Town and Country Planning Act 1990

Appeal by Broadview Energy Developments Limited
Site at Spring Farm Ridge between Greatworth and Helmdon

Planning Inspectorate Reference: APP/Z2830/A/11/2165035

South Northamptonshire Council Ref: S/2010/1437/MAF

PROOF OF EVIDENCE

OF

Robert A Davis BSc(Eng) MIOA

on

Noise Issues

On behalf of the Helmdon, Stuchbury and Greatworth Windfarm Action Group (HSGWAG)

August 2013

Robert Davis Associates
consultants in acoustics and noise control

The Holt Upper Timsbury Romsey Hants SO51 0NU
Tel 01794 367637 email rd@rd-associates.co.uk

Qualifications and Experience

I hold the degree of Bachelor of Science in Engineering from the University of Southampton, and I am a member of the Institute of Acoustics. I have worked in the fields of acoustics and noise control since 1968, and as an acoustics consultant since 1971. I have carried out assessments of environmental noise from existing and proposed industrial sites at numerous locations throughout the UK, and I have presented evidence on these matters in Court and at Public Inquiries.

From 1990-2001 I was Technical Manager of ISVR Consultancy Services (now ISVR Consulting), a consultancy unit within the Institute of Sound and Vibration Research at Southampton University. The Institute is recognised internationally as a centre for teaching, research and consultancy in most aspects of acoustics, noise and vibration. I represented the Institute on British Standards Committees concerned with the measurement and assessment of noise. I left the Institute in 2001 to set up my own practice. I also continue to work with ISVR as an Associate Consultant.

I have experience of the prediction and assessment of noise from wind farms through involvement in research programmes carried out by ISVR and from the assessment of the noise impact of proposed wind farms on specific sites. I have advised local authorities and residents' groups on the prediction and assessment of noise from approximately 40 proposed UK wind turbine installations and I have presented technical evidence on noise at a number of Public Inquiries relating to wind farm planning applications.

I was a member of the Noise Working Group assembled by the DTI in 2006 to review the results of recent research into the causes of complaints from wind farm neighbours about low-frequency noise effects. I am a member of a team of consultants and Universities currently carrying out a research project to investigate amplitude modulation of noise from wind turbines. This project is funded by Renewable UK (previously the British Wind Energy Association).

I am also a member of the Working Group formed by the Institute of Acoustics, at the request of the Department of Energy and Climate Change, to produce a Good Practice Guide for the assessment of wind turbine noise. This guide was published in May 2013 and has since been endorsed by DECC and by DCLG as being supplementary to other guidance referred to in policy documents.

Declaration

The evidence which I have prepared and provide for this Appeal is true and I confirm that the opinions expressed are my true and professional opinions.

1 Introduction

1.1 Broadview Energy Developments Limited applied to South Northamptonshire Council in October 2010 to install five wind turbines on the site at Spring Farm Ridge near Helmdon. The Council refused planning permission but an appeal by Broadview was allowed at an inquiry in May 2012. The appeal decision was quashed following a High Court hearing on 5 December 2012 and the appeal is to be reheard.

1.2 I have been requested by residents' group the Helmdon, Stuchbury and Greatworth Windfarm Action Group (HSGWAG) to carry out an independent assessment of the potential noise impact of the proposed development and to submit evidence on noise to this public inquiry.

1.3 I refer to information in (amongst others) the following documents:

- The Environmental Statement (ES) submitted with the planning application. Section 12 in Volume 2 of the ES presents a noise assessment of the development: this was carried out by TNEI Services Limited on behalf of Broadview. Appendix G in Volume 4 of the ES provides greater detail of the assessment.
- Further Environmental Information (FEI) submitted in February 2012. Additional information relating to noise was presented in Section 12 of the FEI and associated Appendix E.
- The Proof of Evidence of Stephen Arnott (TNEI Services) produced at the first appeal in May 2012 and written response to questions.
- The Decision Letter relating to the first appeal, dated 12 July 2012
- The High Court judgment (ref [2013] EWHC 11 (ADMIN)) relating to the first appeal, dated 16 January 2013.
- A supplementary Note entitled *'Review of compliance with the IOA Good Practice Guidance'* by TNEI, dated 7 August 2013
- Related correspondence.
- Relevant technical information, planning guidance and other documents in the public domain, including other wind farm appeal decisions.

1.4 I am liaising with Stephen Arnott, the Appellant's noise consultant at this appeal, and at the date of this proof I am awaiting responses from Mr Arnott to points I consider need clarification. If these responses or Mr Arnott's evidence to this appeal provide

information that is additional to, or different from, that in the ES and the documents referred to in 1.3 above, I would need to submit a supplementary proof in respect of such information.

2 Format of this Proof

- ***Section 3*** provides a brief description of the relevant features of the proposed wind turbines at Spring Farm Ridge, as set out in the ES and FEI.
- ***Section 4*** summarises relevant national and local policy relating to the assessment of wind farm noise.
- ***Section 5*** describes the procedure adopted in the assessing wind farm noise at the design stage.
- ***Section 6*** reviews the sections on noise contained in the ES, FEI and the August 2012 Note.
- ***Section 7*** sets out my comments on the adequacy of the noise assessment put forward by the Appellant.
- **Section 8** presents my own assessment of the potential noise impact of the development in terms of the effects on local amenity.
- ***Section 9*** refers to other noise issues not specifically addressed in Section 7
- My overall conclusions are presented in **Section 10**.
- Documents to which I refer are listed in **Section 11**

3 Site Description and Proposed Wind Farm Configuration

3.1 The locations of the site, the proposed wind turbines, and dwellings in the vicinity are shown on Figure 5.1 in ES Appendix G. A copy of this figure is attached as my Figure 1. The site is on a ridge, the surrounding land being undulating with some steep-sided valleys, consisting of fields in agricultural use with some small areas of woodland. The local centres of population are the villages of Helmdon to the east, Greatworth to the south west, and Sulgrave to the north west.

