Report number: 4695.01

GREEN CREATE W2V KENT LTD
ANAEROBIC DIGESTER AND CHP PLANT
KNOXBRIDGE FARM, FRITTENDEN, KENT
ASSESSMENT OF ENVIRONMENTAL NOISE EMISSIONS

Prepared for:
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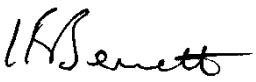

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1 INTRODUCTION

The author was commissioned by E4environment Ltd to provide acoustical consultancy services in connection with the operation of an anaerobic digester (AD), biogas upgrade plant and a 500kW combined heat and power (CHP) plant at Knoxbridge Farm, Cranbrook Road, Frittenden, Kent, for which the applicable planning permission was granted by Tunbridge Wells Borough Council on 28 August 2019 subject to conditions (reference TW/19/1693). The application and subsequent permission had been amended to reflect changes in the layout since the original application was made. There were no planning conditions regarding noise limits, save the restriction of operating hours for vehicles servicing the facility. However, an acoustical assessment was requested by the Environment Agency.

This report therefore presents an assessment of the effects on ambient noise levels in the locality likely to result from the construction and operation of the plant as proposed, and recommends noise mitigation measures where necessary. It is based on information available at the time of writing: some details and the exact specifications of plant are yet to be decided.

The author has experience of several noise assessments in relation to AD and CHP plants in Kent, Devon, Cornwall, Derbyshire and Shropshire, and where detailed noise emission data are unavailable he has drawn on this experience to make realistic estimates of the emissions from the proposed plant.

2 NOISE CRITERIA

2.1 Definitions

It is appropriate at this stage to define some of the terms used in the measurement and specification of noise levels in the environment.

A-weighting

The A-weighted sound pressure level results from filtering a signal by an 'A' filter (BS.4197) whereby both low-frequency and high-frequency components have been attenuated without affecting the components near 1000Hz.

Equivalent continuous noise level (L_{Aeq})

This is the A-weighted noise level which if present for the entire measurement period would produce the same sound energy to be received as was actually received as a result of a signal which varied with time. It is normally abbreviated to 'L_{eq}' or 'L_{Aeq}', and is often followed by a specification of the time period (such as one hour, or five minutes) indicating the period of time to which the measured value has been normalised; for example, '$L_{Aeq,1hr}$'.

L_n index

The L_n resulting from an environmental noise measurement is the level which was exceeded for *n* percent of the measurement period. Thus, an L_{A90} of 35dB represents the A-weighted sound pressure level which was exceeded at the microphone for 90% of the measurement period. Any value of *n* between 0 and 100 is meaningful, but the indices in general use in the UK are L_{A90}, L_{A50} and L_{A10}. The L_{A90} index is generally taken to be representative of the steady background noise level. The L_{A50} is the arithmetic average of all the instantaneous values during the measurement period. The principal use of L_{A10} is in the assessment of road traffic noise. It is a widely accepted convention that five-minute measurement periods are adopted at night, and hourly periods during the day.

2.2 National guidance on control of noise emissions from operations

BS.4142:2014+A1:2019

The acceptability of environmental noise is usually assessed with reference to this well-established and recently updated standard. It recommends that a 'new' industrial noise be compared with the pre-existing background level. Corrections can be made for the additional effects of tonal or impulsive noise, and (in the 1997 and earlier versions) the likelihood of complaints from the local community could be predicted. The standard was subject to extensive revision leading to the publication of the latest version, BS.4142:2014 *Methods for rating and assessing industrial and commercial sound* in November 2014, and this itself was amended and clarified in 2019.

The use of the 1997 methods when considering noise emissions from industrial type processes in rural areas had some shortcomings. A major problem arose from the fact that the minimum background noise levels could often fall well below 30dB(A) at night, which is considerably lower than was anticipated by the original authors of the standard. The basic principle of the standard was to compare the rating level of the 'new' noise with the pre-existing background noise level in the area, on the basis that a new noise source which noticeably increases the levels of ambient noise at a noise-sensitive location such as a private dwelling is likely to provoke justifiable complaints.

