound. 2014.

2. Welwyn Hatfield Borough Council. Notice of Decision: Application no. 6/2015/2528/OUTLINE. April 2016.

3. Department for Environment, Food and Rural Affairs (DEFRA). Noise Policy Statement for England (NPSE). March 2010.

4. Department of Communities and Local Government. National Planning Policy Framework. March 2012.

5. Department of Communities and Local Government. National Planning Policy Framework. July 2018.

6. Department for Environment, Food and Rural Affairs (DEFRA). Planning Practice Guidance – Noise. 2014.

7. Welwyn Hatfield Borough Council. Welwyn Hatfield District Plan. 2005.

8. Southdowns Environmental Consultant Ltd. North Mymms Water Treatment Works, Hertfordshire. BS 4142 Noise Assessment. April 2016.

9. International Organization for Standardisation. ISO 9613 Attenuation of Sound during Propagation Outdoors: Part 2. 1996.

10. British Standards Institution. BS 8233:2014: Guidance on Sound Insulation and Noise Reduction for Buildings. 2014.

APPENDIX A: FIGURES

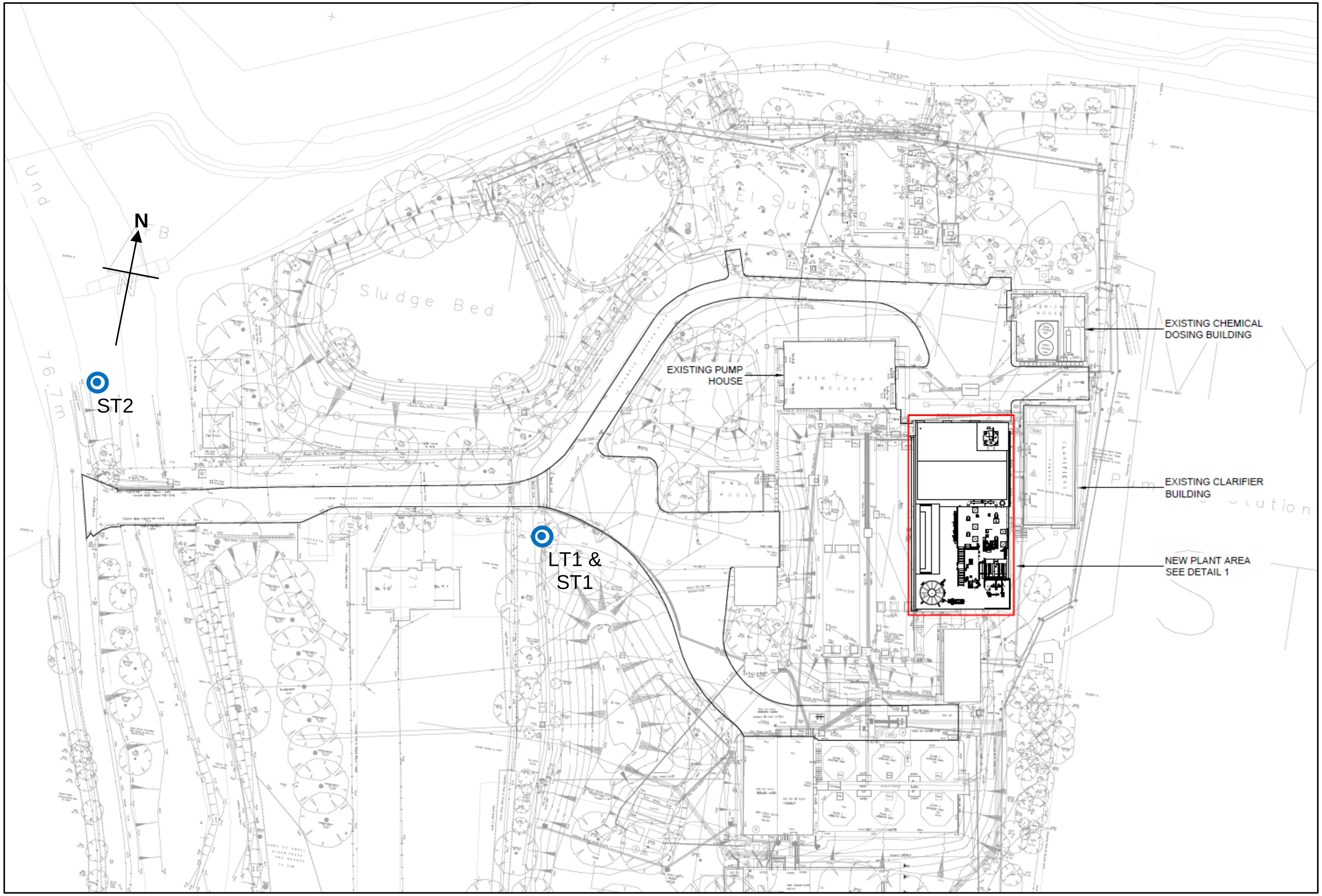


FIGURE A1: NORTH MYMMS WTW SITE LAYOUT AND BASELINE NOISE MONITORING LOCATIONS

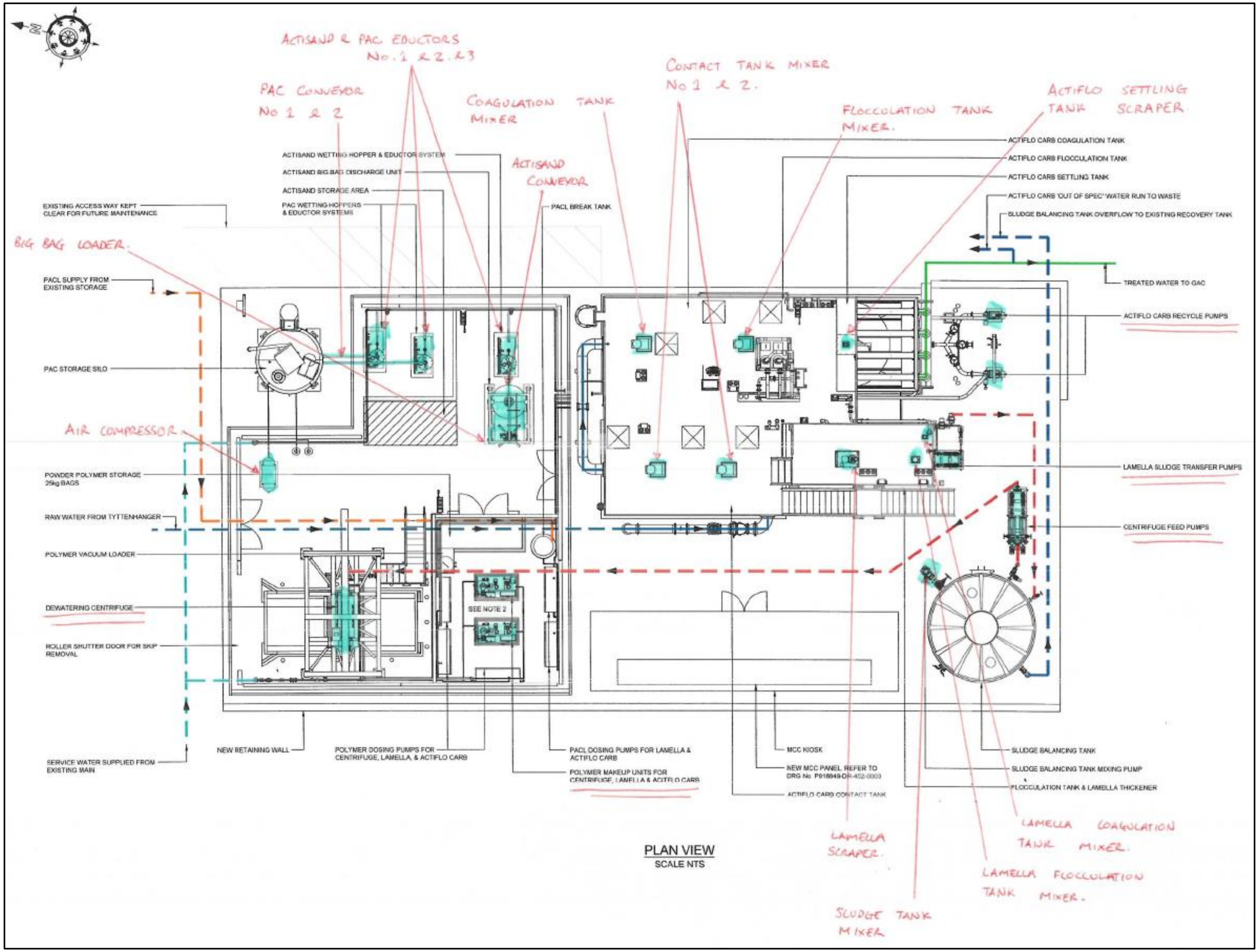


FIGURE A2: NORTH MYMMS METALDEHYDE REMOVAL PLANT – PROPOSED SITE LAYOUT

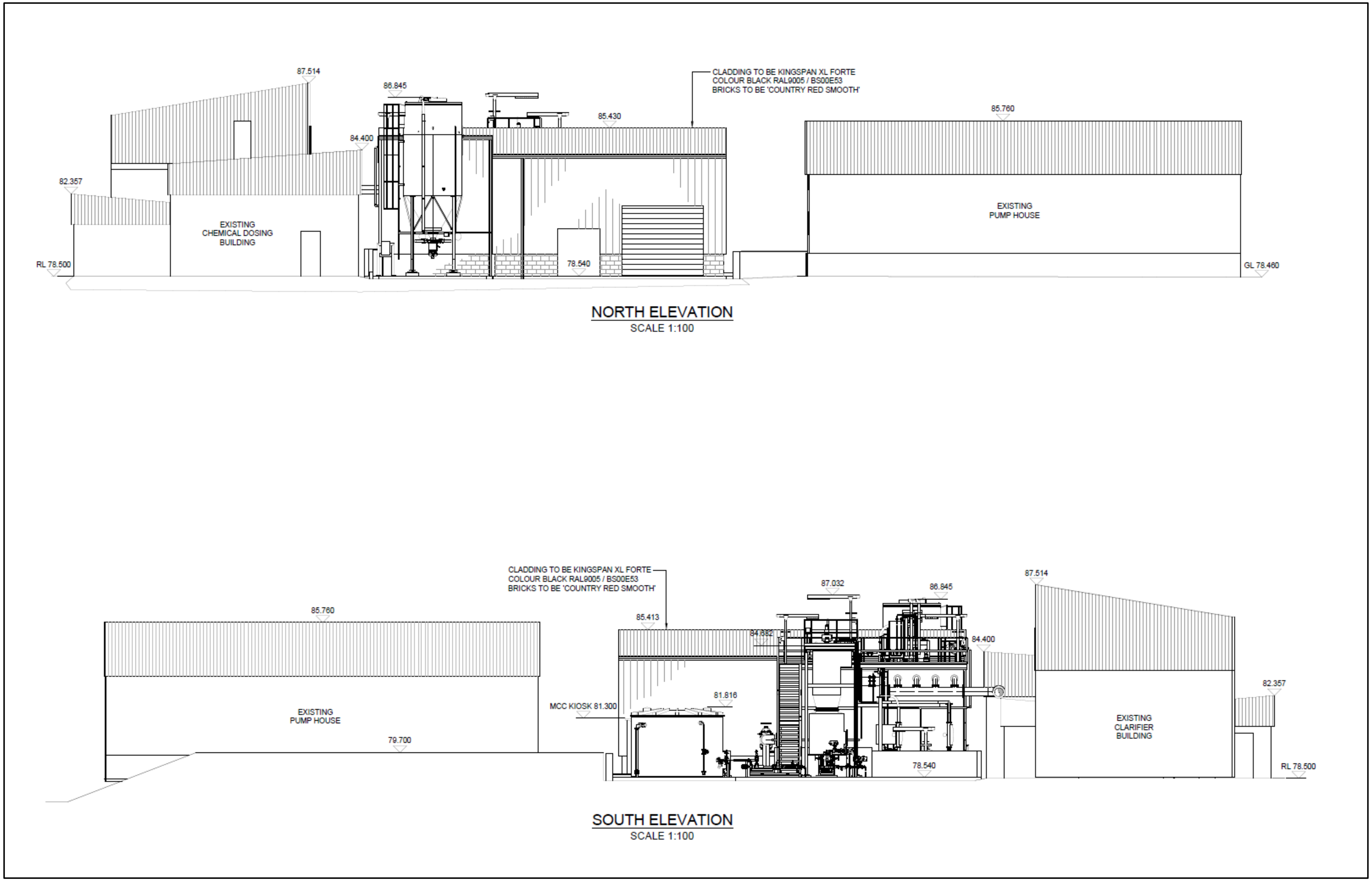
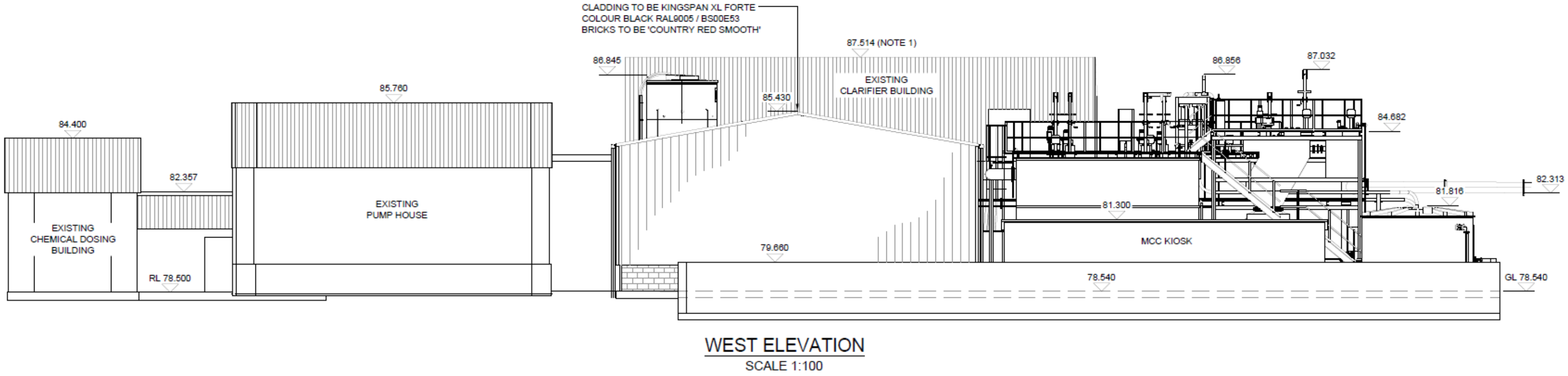