3.2 There are approximately 40 dwellings within 1km of any of the proposed wind turbine locations, including houses on the west side of Helmdon and the north-east side of Greatworth, the closest separation distance being about 500 metres. The nearest

main roads are the A43 about 4.5 km to the south east, and the M40 about 9.5 km to the west.

3.3 The application is to erect five wind turbines with a maximum blade tip height of 126 metres. The noise assessment in the ES was based on a typical 'candidate' turbine, the REPower MM92, which has a rated power output of 2.05MW. The TNEI Note of August 2013 introduces a different candidate turbine, the Vestas V90 2.0 MW.

4 Relevant Policy and Guidance

4.1 I draw attention to some specific details of policies and guidance that I consider relevant to the issue of noise, and make some comments on my reading of them.

4.2 As explained by Mr Muston in his proof of evidence, in the Local Plan Policy G3(D) seeks to ensure that development does not unacceptably harm the amenities of neighbouring properties. Policy S11 in the draft Core Strategy seeks to ensure that there should be no significant adverse impact on the amenity of the area in respect of noise. There is also guidance on noise in the Supplementary Planning Document 'Wind Turbines in the Open Countryside' adopted in December 2010**.**

4.3 The overall national planning policy on noise is set out in the National Planning Policy Framework (the NPPF - CD 2.1) published in March 2012. The NPPF states (inter alia) at para.123 that:

"*Planning policies and decisions should aim to:*

- *avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development:"*
- *identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason"*

4.4 At footnote No. 17 on page 22 the NPPF cross-references to the 'impact' sections of National Policy Statement EN-3 (*NPS for Renewable Energy Infrastructure* [CD 2.8]) and EN-1 (*Overarching NPS for Energy* [CD 2.7]). EN-1 (at 5.11.6) states that:

"…operational noise, with respect to human receptors, should be assessed using the principles of the relevant British Standards and other guidance. Further information

on assessment of particular noise sources may be contained in the technology-specific NPSs. In particular, for renewables (EN-3)…".

4.4 EN-3 refers to ETSU-R-97 '*The Assessment and Rating of Noise from wind farms* [Reference 2 - CD 9.1]. This document provides a means of defining 'acceptable' noise limits for new wind farm developments. The ETSU-R-97 assessment procedure has been routinely applied by developers in support of wind farm planning applications and was (prior to the NPPF) explicitly referred to in the guidance in PPS22 (now withdrawn).

4.5 '*Planning practice guidance for renewable and low carbon energy'* [CD 2.5], issued by the DCLG in July 2013 (effectively replacing the Companion Guide to PPS22) states that …
"ETSU-R-97 should be used by local planning authorities when assessing and rating noise of wind energy developments".
The guidance also endorses the Institute of Acoustics Good Practice Guide (the '*IoA GPG'* [Reference 8 - CD 9.12] as a supplement to ETSU-R-97.

4.6 EN-3 states that (2.7.58):
" Where the correct methodology has been followed and a wind farm is shown to comply with ETSU-R-97 recommended noise limits, the IPC may conclude that it will give little or no weight to adverse noise impacts from the operation of the wind farm".

4.7 I observe that the policy statement does not prescribe that demonstration of compliance with the ETSU-R-97 noise limits is the sole 'test' to be applied to a proposed wind farm, when assessing the impact of the resulting noise levels. The words 'may' and 'little' show that compliance with the ETSU 'test' is not to be taken to be the only consideration.

4.8 I state at this point that I do not consider that ETSU-R-97 alone necessarily provides an adequate basis for assessing the impact of noise from a wind farm on a local population, particularly in rural areas where the existing background noise levels can be very low, particularly at night. I consider that in such cases it is appropriate to refer additionally to other standards and criteria to enable the potential noise impact of a proposed wind farm to be fully assessed. Although EN-3 and the latest DCLG Guidance [CD 2.5] state that ETSU-R-97 should be used for the assessment and rating of wind farm noise, neither document states that ETSU-R-97 should be used

solely, and neither precludes the application of additional guidance and criteria. Inspectors at some Planning Appeals have accepted the case for applying ETSU-R-97 flexibly and making use of additional standards and criteria for assessing noise impact. I discuss this issue in Section 7 of this proof.

5 Approach to Noise Assessment

Construction noise

5.1 Noise affecting the local area will be generated by the use of plant and machinery and by vehicle movements during the construction and decommissioning of a wind farm. The FEI provides a detailed assessment of construction noise in Appendix E. I have no criticism of this assessment, or of the absence of an assessment of decommissioning noise: such an assessment would necessarily be speculative because the working methods likely to be adopted 25-30 years hence cannot be anticipated.

5.2 I consider that construction and decommissioning noise could be controlled to acceptable levels by means of measures such as a requirement to adhere to an approved Construction Management Plan. Noise during these phases can be dealt with by means of a Condition referring to such a Plan, and should not present an obstacle to granting planning permission. Therefore my evidence is concerned only with the noise from operating wind turbines.

Terminology – Units for Noise Measurement and Assessment

5.3 Technical terms relating to the measurement of noise are explained in Appendix1 to this proof. It is standard practice to assess the impact of wind farm noise on the basis of noise levels measured on the dB(A) scale, using the noise metric L_{A90} – the noise level exceeded for 90% of the time. There has been considerable publicity, particularly in the form of material on internet sites, concerning the effects of low-frequency noise and infrasound and ground-borne vibration. It has been suggested that wind turbines can generate levels of low-frequency noise and infrasound, or vibration, that can have direct adverse health effects, and that these factors are not adequately assessed by dB(A) measurements. This is an area of legitimate public concern, but there is no general, scientifically-informed agreement that such effects

can result. I refer to this further in Section 8 of this Proof. Therefore my evidence relates only to the assessment of the levels of wind turbine noise, as measured on the dB(A) scale, likely to be audible at dwellings in the vicinity of the site, and the potential effects of these levels of noise on residential amenity.