The 2014 standard as amended has addressed these problems and now calls for a comparison of the 'new' noise with the pre-existing background sound, with adjustments to be made for particular noise characteristics such as intermittency and tonality. The concepts of NOAEL, LOAEL and SOAEL[1] are included in the latest version of the standard.

1 These are No Observable Adverse Effect Level, Lowest Observable Adverse Effect Level, and Significant Observable Adverse Effect Level respectively.

Integrated Pollution Prevention and Control (IPPC)

Section 2.5.1 of IPPC advises that noise levels should be calculated according to the principles of ISO 9613-2:1996. This is a method of calculating noise levels at a receptor a known distance from a noise source, taking into account atmospheric absorption, soft ground attenuation and geometrical diffusion.

NPPF

The National Planning Policy Framework (NPPF) was published in 2012 and replaced previous Planning Policy Guidance (PPG) 24: *Planning and Noise*. The NPPF provides the following guidance on noise and planning. It states at paragraph 123 that planning policies and decisions should avoid noise giving rise to *'significant adverse impacts … on … quality of life'*, and should mitigate the adverse impacts through the use of conditions, but should recognise that development will often create some noise.

The NPPF also states at paragraph 144 that when determining applications local planning authorities should;

> *'ensure that any unavoidable noise, dust and particle emissions and any blasting vibrations are controlled, mitigated or removed at source'*.

The Technical Guidance to the NPPF deals with noise emissions only from mineral workings (at paragraphs 28 and 29). It is therefore necessary to refer to the provisions of the Noise Policy Statement for England (NPSE) dating from March 2010, which is also referenced by the current PPG (see below).

The aim that adverse impacts on health and quality of life should be mitigated and minimised is the most relevant here: it refers to the situation where the impact of a 'new' noise lies somewhere between LOAEL and SOAEL. This in turn implies that assessment criteria such as those in BS.4142:1997 may be appropriate for a fixed installation. However, the British Standard has since been reviewed and updated.

March 2014 Planning Practice Guidance

The online Planning Practice Guidance appeared in March 2014 and states that noise needs to be considered when a new development may create additional noise, or in the reverse situation when a new development would be sensitive to the prevailing acoustic environment. It refers to the three stated aims of the Noise Policy Statement for England (NPSE):

- To avoid significant adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development;

- To mitigate and minimise adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development;

- Where possible, to contribute to the improvement of health and quality of life through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

The concepts of 'no observed effect level', 'lowest observed adverse effect level', and 'significant observed adverse effect level' (NOEL, LOAEL and SOAEL) as applied by the World Health Organisation were introduced by the NPSE and are referred to by the PPG, although no specific guidance is provided.

2.3 Local planning policy

Tunbridge Wells Borough Council published a Supplementary Planning Document to its Local Plan and adopted it in November 2014. Its stated aim is to ensure sufficient mitigation of noise to prevent substantial loss of amenity at the development stage of a project. It references the NPPF and NPSE summarised above, and makes specific reference to NOEL, LOAEL and SOAEL.

A commentary is provided given on the representation of NOEL, LOAEL and SOAEL in relation to existing British Standards and International guidelines. These are:

- NOEL: Inaudibility

- LOAEL: The guideline values for community noise in specific environments as set out in Table 1 of the World Health Organisation (WHO) *Guidelines for Community Noise* 1999 and in Table 4 of BS.8233:2014 *Guidance on sound insulation and noise reduction for buildings*. The SPD notes that further guidance is given in the WHO *Night Noise Guidelines for Europe* 2009

- SOAEL: Variable values set somewhere above LOAEL dependent on the type of noise source, the receptor, the time of day, *etc*.

The SPD specifies at Section 3.1 that BS.4142:1997 or subsequently updated form should be used to assess noise from new industrial developments, although this is under the heading "major": the proposed development is for the addition of industrial plant to an existing agricultural production facility.

Where an Environmental Impact Assessment (EIA) is deemed necessary, the Borough Council requires in addition to requirements under EIA, an assessment in situations where: there is a proposal for a development generating noise and/or vibration in a noise-sensitive area, defined as premises where noise is likely to cause or contribute to some harmful or otherwise unwanted effect such as annoyance or sleep disturbance (Section 2.3 of the SPD).