FIGURE A3: NORTH/SOUTH ELEVATIONS OF METALDEHYDE REMOVAL PLANT AND ENCLOSURE



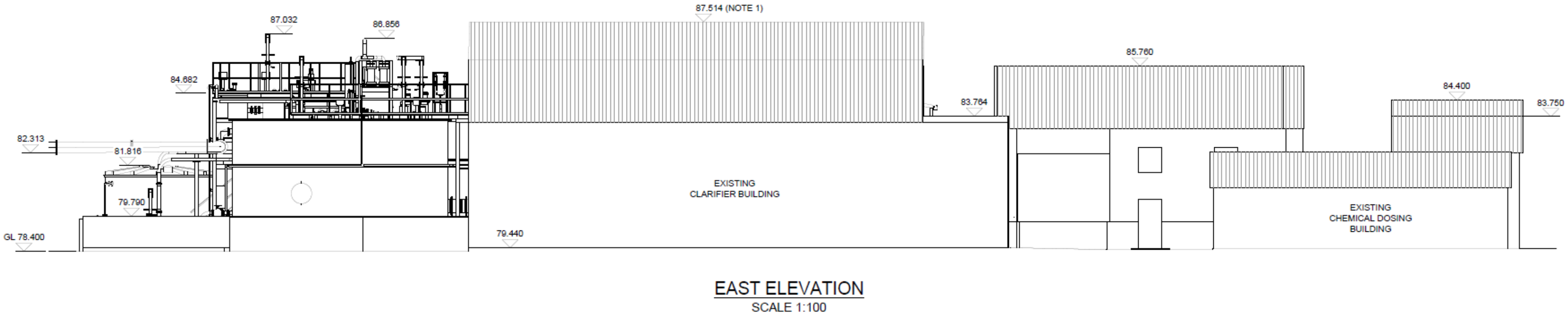


FIGURE A4: EAST/WEST ELEVATIONS OF METALDEHYDE REMOVAL PLANT AND ENCLOSURE

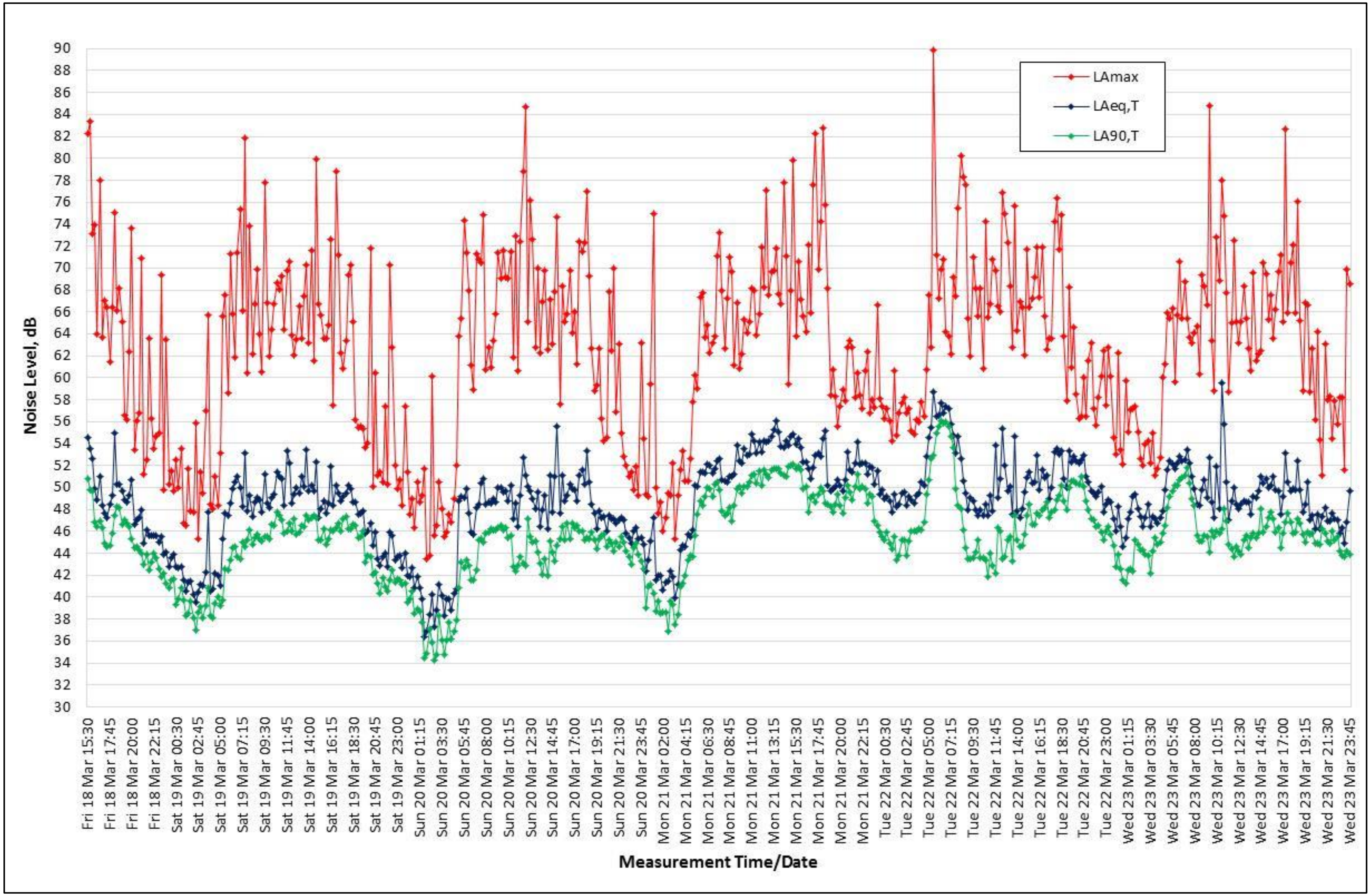


FIGURE A5: UNATTENDED SOUND MONITORING RESULTS AT LT1 (GARDEN OF NO. 71 WARRENGATE ROAD)