Operational noise

5.4 For modern wind turbines, the main source of noise is the interaction of the air with the surfaces of the rotating blades. Noise is radiated from the turbine in all directions, although at the distances we are concerned with here the highest noise levels are created downwind of the turbine. It is a feature of most types of modern wind turbine that noise levels increase as the wind speed increases from the starting ('cut-in') wind speed of around 3m/s to a wind speed of around 8-10m/s, above which the noise emission 'levels out'.

5.5 The noise assessment process in the ES generally follows the procedures set out in ETSU-R-97 as follows:

- Dwellings or groups of dwellings in the vicinity of the site ('receptors'), including the dwellings closest to any proposed turbine location, are identified.
- Noise surveys are carried out to establish typical background noise levels, over a range of wind speeds, close to representative dwellings. Measurements are made of the L_{A90} noise levels in successive 10 minute intervals and correlated with measurements of the concurrent average 10-minute wind speed as measured on the wind farm site. This data produces a 'scatter plot' of noise level against wind speed, which enables a 'best fit' curve to be derived using a mathematical technique termed regression analysis. This curve represents a relationship between average noise level and average wind speed for each location.
- The 'average' values of background noise levels are determined separately for the night time (23.00 – 07.00) and 'quiet daytime' or 'amenity hours' (evening and weekend) periods.
- The results of the background noise surveys are used to derive noise limits. The noise limits proposed in ETSU-R-97 for dwellings are set at:

  5 dB above the 'mean' background level at any wind speed

  or

  a fixed level in the range 35-40 dB during the day (the value in the 35-40 range to be determined from consideration of site-specific factors) and 43 dB at night

  whichever is higher.

- Calculations are performed to predict the noise levels, for a range of wind speeds, that will be created at the representative dwellings when the wind turbines are operating.
- Predicted wind farm noise levels are compared with the derived noise limits to establish compliance.

6 Review of the Noise Assessment in the ES and FEI

(Note: unless otherwise stated, references to paragraph, Figure and Appendix numbers in the ES refer to Appendix G to the 2010 Environmental Statement)

Identification of Receptors

6.1 The ES identifies 11 properties as being representative of dwellings in the vicinity of the site. These are identified as H1 – H11 and are identified on Table 5.1 and on the map on Figure 5.1 in the ES, a copy of which I attach as Figure 1. I agree that these are appropriate general locations for assessing noise from the wind farm: they are distributed round the Appeal site and represent the nearest dwellings to the site. However, it should not be inferred that these are the only dwellings likely to be affected by noise from the wind farm: there is more than one dwelling at some of these locations, and locations H2 and H7 (identified as Station Road and Greatworth) are at the, edges of Helmdon and Greatworth villages where there are many dwellings. I am informed that the house at Fatlands Farm, to the SSE of Grange Farm (identified on the Figure in Appendix 1), previously empty, is now occupied: wind farm noise levels at this dwelling would be similar to those at H2 (Station Road, Helmdon).

Baseline Noise Levels

6.2 TNEI carried out background noise measurements at nine locations (H1 – H9) between 18 March and 25 May 2010 (5.11). Two of monitoring systems (at Peter's Farm and Astral Row, Greatworth – H1 and H7) were relocated during the survey at the residents' request. The measurement procedure is explained in ES paragraphs 5.1.2 – 5.2.40. ES Appendix 5 presents a data sheet for each measurement location, including the two 'replacement' locations at H1 and H7, with photographs showing the equipment installed at each location and its position relative to the dwelling.

6.3 From the information available, the measurement positions appear to be appropriate and in accordance with current good practice [Reference 8 – CD 9.12]. I have some reservations about measurement position 10, the 'replacement' location at H1 (Peter's Farm): this was in a field near the property, amongst long grass, close to trees and hedges and not obviously representative of the environment in the garden of the farmhouse where the equipment was first placed, as shown by comparing the photographs of positions 1 and 10 in ES Appendix 5. However, comparing the data (which combines measurements at both locations) with that from other locations I have no reason to suggest that the data is not valid.

6.4 Overall, I consider that the background noise surveys were properly conducted and would be expected to provide representative measurements of background noise level at the selected positions, which were adequate number and location. The equipment used was fit-for-purpose and operated correctly.

Wind and rainfall measurements

6.5 As described in ES paragraph 5.1.4, wind speed and direction data was derived from a ZephIR LiDAR (light detection and ranging) system during the first 5 weeks of the survey, and subsequently using conventional anemometers mounted on a 60 metre mast. Data was analysed by others (Natural Power Limited and Nexgen). The ZephIR LiDAR incorporates a rain sensor which was used to detect rainfall to enable rain-affected data to be discarded during analysis. During the second period of the survey there was no on-site rain-detection system (such as a recording rain gauge) and periods of rainfall were identified using weather-radar data obtained from the Met Office.

6.6 The use of LiDAR (a ground-based device) for measuring wind speed (and direction) is a relatively recent development but is progressively replacing the use of conventional anemometers mounted on a tall mast. Studies which compare measurements made using both methods on the same site have demonstrated good correlation. LiDAR measurements can be compromised by factors such as the presence of obstructions (buildings or trees) and experience is required in selecting an appropriate location for the equipment, and in filtering the measured data to remove anomalies. The ES provides no information about the installation and operation of the LiDAR, although the operators (Natural Power Limited) are

associated with the system supplier (ZephIR) and I have no reason to question the precision of the LiDAR data.