Tables 1 and 2 of the SPD (Section 1.8) reproduce the guideline internal sound levels from BS.8233: 2014 - *Guidance on sound insulation and noise reduction for buildings*, and information on the health effects of noise observed in the population as presented in the 1999 WHO *Night Noise Guidelines for Europe*. These are reproduced for convenience in Table 1 below.

TABLE 1: BS.8233:2014 Guideline internal sound levels

Activity	Location	07:00h – 23:00h	23:00h – 07:00h
Resting	Living room	35dB $L_{Aeq,16h}$	-
Dining	Dining room or area	40dB $L_{Aeq,16h}$	-
Sleeping and daytime resting	Bedroom	35dB $L_{Aeq,16h}$	30dB $L_{Aeq,8h}$

Where the average night noise level $L_{night,outside}$ is up to 30dB the WHO states that there are no substantial observed biological effects. This is equivalent to the NOEL for night noise. Where the same metric is in the range 30 to 40 dB there are some observed effects on sleep: a value of $L_{night,outside}$ of 40dB is equivalent to the LOAEL for night noise. The latter figure broadly equates to 30dB $L_{Aeq,8h}$ internally.

2.4 Environment Agency

The gov.uk web site presents the Environment Agency's specific requirements for noise assessments involving calculations or modelling. Such assessments should include referenced or derived sound power levels for noise-emitting equipment; heights, directivities and operating times for such machinery; information about site roads and vehicle sound power levels, traffic numbers and speeds; and grid references and heights for site buildings, whether they emit noise or not, as well as off-site buildings which may affect sound levels at receptors (by screening or diffraction).

Receptor locations are to be specified by grid references, addresses or other identification, and the background sound levels $L_{A90,T}$ dB are to be stated. Assessments of off-site road traffic noise are not required by the EA.

2.5 Noise limits

It is appropriate to refer to the SPD summarised above, but BS.4142 provides a tool to assess the likelihood of complaints about noise from the development. It can be used with predictive or actual measurements, or both. Post-development verification checks on predicted levels may be required, particularly where the predicted results are close to limits.

While the British Standard in 1997 specifically referred to its use in industrial noise, it can also have a wider remit, including premises where lorries are loaded

or unloaded by forklift trucks, or mobile machines operate in yards. The current version of the standard confirms that this is appropriate.

The appropriate criterion is that there will be no increase in background levels as a result of the development. The SPD considers that the noise levels at nearby dwellings are do not exceed the current levels of background sound. This is in step with the second aim of the NPSE which is to mitigate and minimise the impact on local residents. No limits are specified by the EA other than those implied by the use of BS.4142:2014, so it is logical to deduce that the LOAEL in BS.8233:2014 is an appropriate criterion for a 24-hour operation.

At night the noise would be experienced by residents inside their home, so a calculation of the noise levels at the façade location is be appropriate if due allowance is made for the attenuation of the building envelope (but none for façade reflection). The sound reduction provided by a partly open window is a minimum of approximately 10dB overall. A design target equivalent to the typical minimum (external) background noise level plus 5dB is therefore sufficient to prevent loss of amenity. The CHP plant will operate 24 hours a day, so night-time noise is likely to be more critical.

Construction noise is usually assessed with reference to BS.5228-1: 2007 Annex E, which says in essence that in a rural area, once the daytime noise level at the nearest affected property reaches 65dB $L_{Aeq,1h}$ then the noise effects are likely to be significant. A slightly lower noise limit of 60dB $L_{Aeq,1h}$ is often considered appropriate for the construction phase of this type of development, being a level of noise comparable with that of normal daytime activities including road traffic movements. Even at very rural locations it would be inappropriate to require average noise levels below 55dB $L_{Aeq,1h}$. These limits are consistent with the EA guidance.

3 BACKGROUND SOUND

3.1 Noise survey

A survey of ambient sound levels would often be undertaken for projects of this sort in order to determine the daytime and night-time background sound levels at noise-sensitive receptors, in terms of $L_{A90,T}$ dB. The EA requirement is that a full noise survey report is to be provided if a BS.4142 assessment has been carried out but

The current Covid-19 pandemic has imposed legal and practical restrictions on the conduct of site noise surveys so although it will be appropriate at some future stage to confirm the typical (NB *not* the minimum) background sound levels in the vicinity of the site, no survey has yet been conducted.