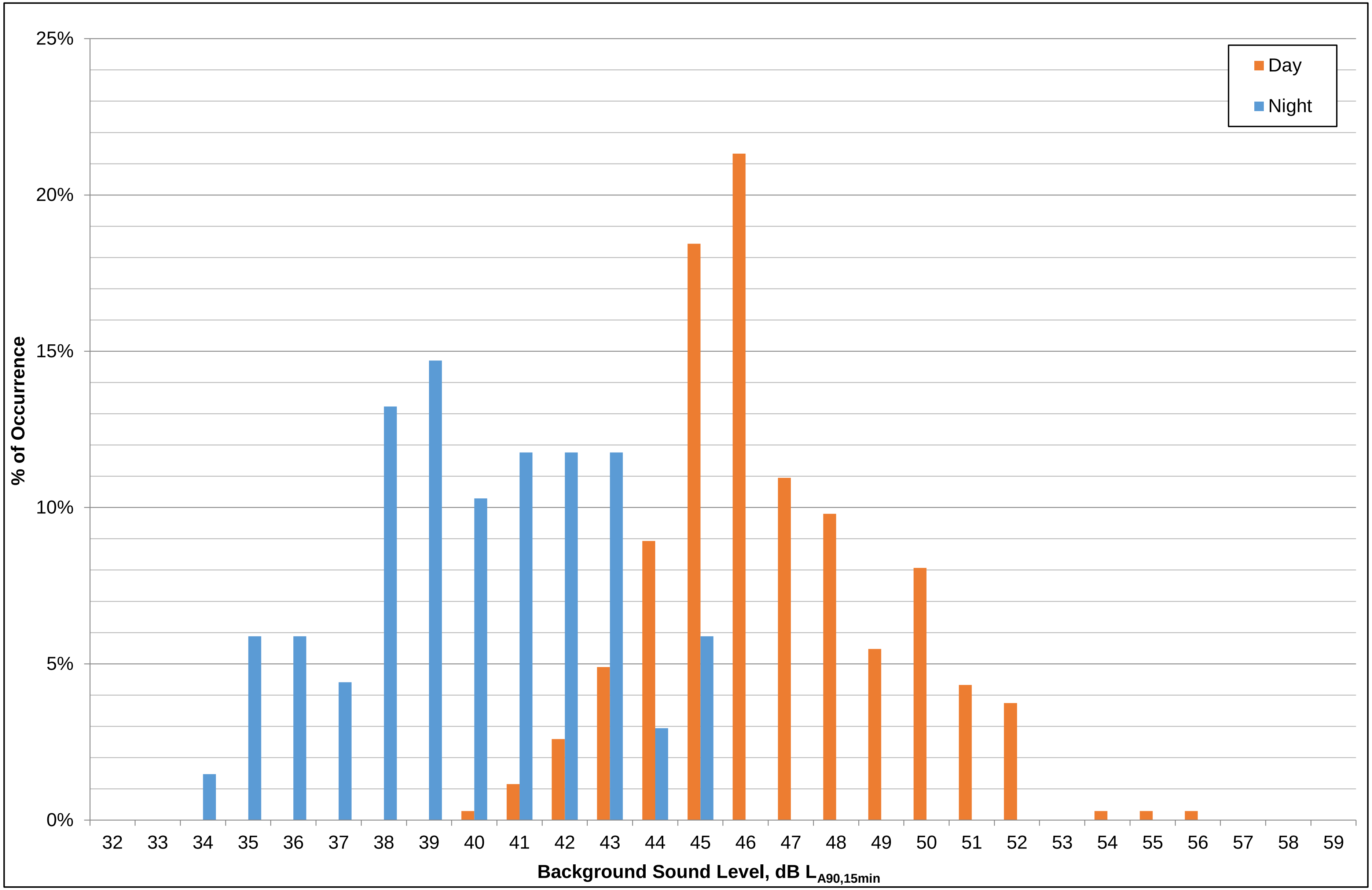


FIGURE A6: STATISTICAL ANALYSIS OF BACKGROUND $L_{A90,15MIN}$ SOUND LEVELS MEASURED AT LT1

FIGURE A7: NORTH MYMMS WTW CALCULATION RECEPTOR LOCATIONS

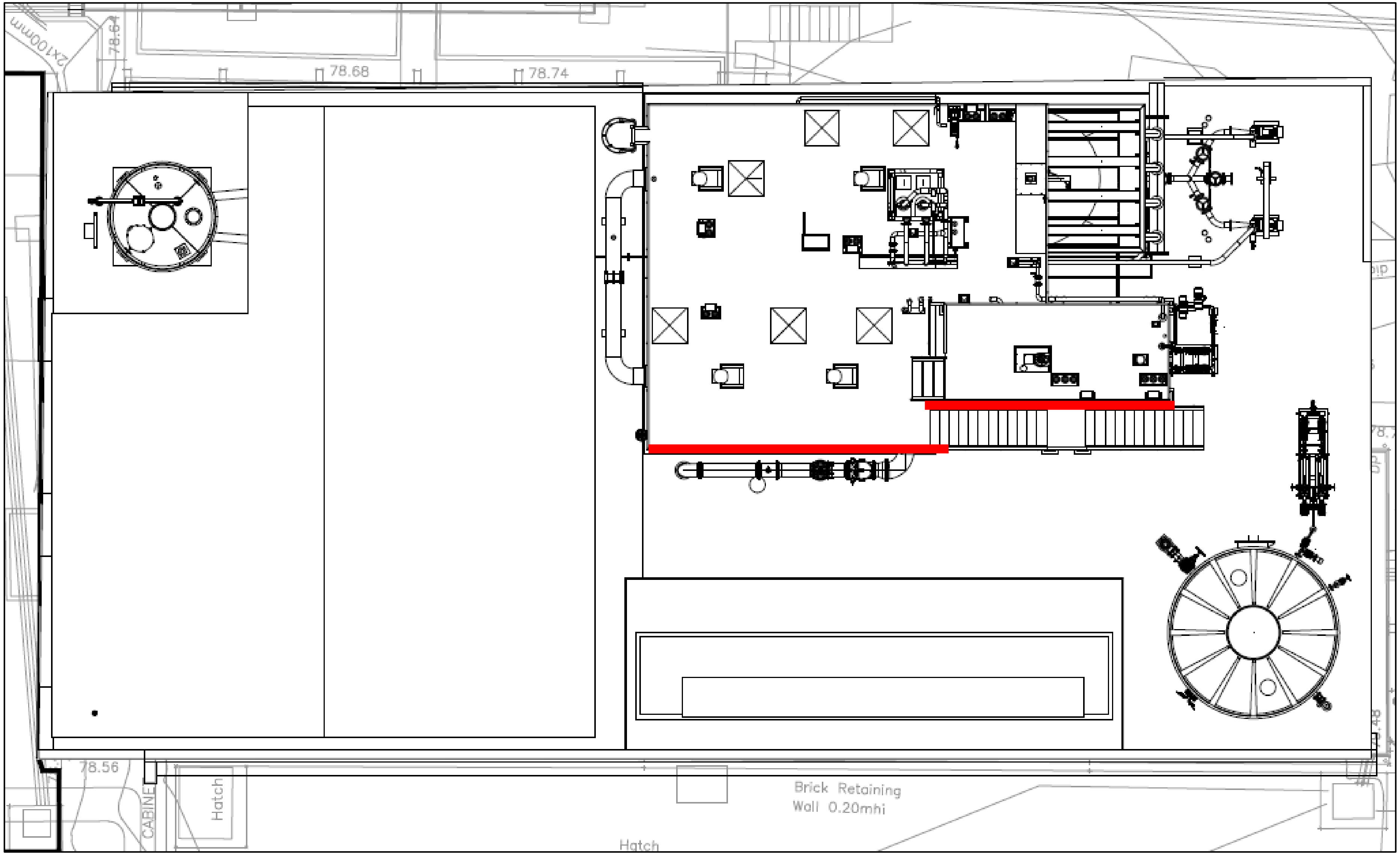


FIGURE A8: RECOMMENDED LOCATION OF 2M HIGH NOISE BARRIER

<u>Note:</u> Red line indicates location of recommended noise barrier (on top of mixer units).

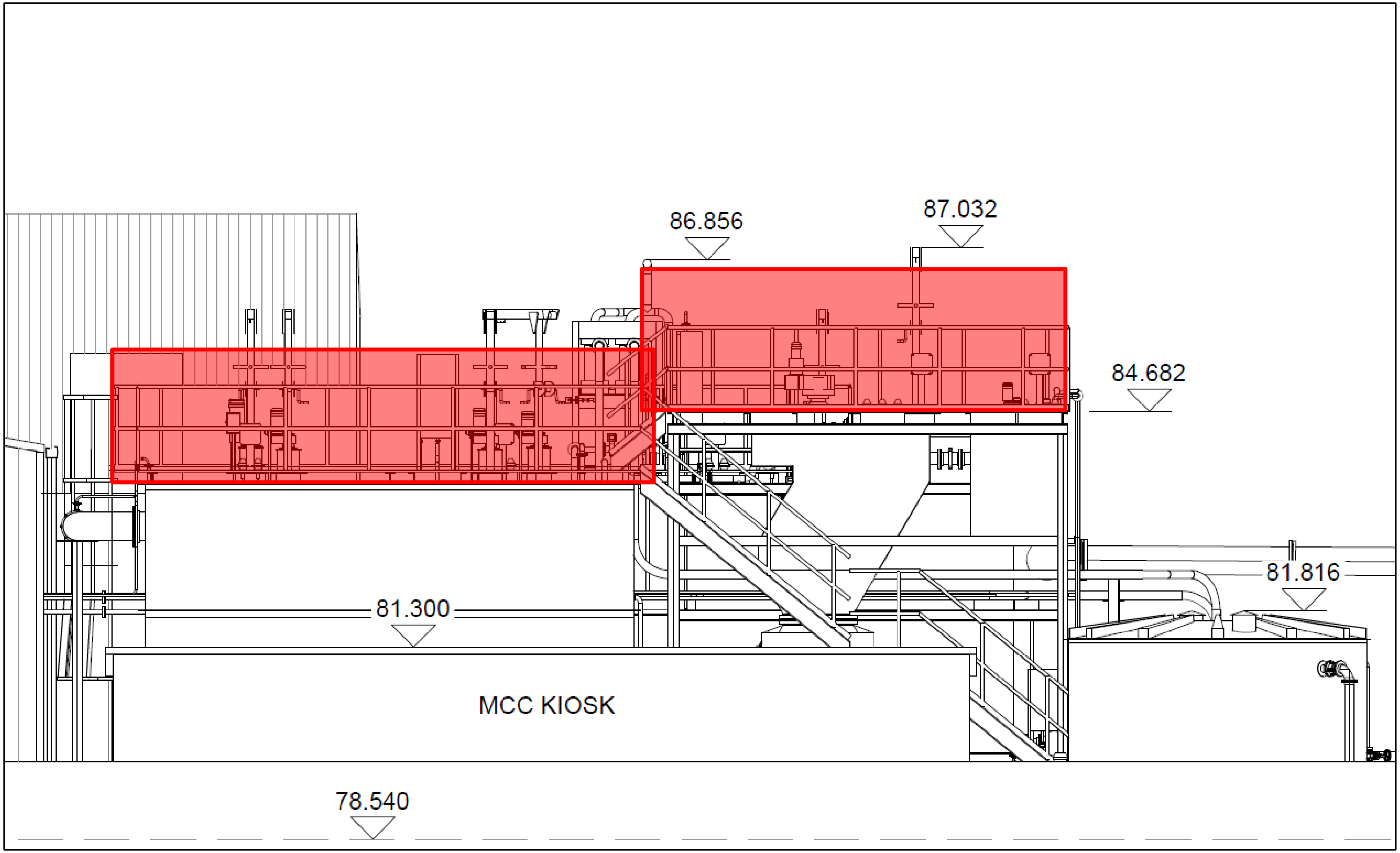


FIGURE A9: ELEVATION DRAWING INDICATING LOCATION OF RECOMMENDED 2M NOISE BARRIER

Note: Red area indicates location of recommended noise barrier.

APPENDIX B: TABLES

Day	Date	Temperature (°C)			Humidity (%)			Wind Speed (ms^{-1})		Precipitation (mm)
		Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Max.	Total
Friday	18-Mar-16	3	-1	7	83	70	100	2	6	0.0
Saturday	19-Mar-16	7	5	9	71	62	81	4	6	0.0
Sunday	20-Mar-16	8	3	12	72	50	87	3	5	0.0
Monday	21-Mar-16	6	1	10	83	62	100	3	6	0.0
Tuesday	22-Mar-16	6	3	9	78	66	93	2	4	0.0
Wednesday	23-Mar-16	6	3	8	77	71	87	2	4	0.0

TABLE B1: WEATHER RECORD OBTAINED FOR SURVEY PERIOD FROM AN INTERNET SOURCE

Note: Meteorological data obtained from www.wunderground.com.

Monitoring Location	Start Time	Dur. (mins)	Measured Sound Levels, dB re. 2 x 10^{-5} Pa.				Comments
			$L_{Amax,F}$	$L_{A10,T}$	$L_{Aeq,T}$	$L_{A90,T}$	e.g. Main Sources, Maximum Levels and No. of Events
ST1	00:02	5	63.9	45.8	44.6	42.8	Road traffic from A1 42-46 dB(A). Sheep bleating 43-45 dB(A). Pump chamber audible below traffic
	00:07	5	56.6	47.5	46.2	44.2	Road traffic from A1 42-46 dB(A). Sheep bleating 43-45 dB(A). Pump chamber audible below traffic
	00:12	5	49.9	46.7	44.8	42.8	Road traffic from A1 42-46 dB(A). Sheep bleating 43-45 dB(A). Pump chamber audible below traffic