6.7 Recommended practice (the IoA GPG) is to obtain rainfall data using a recording rain gauge on or near the site (which could be the rain sensor on LiDAR equipment). The reliability of Met Office weather radar data, as used during the second survey period here, is uncertain because of the available resolution (both of location and time). However, this source was only used for part of the survey period and I would not expect that any errors resulting from mis-identification of periods of rainfall would be significant.

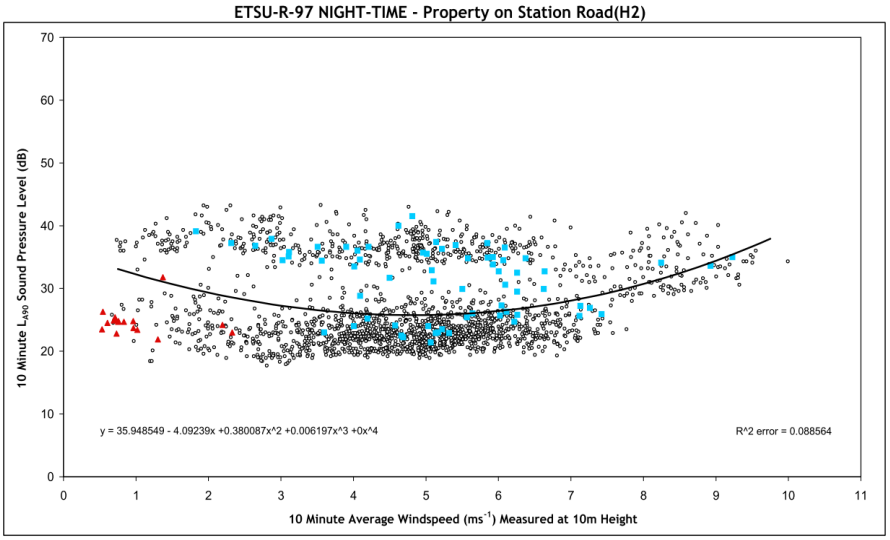
Baseline Noise Levels – Analysis

6.8 The baseline noise data reported in the ES is carried forward to the FEI: Figures 5.2 – 5.23 in the ES are therefore identical to Figures 12.1- 12.22 in Appendix E to the FEI.

6.9 The background noise data was processed after discarding potentially non-typical data (as identified in ES paragraphs 5.2.7 - 5.3.2) to derive scatter plots of noise level against wind speed These plots are shown in the odd-numbered Figures 5.3 - 5.23. They also show the calculated 'best fit' line to the data points, calculated using Excel software. The line is a curve representing the equation shown in the box on each plot. There are separate plots for 'night hours' and 'daytime amenity hours'. The wind speed (the x-axis) is the 'standardised wind speed at 10 metres' calculated from wind speeds measured using the LiDAR or the mast-mounted anemometers: this accords with current practice [Reference 8]. The even-numbered Figures 5.2 - 5.22 show the range of wind speeds and directions during the survey period, again separated into 'quiet daytime' and night time periods. These latter figures are essentially the same (since a single source of wind data is used for all the noise measurement locations) except that in some cases different data points may have been excluded at the different locations.

6.10 I have been provided with the 'raw' noise and wind data and from sample analysis I am satisfied that the data has been analysed in accordance with the procedure adopted and I do not dispute that the measured noise levels represent the background noise climate at the measurement locations during the survey period. The survey covered an adequate range of wind speeds and directions.

6.11 However, I have been concerned about one conspicuous feature of the scatter plots in Figures 5.3 – 5.23 (the odd numbered figures). The scatter plots of night time data (the lower graphs on each page) show in nearly all cases a distinct 'banding' of the data points. Figure 5.5 (for position H2 - Station Road), reproduced below, is a clear example, although the night time noise data for all measurement sites shows this characteristic. For wind speeds up to about 7m/s there are two distinct groups of data points, the lower group in the 20-25dB range and the upper group in the 35-40dB range. All data points (except those shown to be excluded) are taken into account in calculating the best fit line, which clearly is positioned at a higher level than it would be if the upper band of data were excluded.



Extract – Figure 5.5 (lower graph) from ES

6.12 This feature of the night-time noise data was unexplained. I drew attention to it in my note of 5 December 2010 to HSGWAG (attached in my Appendix 2) and TNEI provided a response in Appendix E to the FEI, although I did not consider this response adequate. TNEI have now provided the supplementary Note dated 7 August 2013 which addresses this point by discarding the outlying data points, resulting in revised 'best fit' lines for night time noise.

6.13 In discarding the outlying data, TNEI have concluded that these higher noise level events are the result of the so-called 'dawn chorus', continuous birdsong occurring during spring and early summer months during a period around sunrise. The IoA GPG recommends that noise from this source is discarded, since it is a seasonal phenomenon and therefore not typical of the situation prevailing for the greater part of the year. TNEI have previously declined to discard this data, as explained in

Mr Arnott's proof to the previous inquiry at paragraph 5.8; extracts from that proof are attached in my Appendix 3.

6.14 Whilst I agree that noise clearly identifiable as dawn chorus noise should be excluded, I am not completely satisfied that all the outlying points in the night time noise datasets (as presented in the ES and FEI) result from this source. It is also a possibility that some of these points are the result of early morning road traffic noise from distant sources such as the M40 and A43. If distant road traffic noise is a contributor to background noise levels during the daytime (and it is referred to in the Noise Monitoring Field Data Sheets in Appendix 5 in the ES) then I would expect the level to be dependent on wind direction. Since the nearest main roads (the M40 and the A43) are to the west and the SE respectively I would expect noise from these roads, as perceived around the appeal site, to be lowest when winds were from the NE (between north and east). This could be important for dwellings to the south and west of the site (such as Greatworth Hall and Greatworth village) since it is in this wind direction that wind farm noise levels would be highest. In this situation, to provide a 'like-for-like' comparison, the IoA GPG recommends (paragraphs 3.1.22 – 3.1.24 of Reference 8) that it may be necessary to determine typical background noise levels for the wind direction giving the lowest background noise levels (and hence noise limits) and the highest wind farm noise levels. This 'directional analysis' is achieved by filtering the background noise data to exclude data for wind directions other than those representing the 'worst case'.