Instead, typical rural levels have been assumed for design purposes.

3.2 Likely levels of background sound

The noise sources likely to affect background sound levels in the vicinity of the AD/CHP plant, apart from natural sources such as birds, wind in the trees, and rainfall, include road traffic on the A229 Cranbrook Road, aircraft movements, and noise from the existing poultry farming operations at Knoxbridge Farm.

For design purposes it is reasonable to assume based on that the typical night-time background sound level is around 30dB $L_{A90,15min}$ and the daytime background sound level is between 40 and 45 dB $L_{A90,1h}$.

4 PREDICTED SOUND LEVELS

4.1 Basis of predictions

The predicted noise levels from the site were calculated for the closest potentially noise-sensitive locations. Some of these dwellings are understood to have some financial involvement with the project but for simplicity the same noise criteria are assumed at all properties. They are listed in Table 1 with their OS grid references: in each case, the coordinates shown are the nearest point on the residential façade facing the plant.

TABLE 1: Receptor locations and OS grid coordinates

no.	name	E (m)	N (m)	direction
1	Knoxbridge Farmhouse	678853	240734	230°
2	Knoxbridge Cottages	678829	240702	230°
3	Knoxbridge Café	678874	240697	230°
4	Knoxbridge Barn	678943	240787	230°
5	Knoxbridge Oasthouse	678911	240788	230°
6	Honeywell Oast	678894	240797	230°
7	Field View	678915	240875	240°
8	Streamside	678888	240802	240°
9	Knoxnewfs House	678901	240687	230°
10	Orchard Cottages	678740	240996	230°
11	Rose Cottage Farmhouse	679095	240740	220°
12	Rose Cottage Farm Oast	679083	240718	220°
13	Rose Cottage Barn	679129	240738	210°
14	Little Wadd Farm	679773	240948	120°
15	Little Wadd Oast	679815	240974	110°
16	Little Wadd Stables	679783	240987	110°
17	Great Wadd Farmhouse	679718	240717	140°
18	Great Wadd Oast House	679753	240699	140°
19	Iden Grange	678780	241684	310°
20	Bromley Barn	678575	241306	300°

The decay of sound levels with distance (geometric effects) was taken into account according to the basic acoustical principle of hemispherical radiation over a partially absorbent plane surface, as set out in ISO 9613-2:1996 *Acoustics -- Attenuation of Sound during Propagation Outdoors -- Part 2: General Method of Calculation*. This document is the basis of most commercial noise propagation modelling software, but in this instance the calculations can easily be carried out using a simple spreadsheet approach. The lack of spectral data from the various equipment vendors means that more detailed calculations cannot be justified. The attenuation effects as sound passes over soft ground, and the absorption of high frequencies by the atmosphere, can nevertheless be taken into account using well-established base data for open country. Calm weather is assumed, as this is generally the condition under which sound propagates most readily, and thus the worst case was modelled. There is no direct line of sight between the permitted development and the nearest residential locations, and screening would be provided by intervening buildings, although this factor can be allowed for at a later stage of the calculation process.

4.2 Base data for calculations

Noise emission data for the various items of potentially noisy equipment is scarce, but the available data are presented in Table 2. These figures were supplemented by noise survey data obtained by the author at similar CHP plants, which confirmed that the principal sources of airborne sound power would be the CHP engine package itself, the biogas upgrade plant, the air intake blower and the gas boiler (burner).

The engine and generator set, rated at 500kW, is based on a V12 diesel engine but fired by biogas from the AD plant. The engine and alternator are housed in an acoustic enclosure with air inlet and discharge attenuators and a high-performance engine exhaust system. The specification quotes an exhaust sound power level of 130dB but it should be noted that this is the “open exhaust” figure for exhaust silencer design purposes.