		Cumul.	*63.9*	*46.7*	*45.3*	*43.3*	
ST2	00:27	5	55.8	47.1	45.7	43.8	Road traffic from A1 44-47 dB(A). Running water from Mimmshall Brooke 42-45 dB(A).
	00:32	5	55.5	46.5	45.5	44.2	Road traffic from A1 43-46 dB(A). Mimmshall Brook 42-44 dB(A).
	00:37	5	49.0	47.2	46.1	44.7	Road traffic from A1 43-47 dB(A). Mimmshall Brook 42-45 dB(A).
		Cumul.	*55.8*	*46.9*	*45.8*	*44.2*	
ST1	01:35	5	60.5	44.4	42.6	40.1	Road traffic from A1 40-44 dB(A). Pump chamber ~40 dB(A).
	01:40	5	45.8	43.8	42.5	40.5	Road traffic from A1 40-44 dB(A). Pump chamber 38-39 dB(A).
	01:45	5	47.9	44.7	42.8	40.9	Road traffic from A1 40-45 dB(A). Pump chamber 39 dB(A).
		Cumul.	60.5	44.3	42.6	40.5	
ST2	01:53	5	62.3	47.2	45.4	42.9	Road traffic from A1 42-46 dB(A). Mimmshall Brook 41-43 dB(A).
	01:58	5	49.2	46.7	45.3	43.7	Road traffic from A1 43-46 dB(A). Mimmshall Brook 42-43 dB(A).
	02:03	5	50.0	47.8	46.5	44.9	Road traffic from A1 43-47 dB(A). Mimmshall Brook 42-43 dB(A).
		Cumul.	*62.3*	*47.2*	*45.8*	*43.8*	
ST1	02:11	5	57.7	45.7	44.1	41.8	Road traffic from A1 42-46 dB(A). Pump chamber ~40 dB(A).
	02:16	5	47.9	44.2	42.2	39.8	Road traffic from A1 42-46 dB(A). Pump chamber 38-39 dB(A).
	02:21	5	48.8	45.3	43.3	40.9	Road traffic from A1 442-46 dB(A). Pump chamber 38-39 dB(A).
		Cumul.	57.7	45.1	43.3	40.8	
ST2	02:28	5	63.9	46.8	45.5	43.6	Road traffic from A1 43-47 dB(A). Mimmshall Brook 41-42 dB(A).
	02:33	5	48.8	47.1	45.7	44.2	Road traffic from A1 43-47 dB(A). Mimmshall Brook 41-42 dB(A).
	02:38	5	51.4	47.5	46.2	44.4	Road traffic from A1 43-47 dB(A). Mimmshall Brook 41-42 dB(A).
		Cumul.	*63.9*	*47.1*	*45.8*	*44.1*	