6.15 I also raised this issue in my note for HSGWAG of 5 December 2010 (attached in my Appendix 2) and subsequently with Mr Arnott. The TNEI Note of 7 August 2013 states that directional analysis is "not necessary or beneficial". I have asked Mr Arnott to explain that statement but have not yet received a response. If directional analysis were applied, it is possible that the ETSU-R-97 noise limits for dwellings to the south of the site would be set at lower levels: this could be important for Greatworth Hall and Bungalow Farm, where margins between predicted noise levels and the current derived noise limits are tight (even for the candidate V90 turbine). Depending on the outcome of further explanation sought from Mr Arnott I may need to provide supplementary evidence on this matter.

Prediction of Noise from Wind Turbines

6.16 The noise assessment necessarily relies on *predicted* noise levels from the operating wind farm. The prediction procedure is explained in 6.1 and 6.2 in the ES.

6.17 The predictions in the ES were based on the use of the REPower MM92 2.05 MW wind turbine. The TNEI Note of 7 August 2013 introduces an alternative candidate, the Vestas V90 2.0 MW. Both are variable-speed pitch-regulated turbines. They can be operated in a number of 'modes', by controlling blade pitch and rotational speed, to provide a trade-off between power generation and noise emission. All calculations presented assume that the wind turbines are operating in their 'unconstrained' (highest-noise) mode.

6.18 Noise levels at off-site locations ('receptors') are calculated using the method of ISO 9613-2 [Reference 3 – CD 9.6], as explained in ES paragraphs 6.2 – 6.7. This method is endorsed in the IoA GPG, subject to appropriate input parameters (source and receiver height, ground conditions, temperature/humidity and wind turbine Sound Power Levels) being used. The predictions apply in the situation where the receptors are downwind of the turbines. In practice, noise levels at any particular receptor will vary with wind direction: in upwind conditions, when the wind is blowing in a direction from the receptor towards the wind farm, noise levels will generally be about 10dB lower than in the predicted downwind case.

6.19 The predictions of noise levels at receptors, as presented in the ES (Tables 6.3 – 6.5) and the FEI (Tables 12.6 and 12.7), and produced at the previous appeal, have now been superseded by the Tables and Figures attached to the TNEI Note of 7 August 2013. The noise levels predicted for the MM92 turbine have been revised by applying corrections to the manufacturer's Sound Power Levels in accordance with recommendations in the IoA GPG. With these corrections, predicted noise levels were shown to equal the derived ETSU-R-97 noise limits at some locations. Noise levels for an alternative candidate turbine, the Vestas V90 were therefore provided in the TNEI Note. Subject to my comments in 6.20 below, my observations concerning the effects of noise from the development are based on the noise levels, at receptors, resulting from operation of Vestas V90 turbines, which is the Appellant's revised position.

6.20 I am satisfied that the predictions of noise levels at receptors are mathematically correct, using the adopted method. However, a question remains (at the date of this proof) about the values of Sound Power Level adopted for the Vestas V90 turbines. The TNEI Note of 7 August 2013 does not state the values assumed. No manufacturer's data sheet or test report is provided or referred to. The IoA GPG provides recommendations (in Section 4.2) on the interpretation of manufacturer's data and requires corrections to be added in some cases, depending on the level of information available, to allow for test and measurement uncertainty. I have asked TNEI to confirm the values of Sound Power Level assumed for the Vestas V90 and to provide supporting documentation. Until this is received I am unable to confirm whether or not I agree that noise levels at receptors, for the V90 turbines, are correctly predicted according the IoA GPG. However, as stated in 6.19, my further observations in this proof are based on the assumption that these predicted levels are correct (in these terms).

6.21 Noise prediction is not an 'exact science' and predicted levels are inevitably subject to uncertainty. Recent reported Australian research [Reference 19 – CD 9.11], where measured wind farm noise levels were compared with those predicted using different prediction models (and different input parameters for these models) indicated that the use of the ISO 9613-2 prediction method, with ground factor G of 0.5, as adopted in the ES, although usually slightly over-predicting wind farm noise levels in the surrounding area, can sometimes under-predict noise levels. However, this research relied on measured turbine Sound Power Levels (i.e. without any correction for uncertainty). I am satisfied that there is reasonable confidence that (assuming that appropriate values of Sound Power Level for the Vestas V90 have been adopted) noise levels from wind turbines at Spring Farm Ridge would not exceed those predicted in the TNEI Note of 7 August 2013. There is one possible exception: the noise propagation path from the wind turbines to Helmdon, to the east, is across a valley – 'concave ground'. Research, supported by the Australian study [Reference 18 – CD 9.11], shows that the adopted prediction method is prone to under-prediction in this situation, because of the influence of reflections from the ground surface. The effect is referred to in the IoA GPG (paragraph 4.3.9), which recommends that a correction of +3 dB is added to predictions for propagation across concave ground. This correction is 'triggered' only if the mean propagation height exceeds a specified value (according to a formula). In this case I do not consider that this correction would apply because the mean propagation height would be less than the 'trigger' value. However, the effects of topography on the propagation of wind turbine noise have not

been fully researched and it is likely that enhanced noise propagation effects can occur even when the IoA GPG mean height 'trigger' is not reached. Therefore it is likely that wind farm noise levels at H2 (Station Road) and in Helmdon village would be rather higher than the predictions in the FEI indicate, although the degree of under-prediction would be less than 3dB.