The other potentially significant noise emitters are the biogas upgrade plant (especially its gas compressor), and the various plant housed inside an existing building, including the mixers, various pumps, and the decanter. For calculation purposes the building itself is regarded as the noise source, with a 15dB reduction in radiated sound power to allow for the attenuation of the building envelope.

In most cases the available noise data refer to the sound pressure level at an unspecified distance: unless the measurement distance is included it is reasonable to assume it to be 1m. This in turn means that the sound power level L_{wA} can be calculated for use in the prediction of environmental noise levels, provided that the overall dimensions of the noise-emitting elements are known. However, the frequency content of the noise from each source is undefined, so

a notional octave band spectrum was adopted with a bias towards the lower end of the frequency range.

The OS grid coordinates of the acoustic centre of each source assumed for calculation purposes are also shown in Table 2.

TABLE 2: Plant noise emission data

plant	L_{pA} at 1m, dB	L_{wA}, dB	E (m)	N (m)
Mixer	73	86		
Grit washer classifier	70	80		
Pumps (5)	78	94		
Boiler (burner)	81	89		
Decanter	85	96		
Total, process building†		99	679423	241173
Biogas upgrade plant*		96	679467	241211
Blower/scrubbers		91	679404	241187
CHP packaged unit		91	679461	241197
Flare		83	679486	241215

* includes compressor

† sources are lumped together for calculation purposes

Noise levels (L_{Aeq}) at receptor locations were then calculated using the sound power levels in Table 1. These source levels equate to 100dB(A) overall and represent the average sound power levels propagating from the packaged CHP plants with standard acoustic noise control features including high-performance engine exhaust silencers.

All the noise sources were lumped together and for each receptor in turn they were all assumed to be at the nearest source location to that receptor. The separation distances used are shown in Table 3.

TABLE 3: Minimum source-receptor distances for calculations

no.	name	m	no.		m
1	Knoxbridge F'mhouse	713	11	Rose Cottage F'mhouse	543
2	Knoxbridge Cottages	752	12	Rose Cottage Fm Oast	568
3	Knoxbridge Café	722	13	Rose Cottage Barn	525
4	Knoxbridge Barn	610	14	Little Wadd Farm	392
5	Knoxbridge Oasthouse	634	15	Little Wadd Oast	408
6	Honeywell Oast	642	16	Little Wadd Stables	374
7	Field View	580	17	Great Wadd F'mhouse	543
8	Streamside	644	18	Great Wadd Oast House	578
9	Knoxnewfs House	709	19	Iden Grange	798
10	Orchard Cottages	691	20	Bromley Barn	984

The resulting sound pressure levels L_p were calculated from the following expression:

$$L_p = L_w - 20 \log r - 11 + DI + \Sigma A \text{ [dB]}$$

where *r* is the separation distance in metres between the noise source and the receptor; DI is the directivity index, assumed to be +3dB for sound propagation over a reflecting plane surface; and ΣA is the aggregate excess attenuation resulting from the ground effects attenuation A_G and the atmospheric absorption A_A. The two terms A_G and A_A are frequency dependent, but geometrical attenuation is not. The soft ground attenuation factor *G* is taken as 0.9 because the intervening ground is all cultivated agricultural land.

4.3 Predicted noise levels

Table 4 shows the predicted overall noise levels, L_{Aeq}, (in the absence of background noise) produced by the plant in total, at each receptor. These values disregard any screening effects, which will be considered later in this report.

TABLE 4: Overall A-weighted sound levels L_{Aeq} dB (no screening)

no.	name	dB	no.		dB
1	Knoxbridge F'mhouse	27	11	Rose Cottage F'mhouse	30
2	Knoxbridge Cottages	27	12	Rose Cottage Fm Oast	30
3	Knoxbridge Café	27	13	Rose Cottage Barn	31
4	Knoxbridge Barn	29	14	Little Wadd Farm	34
5	Knoxbridge Oasthouse	29	15	Little Wadd Oast	33
6	Honeywell Oast	29	16	Little Wadd Stables	34
7	Field View	30	17	Great Wadd F'mhouse	30
8	Streamside	29	18	Great Wadd Oast House	30
9	Knoxnewfs House	28	19	Iden Grange	26
10	Orchard Cottages	28	20	Bromley Barn	26

The overall A-weighted levels of 34dB $L_{Aeq,T}$ at two locations will be in excess of the background sound level of 30dB $L_{A90,15min}$ at night, so the design criterion no more than a 5dB excess over background may not be met. The predicted levels at several other locations are likely to remain below the typical night-time background sound level.