TABLE B2: ATTENDED SOUND SURVEY RESULTS, THURSDAY 24TH MARCH 2016

Date of Meas.	Start Time	Measured Sound Levels, dB re. 2 x 10^{-5} Pa.		
		$L_{Amax,F}$	$L_{Aeq,T}$	$L_{A90,T}$
Friday	15:30	82.3	54.6	50.8
18-Mar-16	15:45	83.4	53.5	49.8
	16:00	73.1	52.6	49.7
	16:15	73.9	49.9	46.8
	16:30	64.0	48.9	46.4
	16:45	78.0	51.0	46.9
	17:00	63.7	48.4	46.3
	17:15	67.0	47.7	44.9
	17:30	66.4	47.2	44.6
	17:45	61.5	48.5	44.7
	18:00	66.4	49.3	45.8
	18:15	75.1	55.0	47.5
	18:30	66.1	50.3	48.3
	18:45	68.2	50.3	48.2
	19:00	65.1	49.7	46.6
	19:15	56.6	48.9	47.0
	19:30	56.2	48.7	46.7
	19:45	62.4	49.3	46.4
	20:00	73.6	50.7	45.3
	20:15	53.4	46.6	44.5
	20:30	56.1	47.0	44.6
	20:45	56.8	47.2	44.3
	21:00	70.9	48.0	44.0
	21:15	51.2	44.9	43.0
	21:30	52.5	46.1	43.9
	21:45	63.6	45.6	42.5
	22:00	56.3	45.6	43.2
	22:15	53.5	45.6	44.0
	22:30	54.7	45.6	43.6
	22:45	55.0	45.0	42.6
	Arith. Average	*64.2*	*48.7*	*45.8*
	Log. Average	*73.1*	*49.7*	*46.3*
	Min. Value	*51.2*	*44.9*	*42.5*
	Max. Value	*83.4*	*55.0*	*50.8*

TABLE B3: UNATTENDED SOUND MONITORING RESULTS AT LT1

Date of Meas.	Start Time	Measured Sound Levels, dB re. 2 x 10^{-5} Pa.		
		$L_{Amax,F}$	$L_{Aeq,T}$	$L_{A90,T}$
Friday	23:00	69.4	45.5	41.9
18-Mar-16	23:15	49.8	43.9	42.2
	23:30	63.5	44.1	41.3
	23:45	50.3	42.8	40.9
Saturday	00:00	51.5	43.6	41.6
19-Mar-16	00:15	49.7	43.9	41.7
	00:30	52.5	42.8	39.3
	00:45	50.0	42.7	39.8
	01:00	53.5	42.8	40.9
	01:15	46.7	41.6	39.7
	01:30	46.5	40.5	38.3
	01:45	51.7	41.4	38.5
	02:00	47.9	41.5	39.6
	02:15	47.8	40.2	38.1
	02:30	55.9	39.5	37.0
	02:45	45.3	40.4	38.6
	03:00	51.4	41.2	39.1
	03:15	49.5	41.1	38.1
	03:30	57.0	42.3	39.2
	03:45	65.7	47.8	40.9
	04:00	48.5	40.5	38.3
	04:15	48.1	40.8	38.1
	04:30	51.0	42.2	39.4
	04:45	48.4	42.0	40.0
	05:00	53.1	41.1	39.2
	05:15	65.6	45.3	39.7
	05:30	67.5	47.7	42.6
	05:45	58.6	47.5	42.5
	06:00	71.3	48.6	43.4
	06:15	65.8	49.9	44.5
	06:30	61.9	50.5	44.6
	06:45	71.4	51.0	43.7
	Arith. Average	*55.2*	*43.6*	*40.4*
	Log. Average	*62.7*	*45.0*	*40.9*
	Min. Value	*45.3*	*39.5*	*37.0*
	Max. Value	*71.4*	*51.0*	*44.6*

TABLE B3(CTD): UNATTENDED SOUND MONITORING RESULTS AT LT1

Date of Meas.	Start Time	Measured Sound Levels, dB re. 2 x 10^{-5} Pa.		
		$L_{Amax,F}$	$L_{Aeq,T}$	$L_{A90,T}$
Saturday 19-Mar-16	07:00	75.4	50.0	43.5
	07:15	66.1	48.3	45.0
	07:30	81.9	53.1	44.6
	07:45	60.4	47.9	45.2
	08:00	73.8	49.3	46.1
	08:15	62.2	47.4	44.8
	08:30	66.7	48.7	45.4
	08:45	69.9	49.1	45.7
	09:00	64.0	48.9	45.3
	09:15	60.5	47.8	45.1
	09:30	77.8	51.2	45.5
	09:45	66.8	48.6	45.5
	10:00	62.0	48.2	45.3
	10:15	64.4	49.1	46.6
	10:30	66.7	49.4	46.5
	10:45	68.7	51.4	47.8
	11:00	68.1	51.0	47.5
	11:15	69.3	50.8	47.0
	11:30	64.4	48.4	45.8
	11:45	69.8	53.3	46.0
	12:00	70.6	52.2	46.7
	12:15	63.9	48.6	46.0
	12:30	62.1	49.4	47.1
	12:45	63.5	50.0	45.7
	13:00	66.5	49.5	45.9
	13:15	63.6	51.0	46.5
	13:30	67.4	50.1	46.4
	13:45	70.3	53.4	47.5
	14:00	63.2	49.7	47.0
	14:15	71.6	50.2	47.2
	14:30	61.6	49.7	47.5
	14:45	79.9	52.3	47.2
	15:00	66.7	47.2	45.2
	15:15	65.7	48.1	45.2
	15:30	63.6	48.8	46.2
	15:45	63.6	47.7	44.8
	16:00	64.8	48.6	45.3

TABLE B3(CTD): UNATTENDED SOUND MONITORING RESULTS AT LT1

Date of Meas.	Start Time	Measured Sound Levels, dB re. 2 x 10^{-5} Pa.		
		$L_{Amax,F}$	$L_{Aeq,T}$	$L_{A90,T}$
Saturday	16:15	72.6	51.9	46.1
19-Mar-16	16:30	57.5	48.4	46.0
	16:45	78.8	50.2	46.3
	17:00	71.2	49.5	46.7
	17:15	62.3	48.8	46.0
	17:30	60.8	49.2	47.1
	17:45	63.4	49.5	47.3
	18:00	69.4	50.2	46.2
	18:15	70.3	49.9	46.2
	18:30	65.1	48.7	46.6
	18:45	56.2	48.7	46.5
	19:00	55.5	47.6	45.4
	19:15	55.6	47.7	45.5
	19:30	55.4	47.9	46.0
	19:45	53.6	45.8	43.2
	20:00	54.0	46.0	43.8
	20:15	71.8	46.7	43.7
	20:30	50.1	44.7	42.1
	20:45	60.4	45.9	42.3
	21:00	51.1	43.5	41.3
	21:15	51.4	42.9	40.3
	21:30	50.5	43.7	41.8
	21:45	57.4	44.0	41.0
	22:00	50.3	42.8	40.6
	22:15	70.3	45.9	41.6
	22:30	62.8	45.6	42.5
	22:45	52.0	43.4	41.4
	Arith. Average	*64.3*	*48.6*	*45.2*
	Log. Average	*70.3*	*49.2*	*45.6*
	Min. Value	*50.1*	*42.8*	*40.3*
	Max. Value	*81.9*	*53.4*	*47.8*
	23:00	49.9	43.7	41.7
	23:15	50.7	43.8	41.6
	23:30	48.4	42.7	41.2
	23:45	57.4	44.0	41.3
Sunday	00:00	51.4	42.0	39.5
20-Mar-16	00:15	47.6	41.9	39.8