Assessment of Noise Impact in the ES/FEI/Note of 7 August

6.22 The noise assessment in the Appellant's documents is based on comparisons, at each of the 11 representative receptors, between the predicted wind farm noise levels and the derived ETSU-R-97 noise limits, which are set at 5dB above the average background noise levels but subject to lower limit values of 35dB during the day and 43dB at night. These comparisons are shown on the Figures and Tables SG1 – SG11 in the TNEI Note of 7 August 2013.

6.23 The Figures and Tables show that in all cases the predicted noise levels for the Vestas V90 turbine are lower than the ETSU-R-97 limits. Noise levels approach the limits most closely at wind speeds around 5-7m/s during the daytime. The margins between noise limits are tightest at four receptors - Spring Farm, Bungalow Farm, Greatworth Hall and Stuchbury Hall Farm, being between 1.5 and 2.8dB. With the original MM92 candidate turbine, the revised predictions show that the compliance margins would be minimal or zero at some locations.

6.24 Therefore, subject to confirmation that the assumed Sound Power Levels for the V90 turbine are shown to be valid in accordance with the IoA GPG recommendations, I am satisfied that the development, if it used these turbines, would comply with the derived ETSU-R-97 noise limits. I am not convinced that the MM92 wind turbines would operate within these limits, because of the absence (or minimal extent) of any safety margin between predicted noise levels and limits at Greatworth Hall, Bungalow Farm, Stuchbury Hall Farm and Spring Farm.

6.25 It might be argued that if planning permission were granted then noise levels would have to comply with noise limits imposed by conditions and that if noise levels were non-compliant this could be mitigated by operating some wind turbines in lower noise modes. However, such operation is not proposed in the ES, and it would in any case incur some reduction in the generating capacity of the scheme, and by an indeterminate amount. Also, in the event that noise levels were found to exceed the

prescribed limits, considerable time could be required to carry out the measurements required to establish the extent of non-compliance, and to devise and implement the necessary mitigation. During this time residents would continue to be exposed to noise levels in excess of the permitted maxima. There would also be uncertainties in practice as to whether, and if so when, the local planning authority would decide to take effective enforcement action because of availability of resources. Therefore in my view it is essential planning permission should not be granted unless there is reasonable certainty that the development, as proposed, would comply with noise limits in conditions.

6.26 Even if it were shown that the wind turbines, as proposed, can operate within appropriate ETSU-R-97 noise limits, noise from the wind turbines is still likely to have a significant adverse effect on the amenity of local residents, as discussed in Section 7 below.

7 Assessment of Noise Impact - Discussion

7.1 The noise assessment in the ES/FEI and the TNEI Note of August 2013 is based solely on comparison between predicted turbine noise levels and the upper bound of the ETSU noise limits. In my view this approach does not provide an adequate assessment of noise impact. ETSU-R-97 has been criticised by many individuals and groups as being out-of-date and over-generous to wind farm developers in the way it sets noise limits. I accept that ETSU is endorsed in official guidance and I do not contend that the ETSU-R-97 recommendations and proposals should be subverted. However, my view is that establishing only whether wind farm noise levels would (or would not) comply with the ETSU limits does not offer a means of fully describing and considering the noise impact of a proposed wind farm. It is important to understand what ETSU does and what it does not do. The ETSU noise limits are not levels at which there is no adverse noise impact, but are the maximum acceptable 'not-to-be exceeded' levels. Adverse noise impacts can occur at noise levels lower than the ETSU limits, and these impacts should be taken into account as relevant considerations. I explain these statements in the following paragraphs.

7.2 Where background levels exceed a value in the range 30-35 dB in the daytime and 38 dB L_{A90} at night, ETSU recommends noise limits set at values 5 dB L_{A90} higher than the background levels. ETSU accepts that noise at this level above background noise is

"at the upper end of the range which can be considered to be of marginal significance". Therefore it is clear that the authors accepted that noise levels at or close to the proposed limits (of 5dB above background levels) are not 'insignificant' in terms of the likely impact on residents - they are (in the words of ETSU) at the upper end of the 'marginal significance' range.

7.3 Where background levels are lower than the above values, ETSU applies fixed limits of 35-40 dB in the daytime and 43 dB L_{A90} at night. This can permit very significant increases in noise levels in rural areas where background noise levels are currently low, which means that turbine noise will often be audible, both inside and outside dwellings, in some wind conditions.

7.4 ETSU recommends night time noise limits which are (in most rural situations) less stringent than daytime limits. This is illogical and inconsistent with other community noise criteria, which invariably call for lower noise levels at night than during the day. . Also, the ETSU lower night time limit of 43 dB L_{A90} was based on the 1980 World Health Organization (WHO) guidelines, which were revised in 1999. As explained in 8.11 below, external noise above 38 dB LA_{90}, at night, whilst complying with the ETSU noise limits, would result in levels inside bedrooms, with windows open, breaching the current (1999) WHO guideline levels [Reference 5 – extract in my Appendix 4], which are based on avoiding 'negative effects on sleep'.