However, all receptor locations to the south-west of the site will benefit from considerable screening, because the existing poultry production buildings form considerable barriers to the propagation of sound. The direct path between the area in which the CHP and biogas upgrade plants is screened in such a way that the resultant A-weighted noise level outside these property will be reduced by at least 10dB. The resulting sound levels inside bedrooms will be below the LOAEL at all times.

The noise from the plant received at Great Wadd Farmhouse and Great Wadd Oasthouse will also be screened by the existing buildings to a rather lesser extent, and also by the earthworks surrounding the site. There will be a net screening benefit of at least 5dB because of the lack of a direct sightline. It can therefore be concluded that within these properties the sound levels will also be below the LOAEL.

The three properties at Little Wadd Farm (the former stables, oast and farmhouse) will not benefit from significant screening by buildings as far as the CHP and biogas upgrade packages are concerned. However, the five gas tanks surrounded by a form a substantial barrier to the propagation of sound, and these are surrounded by a metal palisade fence. The entire compound sits within earth berms and none of the plant will be visible from the three receptors. A reduction in sound level of a least 3dB can be assumed, meaning that a 30dB background level will only just be exceeded outside the receptors. It is concluded that the internal sound levels are below the LOAEL.

The external sound levels once screening is taken into account are shown in Table 5.

TABLE 5: Overall A-weighted sound levels L_{Aeq} dB allowing for screening

no.	name	dB	no.		dB
1	Knoxbridge F'mhouse	17	11	Rose Cottage F'mhouse	20
2	Knoxbridge Cottages	17	12	Rose Cottage Fm Oast	20
3	Knoxbridge Café	17	13	Rose Cottage Barn	21
4	Knoxbridge Barn	19	14	Little Wadd Farm	31
5	Knoxbridge Oasthouse	19	15	Little Wadd Oast	30
6	Honeywell Oast	19	16	Little Wadd Stables	31
7	Field View	20	17	Great Wadd F'mhouse	25
8	Streamside	19	18	Great Wadd Oast House	25
9	Knoxnewfs House	18	19	Iden Grange	24
10	Orchard Cottages	18	20	Bromley Barn	24

4.4 Mobile plant

Mechanical handling

The types and numbers of mobile plant (apart from visiting goods vehicles) to be used on the site are not known at this stage, but it would be usual practice for there to be at least one telescopic handler and one wheeled loading shovel in operation around the yard. The typical sound power level emitted by either of these machines would be 104dB $L_{Aeq,T}$. Experience suggests that it would be unusual for both to be required concurrently. A 50% "on-time" can be assumed.

The daytime sound levels at receptor locations from these machines will be comparable with those from the fixed plant. The combination of CHP and associated plant noise with noise from mobile handling at any receptor will be a

maximum of 35dB $L_{Aeq,1h.}$ This is 5 to 10 dB below the general levels of background sound t be expected, and thus well below the daytime LOAEL.

Deliveries

Noise from visiting large goods vehicles (LGVs) will be kept at acceptable levels by planning condition nos. 5 and 6. Condition 5 restricts the numbers of movements to 112 daily (56 in, 56 out) and Condition 6 restricts the hours of operation to 07:00h Mondays to Fridays and 07:00h to 3:00h Saturdays. No LGV movements are permitted on Sunday or Bank Holidays. The numbers of LGV movements associated with current poultry farming operations are not known to the author.

5 CONCLUSIONS

A study of environmental noise levels in the vicinity of the permitted AD and CHP plant shows that the noise levels will be acceptably low. Even in the small hours of the night, the plant will not reach a margin of 5dB above a notional background sound level, and this will mean that noise levels inside potentially affected residential buildings never exceed the guideline values in BS.8233:2014.

Noise will be below the LOAEL at all times of night, and is acceptable.