TABLE B3(CTD): UNATTENDED SOUND MONITORING RESULTS AT LT1

Date of Meas.	Start Time	Measured Sound Levels, dB re. 2 x 10^{-5} Pa.		
		$L_{Amax,F}$	$L_{Aeq,T}$	$L_{A90,T}$
Sunday 20-Mar-16	00:30	49.0	42.7	40.6
	00:45	46.3	40.9	38.5
	01:00	50.5	41.9	38.9
	01:15	48.7	40.9	38.7
	01:30	49.3	39.8	37.7
	01:45	51.7	36.4	34.5
	02:00	43.5	36.9	34.9
	02:15	43.8	38.4	37.1
	02:30	60.1	40.2	35.9
	02:45	45.6	37.3	34.3
	03:00	46.5	38.8	34.8
	03:15	50.5	41.2	38.3
	03:30	48.1	40.1	36.1
	03:45	45.5	38.3	34.8
	04:00	45.9	39.8	36.1
	04:15	47.6	39.8	37.7
	04:30	46.8	38.8	36.2
	04:45	49.0	40.3	36.9
	05:00	52.0	40.8	37.9
	05:15	63.8	48.8	40.9
	05:30	65.4	49.2	43.2
	05:45	74.3	49.1	42.7
	06:00	71.4	49.9	43.4
	06:15	68.0	47.7	42.9
	06:30	61.1	45.9	41.6
	06:45	58.9	45.7	41.6
	Arith. Average	*52.8*	*42.1*	*38.8*
	Log. Average	*62.6*	*43.9*	*39.7*
	Min. Value	*43.5*	*36.4*	*34.3*
	Max. Value	*74.3*	*49.9*	*43.4*
	07:00	71.3	48.2	42.5
	07:15	70.8	48.5	45.2
	07:30	70.5	50.4	45.3
	07:45	74.8	50.8	45.0
	08:00	60.7	48.5	45.8
	08:15	62.8	48.7	45.9

TABLE B3(CTD): UNATTENDED SOUND MONITORING RESULTS AT LT1

Date of Meas.	Start Time	Measured Sound Levels, dB re. 2 x 10^{-5} Pa.		
		$L_{Amax,F}$	$L_{Aeq,T}$	$L_{A90,T}$
Sunday 20-Mar-16	08:30	60.9	48.6	46.2
	08:45	63.4	49.0	46.1
	09:00	65.8	48.7	46.1
	09:15	71.4	50.0	46.3
	09:30	69.1	50.0	46.5
	09:45	71.6	49.6	46.1
	10:00	69.2	49.7	46.3
	10:15	69.1	48.8	45.4
	10:30	71.5	50.2	45.6
	10:45	61.9	47.1	42.8
	11:00	72.9	48.6	42.4
	11:15	60.6	46.4	42.9
	11:30	72.4	49.3	43.7
	11:45	78.8	52.7	43.1
	12:00	84.7	51.1	42.9
	12:15	65.1	50.1	47.1
	12:30	76.2	49.7	45.5
	12:45	72.6	49.0	45.0
	13:00	62.8	48.1	45.1
	13:15	70.0	49.6	44.1
	13:30	62.3	46.4	43.1
	13:45	66.9	48.0	42.1
	14:00	69.8	49.3	43.5
	14:15	62.6	46.2	42.0
	14:30	67.1	51.1	45.1
	14:45	63.1	47.8	44.1
	15:00	67.8	51.0	43.3
	15:15	74.6	55.6	44.7
	15:30	57.6	47.7	45.3
	15:45	68.4	51.1	46.4
	16:00	65.1	48.8	45.2
	16:15	65.8	49.3	46.7
	16:30	69.8	50.3	45.3
	16:45	64.1	49.9	46.7
	17:00	66.0	49.8	46.3
	17:15	61.3	48.8	46.5
	17:30	72.4	51.1	46.0

TABLE B3(CTD): UNATTENDED SOUND MONITORING RESULTS AT LT1

Date of Meas.	Start Time	Measured Sound Levels, dB re. 2 x 10^{-5} Pa.		
		$L_{Amax,F}$	$L_{Aeq,T}$	$L_{A90,T}$
Sunday 20-Mar-16	17:45	71.5	51.6	46.0
	18:00	72.3	50.3	45.2
	18:15	77.0	53.3	45.4
	18:30	69.3	50.5	45.3
	18:45	62.7	48.5	45.9
	19:00	58.8	47.7	45.2
	19:15	59.3	46.2	44.4
	19:30	62.7	47.9	45.3
	19:45	56.3	47.2	45.6
	20:00	54.2	47.4	45.7
	20:15	54.6	46.0	44.6
	20:30	67.8	47.5	45.2
	20:45	62.5	47.1	44.9
	21:00	70.0	47.1	44.2
	21:15	56.9	46.7	45.0
	21:30	63.1	47.0	44.6
	21:45	55.0	47.2	45.5
	22:00	52.8	47.0	45.0
	22:15	52.0	45.8	44.2
	22:30	51.0	45.4	43.7
	22:45	51.4	44.9	43.0
	Arith. Average	*65.7*	*48.8*	*44.9*
	Log. Average	*71.3*	*49.3*	*45.1*
	Min. Value	*51.0*	*44.9*	*42.0*
	Max. Value	*84.7*	*55.6*	*47.1*
	23:00	49.8	46.0	44.5
	23:15	51.9	46.3	44.9
	23:30	49.3	45.3	43.9
	23:45	63.2	45.4	43.3
Monday 21-Mar-16	00:00	54.5	44.8	42.6
	00:15	49.4	42.4	39.0
	00:30	49.2	43.4	41.0
	00:45	59.4	45.1	41.2
	01:00	75.0	47.2	40.3
	01:15	50.0	41.6	38.7
	01:30	47.7	42.0	39.6

TABLE B3(CTD): UNATTENDED SOUND MONITORING RESULTS AT LT1

Date of Meas.	Start Time	Measured Sound Levels, dB re. 2 x 10^{-5} Pa.		
		$L_{Amax,F}$	$L_{Aeq,T}$	$L_{A90,T}$
Monday 21-Mar-16	01:45	48.7	42.0	38.5
	02:00	46.0	40.7	38.6
	02:15	47.2	41.4	38.6
	02:30	49.5	41.5	36.9
	02:45	49.3	42.4	39.6
	03:00	52.2	41.9	39.3
	03:15	45.3	39.9	37.5
	03:30	49.3	41.2	38.4
	03:45	51.6	44.3	41.0
	04:00	53.3	44.7	41.3
	04:15	50.6	44.6	42.0
	04:30	50.6	45.7	43.4
	04:45	52.6	45.5	43.8
	05:00	57.8	46.1	43.7
	05:15	60.2	50.2	45.6
	05:30	59.0	50.1	47.6
	05:45	67.3	51.4	48.8
	06:00	67.7	51.4	48.4
	06:15	63.7	51.3	49.2
	06:30	64.8	52.1	50.0
	06:45	62.3	52.0	49.9
	Arith. Average	*54.6*	*45.3*	*42.5*
	Log. Average	*62.6*	*46.9*	*44.4*
	Min. Value	*45.3*	*39.9*	*36.9*
	Max. Value	*75.0*	*52.1*	*50.0*
	07:00	63.2	51.3	49.2
	07:15	63.8	51.7	50.3
	07:30	71.1	52.4	50.5
	07:45	73.2	52.6	49.8
	08:00	68.0	50.7	47.9
	08:15	62.7	50.6	47.5
	08:30	67.2	50.5	47.7
	08:45	71.0	51.0	48.2
	09:00	69.7	51.0	46.9
	09:15	61.1	51.2	48.4
	09:30	66.8	53.8	49.9

TABLE B3(CTD): UNATTENDED SOUND MONITORING RESULTS AT LT1

Date of Meas.	Start Time	Measured Sound Levels, dB re. 2 x 10^{-5} Pa.		
		$L_{Amax,F}$	$L_{Aeq,T}$	$L_{A90,T}$
Monday 21-Mar-16	09:45	60.8	52.4	50.1
	10:00	62.2	52.2	49.5
	10:15	65.3	53.5	50.1
	10:30	64.1	52.9	50.1
	10:45	65.1	53.0	50.5
	11:00	68.2	54.9	51.1
	11:15	68.0	54.3	51.2
	11:30	63.9	53.1	50.4
	11:45	65.8	54.1	51.5
	12:00	71.9	53.2	50.2
	12:15	68.3	54.3	51.6
	12:30	77.1	54.1	51.2
	12:45	67.5	54.2	50.9
	13:00	69.7	54.7	51.6
	13:15	69.8	55.3	51.7
	13:30	71.8	56.1	51.7
	13:45	67.6	55.1	51.7
	14:00	66.7	53.7	51.3
	14:15	77.8	53.6	51.1
	14:30	71.1	54.3	51.0
	14:45	59.4	53.8	51.9
	15:00	67.9	54.7	52.0
	15:15	79.8	54.9	52.1
	15:30	63.8	53.9	51.7
	15:45	70.6	54.5	51.9
	16:00	67.1	53.6	51.6
	16:15	65.6	52.3	49.9
	16:30	64.2	52.3	50.1
	16:45	72.1	51.7	47.8
	17:00	65.9	50.8	49.1
	17:15	77.6	51.8	49.3
	17:30	82.3	52.9	48.7
	17:45	69.9	53.1	49.4
	18:00	74.2	52.8	50.0
	18:15	82.8	54.5	49.7
	18:30	75.8	55.2	48.6
	18:45	68.2	50.2	48.5