7.5 The authors of ETSU accepted that the proposed noise limits were a compromise between protecting residents and not placing undue restrictions on the development of renewable energy. It is not clear to me how what the authors saw as the same 'compromise' is applicable to all proposed wind farm locations, irrespective of the nature of the area (and specifically, irrespective of the level of existing ambient background noise when wind speeds are low, when the lower fixed noise limits apply). The only measure of flexibility in the ETSU guidelines lies in the choice of lower daytime noise limit in the range 35-40 dB $L_{A90.}$

7.6 The graph below shows examples of night time background noise levels at two proposed wind farm sites: Site 1 (the solid red line) is in Norfolk, distant from main roads. Site 2 (the solid blue line) is in Hampshire, within 500 metres of a main trunk road. Background noise levels at wind speeds between 4 and 7m/s are 10-16dB apart, but the ETSU-R-97 noise limits up to 6m/s wind speed are identical (the lower fixed limit of 43dB) and are only 1dB different at 7m/s. Clearly the impact of a wind

farm producing a noise level of (say) 40dB at a wind speed of 5m/s would be greater at Site 1 than at Site 2.

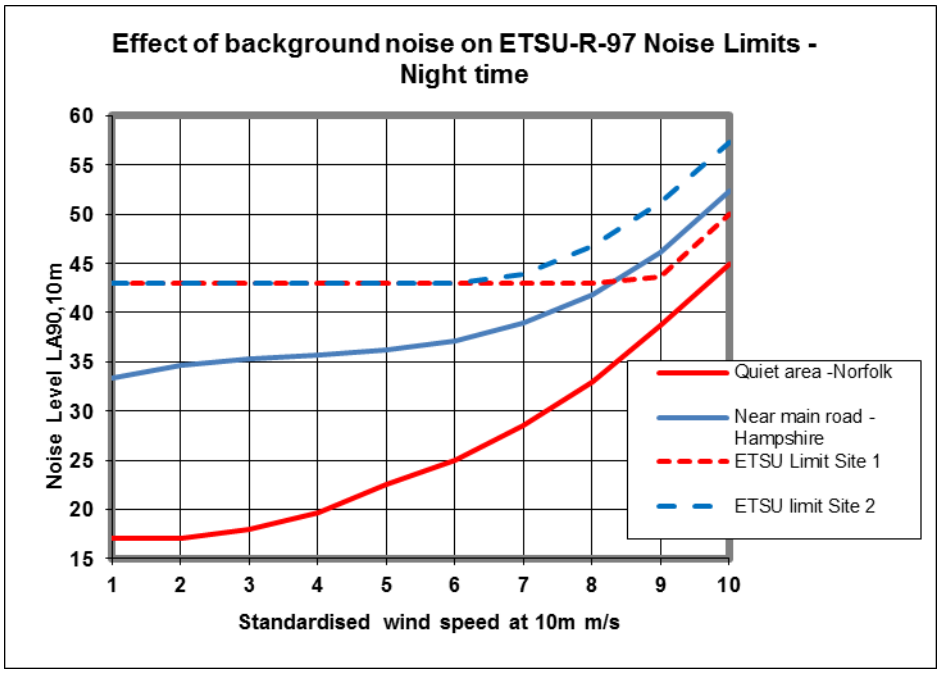


Figure F7.6

7.7 The ETSU assessment method takes no specific account of the presence of enhanced amplitude modulation (blade swish or thump) which, if detectable at a dwelling, would make wind turbine noise more noticeable and intrusive than steady noise of the same mean level. Amplitude modulation has been found to be the cause of complaints from residents near some UK wind farms, although the problem has been often incorrectly referred to as low frequency noise or infrasound. The causes are not understood and further research is in progress: the background to the research commissioned by RenewableUK is attached in my Appendix 9. This remains an area of uncertainty. I refer further to amplitude modulation (AM) in Sections 8 and 9 below.

7.8 In my opinion the ETSU noise limits should be taken as the maximum acceptable 'not to be exceeded' noise levels. This is what happens in practice: I am not aware of any wind farm granted planning permission since 1997 which is permitted to generate noise levels in excess of the ETSU limits. There will be adverse noise impacts at lower levels, particularly in areas where existing background levels are very low. It is accepted practice in environmental assessments to rate impacts on a semantic scale (using terms such as "negligible-low-medium-high-very high"). ETSU provides no such means of establishing the significance of noise impact; it merely proposes a method of

establishing noise limits that are at the upper limit of acceptability. To put it simply, it offers a 'pass/fail' approach. Clearly noise levels do not change from being 'of no consequence' to 'unacceptable' as a threshold is reached and passed. It follows that there must be an adverse noise impact at noise levels that are lower than the ETSU limits. If there are such impacts they should be taken into account.

7.9 I am aware that these views have not been accepted at some previous public inquiries. Inspectors have taken the view that provided it has been shown that wind farm noise levels can comply with the ETSU limits, as demonstrated by a robust assessment based on a 'candidate' turbine, and a condition is imposed to contain noise within these limits, then noise is not a factor in determining the appeal.

7.10 However, at a number of inquiries (I quote examples in 7.12 - 7.24 below), Inspectors have expressed concerns about a number of noise-related issues, even in situations where a noise assessment demonstrates that noise levels would not exceed the ETSU limits. The issues included: uncertainties associated with the predicted noise levels, the reliance on a 'candidate' turbine in the assessment, and the likelihood of loss of amenity in tranquil locations where existing background noise levels are very low. Inspectors have also expressed concerns about the possibility of amplitude modulation, and about the effectiveness of conditions in constraining noise levels within prescribed limits. Inspectors have also drawn attention to the need for background noise levels to be reliably determined, and have expressed concern in cases where a noise assessment shows minimal 'safety margin' between predicted noise levels and noise limits. These considerations have not in all cases changed the outcome of an appeal, but they have been taken into account in the overall balancing exercise.