The permitted anaerobic digester, biogas upgrade plant, ancillary equipment and combined heat and power plant will not give rise to noise nuisance or loss of amenity at neighbouring residential properties. No further noise mitigation will be necessary.

Daytime sound levels from fixed plant will be well below the current background sound levels.

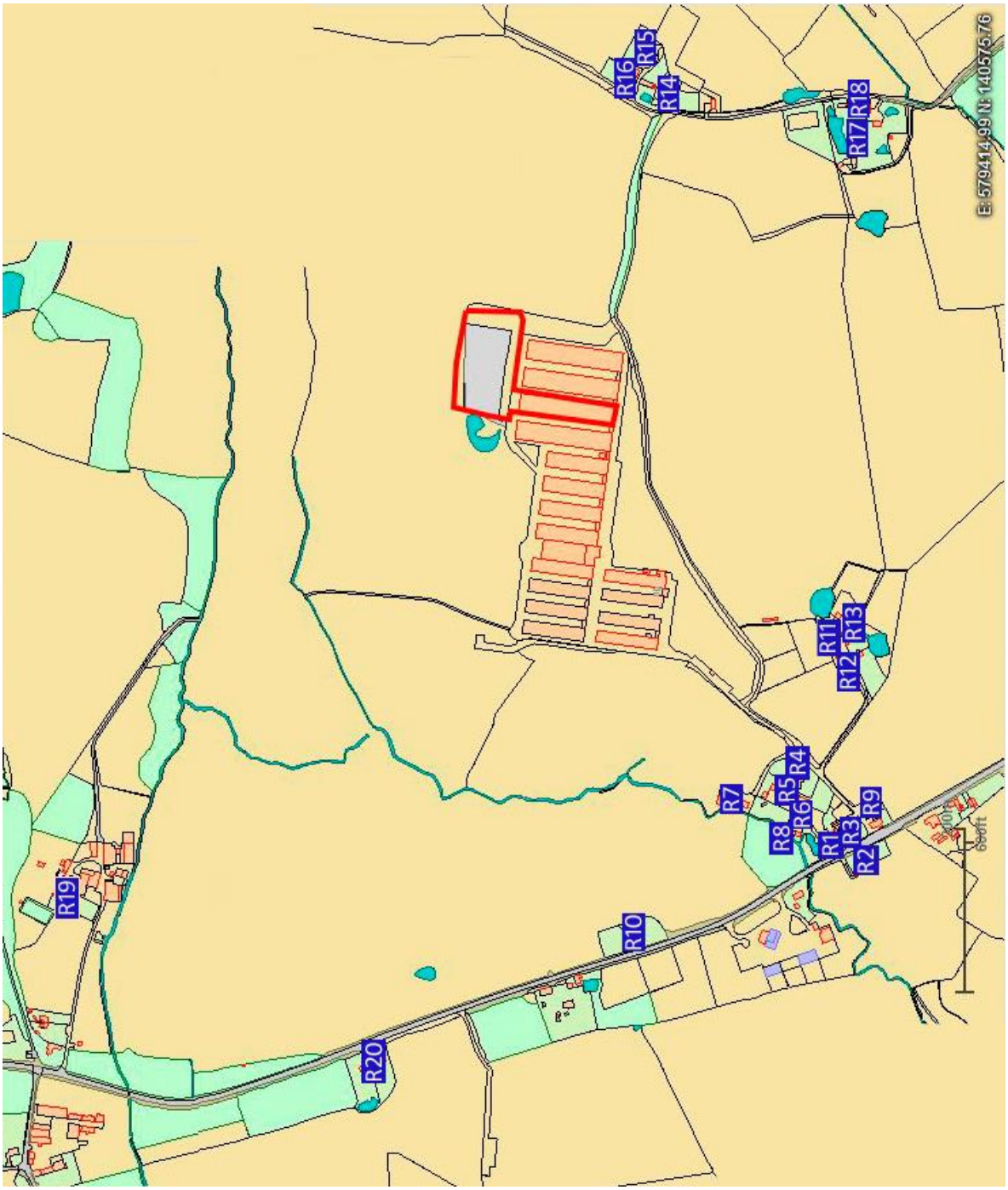

Figure 1: Noise prediction locations