TABLE B3(CTD): UNATTENDED SOUND MONITORING RESULTS AT LT1

Date of Meas.	Start Time	Measured Sound Levels, dB re. 2 x 10^{-5} Pa.		
		$L_{Amax,F}$	$L_{Aeq,T}$	$L_{A90,T}$
Monday 21-Mar-16	19:00	58.4	49.7	48.3
	19:15	60.7	49.9	47.8
	19:30	58.3	50.1	48.5
	19:45	55.6	50.7	49.4
	20:00	57.4	50.2	48.4
	20:15	58.9	49.7	47.7
	20:30	57.9	50.7	49.1
	20:45	62.8	53.2	50.2
	21:00	63.4	51.6	49.6
	21:15	62.8	51.4	48.9
	21:30	58.2	52.2	50.1
	21:45	60.4	54.1	51.2
	22:00	58.4	52.1	49.9
	22:15	57.2	52.2	50.1
	22:30	60.6	52.2	49.9
	22:45	62.4	51.2	48.6
	Arith. Average	*66.6*	*52.7*	*49.9*
	Log. Average	*71.8*	*53.0*	*50.1*
	Min. Value	*55.6*	*49.7*	*46.9*
	Max. Value	*82.8*	*56.1*	*52.1*
	23:00	56.8	51.9	49.4
	23:15	58.0	51.8	49.2
	23:30	57.3	50.3	46.9
	23:45	66.6	51.5	46.5
	00:00	58.1	49.4	45.9
	00:15	57.4	49.8	45.5
	00:30	56.3	49.0	45.2
	00:45	57.2	49.2	45.9
	01:00	56.1	48.8	44.9
	01:15	54.2	47.8	44.4
	01:30	60.6	49.4	45.5
	01:45	54.8	48.3	43.4
	02:00	56.8	48.5	43.8
	02:15	57.7	49.5	45.2
	02:30	58.2	49.6	45.2
	02:45	56.8	48.4	43.8

TABLE B3(CTD): UNATTENDED SOUND MONITORING RESULTS AT LT1

Date of Meas.	Start Time	Measured Sound Levels, dB re. 2 x 10^{-5} Pa.		
		$L_{Amax,F}$	$L_{Aeq,T}$	$L_{A90,T}$
Tuesday 22-Mar-16	03:00	57.2	49.2	45.1
	03:15	55.2	48.9	46.0
	03:30	54.9	48.6	46.0
	03:45	56.2	49.3	46.0
	04:00	56.0	49.5	46.2
	04:15	57.8	50.5	46.1
	04:30	56.5	50.2	46.8
	04:45	60.7	52.8	49.4
	05:00	67.5	54.6	50.7
	05:15	62.8	55.5	52.6
	05:30	89.9	58.7	52.9
	05:45	71.2	56.5	55.0
	06:00	67.2	56.6	55.6
	06:15	69.9	57.7	56.1
	06:30	70.8	56.8	55.9
	06:45	64.2	57.4	56.0
	Arith. Average	*60.7*	*51.4*	*48.0*
	Log. Average	*75.1*	*52.9*	*50.2*
	Min. Value	*54.2*	*47.8*	*43.4*
	Max. Value	*89.9*	*58.7*	*56.1*
	07:00	63.8	57.2	55.6
	07:15	62.2	55.8	54.7
	07:30	69.2	54.8	53.6
	07:45	67.4	53.1	49.9
	08:00	75.5	54.7	48.4
	08:15	80.2	52.6	48.1
	08:30	78.3	50.6	46.1
	08:45	77.6	49.5	44.5
	09:00	65.4	48.0	43.5
	09:15	62.0	49.1	43.5
	09:30	71.0	48.8	43.6
	09:45	68.2	48.0	44.1
	10:00	65.6	47.5	45.2
	10:15	68.2	48.0	43.6
	10:30	60.8	47.5	43.6
	10:45	74.2	48.5	43.4

TABLE B3(CTD): UNATTENDED SOUND MONITORING RESULTS AT LT1

Date of Meas.	Start Time	Measured Sound Levels, dB re. 2 x 10^{-5} Pa.		
		$L_{Amax,F}$	$L_{Aeq,T}$	$L_{A90,T}$
Tuesday 22-Mar-16	11:00	65.5	47.5	41.9
	11:15	66.7	49.3	44.0
	11:30	70.8	47.9	42.9
	11:45	69.8	53.8	42.2
	12:00	66.5	49.1	46.3
	12:15	66.0	50.8	46.0
	12:30	76.9	55.4	43.5
	12:45	75.0	52.0	43.7
	13:00	72.3	49.7	45.2
	13:15	68.4	50.1	45.5
	13:30	62.8	47.6	43.3
	13:45	75.7	54.7	47.5
	14:00	64.3	47.9	45.2
	14:15	66.9	47.2	44.6
	14:30	66.4	48.1	44.7
	14:45	62.1	49.6	45.7
	15:00	71.7	50.9	47.5
	15:15	66.4	51.4	48.5
	15:30	67.2	50.4	46.6
	15:45	69.2	50.5	46.6
	16:00	71.9	52.9	47.7
	16:15	67.3	49.8	47.5
	16:30	71.9	51.6	48.0
	16:45	65.6	50.9	48.2
	17:00	62.6	51.1	48.7
	17:15	63.6	49.0	47.2
	17:30	63.6	50.0	47.8
	17:45	74.2	53.2	48.0
	18:00	76.4	53.5	48.9
	18:15	71.7	53.0	49.3
	18:30	74.8	53.3	50.2
	18:45	63.8	50.8	48.8
	19:00	57.9	50.0	48.0
	19:15	68.3	53.3	50.0
	19:30	60.9	52.3	50.6
	19:45	64.6	52.8	50.6
	20:00	58.5	52.4	50.4

TABLE B3(CTD): UNATTENDED SOUND MONITORING RESULTS AT LT1

Date of Meas.	Start Time	Measured Sound Levels, dB re. 2 x 10^{-5} Pa.		
		$L_{Amax,F}$	$L_{Aeq,T}$	$L_{A90,T}$
Tuesday 22-Mar-16	20:15	56.3	52.2	50.3
	20:30	56.5	52.5	51.0
	20:45	60.0	52.9	50.1
	21:00	56.5	51.0	48.8
	21:15	61.6	50.5	48.0
	21:30	63.2	49.7	47.1
	21:45	57.2	49.5	47.0
	22:00	55.7	49.2	46.4
	22:15	58.2	49.6	46.5
	22:30	60.1	50.1	45.9
	22:45	62.5	47.8	45.2
	Arith. Average	*66.7*	*50.8*	*47.0*
	Log. Average	*70.7*	*51.5*	*48.1*
	Min. Value	*55.7*	*47.2*	*41.9*
	Max. Value	*80.2*	*57.2*	*55.6*
	23:00	57.5	48.5	46.0
	23:15	62.8	48.9	46.4
	23:30	60.1	48.7	45.7
	23:45	54.6	47.1	44.7
	00:00	53.0	46.0	42.8
	00:15	62.3	48.3	43.9
	00:30	53.4	46.4	42.6
	00:45	52.1	44.6	41.6
	01:00	59.7	45.4	41.3
	01:15	55.1	47.1	42.5
	01:30	57.1	47.8	42.6
	01:45	57.2	49.2	42.4
	02:00	57.4	49.4	45.2
	02:15	55.1	48.1	44.8
	02:30	52.6	47.4	44.3
	02:45	52.0	46.4	44.3
	03:00	53.9	47.2	43.9
	03:15	54.3	48.5	43.8
	03:30	52.2	46.4	42.2
	03:45	55.0	47.3	44.2

TABLE B3(CTD): UNATTENDED SOUND MONITORING RESULTS AT LT1

Date of Meas.	Start Time	Measured Sound Levels, dB re. 2 x 10^{-5} Pa.		
		$L_{Amax,F}$	$L_{Aeq,T}$	$L_{A90,T}$
Wednesday 23-Mar-16	04:00	51.1	47.1	45.4
	04:15	51.7	46.7	44.8
	04:30	52.7	47.2	45.0
	04:45	60.0	47.9	45.8
	05:00	61.3	49.8	46.5
	05:15	65.9	51.6	48.2
	05:30	65.4	52.4	49.2
	05:45	66.3	52.1	49.7
	06:00	59.6	51.7	50.2
	06:15	65.7	52.2	50.2
	06:30	70.6	52.8	50.7
	06:45	65.4	52.4	50.9
	Arith. Average	*57.9*	*48.5*	*45.4*
	Log. Average	*61.4*	*49.1*	*46.3*
	Min. Value	*51.1*	*44.6*	*41.3*
	Max. Value	*70.6*	*52.8*	*50.9*
	07:00	68.8	52.5	51.1
	07:15	65.4	53.4	51.8
	07:30	63.7	52.2	50.4
	07:45	63.2	51.0	49.0
	08:00	64.1	49.9	48.4
	08:15	64.7	48.5	45.6
	08:30	60.3	48.4	45.1
	08:45	69.4	49.8	45.1
	09:00	68.4	50.7	45.6
	09:15	66.6	49.1	45.5
	09:30	84.8	52.7	44.1
	09:45	63.4	48.7	46.0
	10:00	58.8	47.2	45.5
	10:15	72.8	51.9	46.0
	10:30	68.9	48.1	45.8
	10:45	78.0	59.5	46.2
	11:00	74.7	55.8	48.1
	11:15	67.7	50.5	46.9
	11:30	58.7	47.0	44.8

TABLE B3(CTD): UNATTENDED SOUND MONITORING RESULTS AT LT1

Date of Meas.	Start Time	Measured Sound Levels, dB re. 2 x 10^{-5} Pa.		
		$L_{Amax,F}$	$L_{Aeq,T}$	$L_{A90,T}$
Wednesday 23-Mar-16	11:45	65.0	48.8	44.4
	12:00	72.5	50.0	43.7
	12:15	65.1	48.5	44.6
	12:30	63.2	48.1	44.2
	12:45	65.1	48.5	43.9
	13:00	68.4	48.8	45.2
	13:15	65.4	48.7	45.6
	13:30	62.7	48.7	44.5
	13:45	60.6	47.6	45.4
	14:00	69.6	49.2	45.8
	14:15	61.6	49.1	45.4
	14:30	62.2	49.7	45.8
	14:45	62.5	51.0	48.1
	15:00	70.5	50.4	45.9
	15:15	69.5	50.8	46.4
	15:30	65.3	50.0	47.2
	15:45	67.5	50.2	47.8
	16:00	63.6	51.0	47.1
	16:15	66.2	49.8	45.9
	16:30	69.7	49.7	46.3
	16:45	71.2	47.6	44.5
	17:00	65.1	49.2	45.8
	17:15	82.7	53.1	46.8
	17:30	65.9	50.5	47.7
	17:45	70.5	49.7	46.8
	18:00	72.1	49.9	45.8
	18:15	65.9	49.8	45.9
	18:30	76.1	52.4	47.1
	18:45	65.2	49.8	46.7
	19:00	58.8	47.8	45.7
	19:15	66.8	48.5	45.0
	19:30	66.6	50.5	45.9
	19:45	58.7	47.0	45.7
	20:00	62.7	47.5	45.8
	20:15	56.2	46.2	44.9
	20:30	64.2	47.6	44.9

TABLE B3(CTD): UNATTENDED SOUND MONITORING RESULTS AT LT1

Date of Meas.	Start Time	Measured Sound Levels, dB re. 2 x 10^{-5} Pa.		
		$L_{Amax,F}$	$L_{Aeq,T}$	$L_{A90,T}$
Wednesday 23-Mar-16	20:45	54.4	46.2	44.8
	21:00	51.1	47.4	46.2
	21:15	63.1	48.2	45.8
	21:30	58.0	46.9	45.1
	21:45	58.3	46.9	44.9
	22:00	54.5	47.7	46.0
	22:15	57.9	47.1	45.2
	22:30	55.8	47.0	45.5
	22:45	58.2	45.8	44.2
	Arith. Average	*65.3*	*49.5*	*46.0*
	Log. Average	*71.4*	*50.3*	*46.4*
	Min. Value	*51.1*	*45.8*	*43.7*
	Max. Value	*84.8*	*59.5*	*51.8*
	23:00	58.2	46.3	43.8
	23:15	51.6	44.9	43.7
	23:30	69.9	46.8	44.2
	23:45	68.6	49.7	43.9
	Arith. Average	*63.4*	*48.6*	*45.7*
	Log. Average	*70.5*	*48.7*	*45.6*
	Min. Value	*51.1*	*44.9*	*43.7*
	Max. Value	*84.8*	*59.5*	*51.8*

TABLE B3(CTD): UNATTENDED SOUND MONITORING RESULTS AT LT1

Plant Item	1/3 Octave Band Sound Power Level, dB (lin) re. 10^{-12} W (Hz)																													
	25	31	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k	12.5k	16k	20k
Contact Tank Mixer	65	68	69	69	68	71	73	71	73	73	74	72	72	75	76	78	78	78	78	78	77	76	75	74	73	71	70	69	65	60
Coagulation Tank Mixer	65	68	69	69	68	71	73	71	73	73	74	72	72	75	76	78	78	78	78	78	77	76	75	74	73	71	70	69	65	60
Flocculation Tank Mixer	65	68	69	69	68	71	73	71	73	73	74	72	72	75	76	78	78	78	78	78	77	76	75	74	73	71	70	69	65	60
Actiflo Settling Tank Scraper	65	68	69	69	68	71	73	71	73	73	74	72	72	75	76	78	78	78	78	78	77	76	75	74	73	71	70	69	65	60
Actiflo Recycle Pump	73	76	75	75	73	74	79	78	75	77	79	76	75	83	77	76	76	75	77	76	82	73	68	70	66	63	60	57	54	49
Air Compressor	73	76	75	75	73	74	79	78	75	77	79	76	75	83	77	76	76	75	77	76	82	73	68	70	66	63	60	57	54	49
PAC Conveyor	65	68	69	69	68	71	73	71	73	73	74	72	72	75	76	78	78	78	78	78	77	76	75	74	73	71	70	69	65	60
PAC Eductor	65	68	69	69	68	71	73	71	73	73	74	72	72	75	76	78	78	78	78	78	77	76	75	74	73	71	70	69	65	60
Actisand Conveyor	65	68	69	69	68	71	73	71	73	73	74	72	72	75	76	78	78	78	78	78	77	76	75	74	73	71	70	69	65	60
Actisand Eductor	65	68	69	69	68	71	73	71	73	73	74	72	72	75	76	78	78	78	78	78	77	76	75	74	73	71	70	69	65	60
Actisand Big Bag Loader	65	68	69	69	68	71	73	71	73	73	74	72	72	75	76	78	78	78	78	78	77	76	75	74	73	71	70	69	65	60
Lamella Coagulation Tank Mixer	65	68	69	69	68	71	73	71	73	73	74	72	72	75	76	78	78	78	78	78	77	76	75	74	73	71	70	69	65	60
Lamella Flocculation Tank Mixer	65	68	69	69	68	71	73	71	73	73	74	72	72	75	76	78	78	78	78	78	77	76	75	74	73	71	70	69	65	60
Lamella Thickener Scraper	65	68	69	69	68	71	73	71	73	73	74	72	72	75	76	78	78	78	78	78	77	76	75	74	73	71	70	69	65	60
Lamella Sludge Pump	73	76	75	75	73	74	79	78	75	77	79	76	75	83	77	76	76	75	77	76	82	73	68	70	66	63	60	57	54	49
Sludge Balancing Tank Mixing Pump	67	70	69	69	67	68	73	72	69	71	73	70	69	77	71	70	70	69	71	70	76	67	62	64	60	57	54	51	48	43
Centrifuge Feed Pump	73	76	75	75	73	74	79	78	75	77	79	76	75	83	77	76	76	75	77	76	82	73	68	70	66	63	60	57	54	49
Centrifuge	75	78	77	77	75	76	81	80	77	79	81	78	77	85	79	78	78	77	79	78	84	75	70	72	68	65	62	59	56	51
Polymer Makeup Kit	57	60	61	61	60	63	65	63	65	65	66	64	64	67	68	70	70	70	70	70	69	68	67	66	65	63	62	61	57	52

TABLE B4: ASSUMED WTW PLANT 1/3 OCTAVE BAND SOURCE TERM SPECTRA

Section of Structure	Material	Sound Reduction Index, R_w by Octave Band Centre Frequency, Hz								Reference
		63	125	250	500	1k	2k	4k	8k	
Bottom of Walls	Single Leaf Brick	30	36	37	40	46	54	57	59	Woods
Walls and Roof	Trapezoidal Insulated Wall Panel KS1000 RW	20	18	20	24	20	29	39	47	Kingspan Product Data Sheet
Roller Shutter / Door	1mm Corrugated Steel	10	14	16	20	25	29	23	20	SoundPLAN library

TABLE B5: ASSUMED OCTAVE BAND SOUND REDUCTION INDEX FOR BUILDING ELEMENTS

Section of Structure	Material	Absorption Coefficient by Octave Band Centre Frequency, Hz								Reference
		63	125	250	500	1k	2k	4k	8k	
Bottom of Walls	Brickwork	0.05	0.05	0.04	0.02	0.04	0.05	0.05	0.05	Woods
Walls and Roof	Trapezoidal Insulated Wall Panel KS1000 RW	0.20	0.40	0.70	0.70	0.60	0.60	0.40	0.20	https://www.scribd.com/document/144171047/Acoustic-Panel
Roller Shutter / Door	Concrete	0.02	0.02	0.02	0.02	0.03	0.04	0.04	0.05	SoundPLAN library

TABLE B6: ASSUMED OCTAVE BAND ABSORPTION COEFFICIENTS FOR BUILDING ELEMENTS