7.11 I refer below to observations made and opinions expressed by Inspectors at more recent Inquiries. The extracts are necessarily selective. I have attempted to avoid editing which has the result of misrepresenting the views stated. I refer to the paragraph numbers in the Decision Letters in all cases in order that the extracts can be placed in context

Rossie, Fife (February 2008) [Reference 10 - CD 6.32]

7.12 The Reporter commented:

"My main conclusion on noise is that, subject to some reservations about AM, the

ETSU-R-97 standards would be met. To that extent, the proposal would therefore be acceptable from a noise point of view. However, as the appellant acknowledged, under some conditions during both day and night the turbines would result in a noticeable increase in noise levels at a large number of properties. This is not relevant in terms of ETSU-R-97, which is concerned with acceptability, not audibility. However, when people who are opposed to wind farms are able to hear, as well as see, the turbines, I believe that can increase the impact on residential amenity. Given the close proximity of the turbines to a large number of houses, particularly in Auchtermuchty, I attach some weight to this issue (28)".

Beech Tree Farm, Goveton, Kingsbridge (April 2009) [Reference 11- CD 6.33]

7.13 The Inspector said that:

"ETSU is not to be interpreted as statute or applied inflexibly, especially as the document describes a framework for the measurement of wind farm noise and gives indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours without placing unreasonable restriction on wind farm development….. I have had regard to it as guidance on good practice in assessing the likely change to the noise environment, in considering the effects on amenity, and in the balancing exercise to be made in the circumstances which apply here".(35)

"I find that the proposed development would by reason of noise, impair the residential amenity of the occupiers of Pasture Combe to some extent; and that it might detract, at times, from the tranquillity currently enjoyed by those living or working in, or visiting, this part of the countryside…. The degree of harm arising from noise, and the extent of any policy conflict, are matters to be weighed in the balance – having regard to relevant policy and taking into account that there is no dispute in this case that the proposed development would not breach ETSU indicative limits. I return to this balance later".(45)

and:

"… Turbine noise would, to some extent, adversely affect the residential amenity of those living nearby, and would at times impair the tranquillity of the area. This is a factor to be weighed in the balance". (48)

Nantglyn (November 2009) [Reference 12 – CD 6.34]

7.14 In dismissing the Appeal, the Inspector stated that:

"… I have no doubt that these turbines could, with the suggested conditions, operate within or at the levels suggested in ETSU-R-97. These are the standards normally applied in Wales, however they are for guidance and are not absolute values. The problem is that those noise levels do not mean that the turbines cannot be heard." (21)
and:
***"**The cumulative increase in noise, whilst likely to be within ETSU-R-97 levels, would result in a level of harm which would conflict with UDP policy …criteria" (23)*

Den Brook (North Tawton) (December 2009) [Reference 13 – CD 6.2]

7.15 In allowing the Appeal, the Inspector addressed noise issues extensively in paragraphs 69-122. Whilst acknowledging the significance of ETSU-R-97 he referred to a number of reservations (in paragraphs 71-79), including the requirement to modify the ETSU procedure to take account of site-specific wind shear (72), the fact that the authors of ETSU recommended that it should be reviewed after 2 years, whereas no review has taken place (71), and that there is legitimate debate about the issue of night-time noise and sleep disturbance (77-78). The Inspector referred to these matters as follows:

"… to provide a context for the ensuing considerations, and to record my sympathy with the view that a review of ETSU-R-97 is overdue" (80).

7.16 At (118) the Inspector said that

"The parties are effectively in agreement that the utility of ETSU-R-97 is questionable in some respects, and I have also been quite critical in a number of respects".

Grise [Reference 14 - CD 6.35]

7.17 The Inspector said:
"*Given my concerns regarding the nature of the background noise levels …. and their critical importance in setting noise levels for the operation of the wind farm, I consider that the figures should be treated with considerable caution. This, coupled with my discomfort as to the limited headroom that appears to be in the comparative figures leads me to the conclusion that there is a distinct possibility that the living conditions of the residents of (3 dwellings) and potentially some other properties would be significantly and unacceptably affected by noise…." (11.66).*

In 11.58 and 11.59 the Inspector gave some significance to the observation that although noise levels were shown to comply with the ETSU night-time noise limits the predicted noise levels exceeded the existing background noise levels by more than 5dB at some wind speeds.

Matlock Moor [Reference 15 - CD 6.36]

7.18 The Inspector expressed concern that predicted noise levels were either at the ETSU limit or within 2dB of the limit at 2 dwellings (82).

7.19 The Inspector observed that the predicted noise level could at some times exceed the background noise level by around 10dB at (2 dwellings), and said:
"I *anticipate that the tranquillity currently enjoyed by the residents and visitors at these properties would be spoiled as a result. A 10dB increase in noise would double the noise experienced and according to BS4142:1997….noise complaints are …. likely in such circumstances" (84).*

7.20 At (86) the Inspector expressed concern that since compliance with noise limits was likely to be marginal at some dwellings, with little or no '*safety cushion'*, the noise conditions might be '*brought into play with some frequency'*. The investigations required to check compliance with conditions could take many weeks to resolve and, during that time, complainants might have to live with a noise problem. If this situation were to arise it could have a serious impact on their living conditions.

Moorsyde [Reference 16 – CD 6.37]

7.21 At (331) the Inspector expressed concern that, even ignoring criticisms from the residents' group about the background noise levels and the noise predictions, it would be '*a challenge'* for the wind farm operator to meet the ETSU noise limits at all times and observed that: .
"…*at certain times and in certain places the ETSU-R-97 limits would be met with only 2dB to spare… at three properties there would be significant potential for the noise limits to be exceeded".*

7.22 Although the Appellant had offered mitigation (reducing the power of the three nearest turbines in certain wind conditions, if necessary) the Inspector said that the

potential for the noise limits to be exceeded, and the complexities involved in enforcing the noise conditions, was '*a matter that causes me considerable concern'.*

Princes Soft Drinks (Bradford) [Reference 17 – CD 6.38]

7.23 At paragraphs 36-37, the Inspector raised questions about the uncertainties involved in calculating the 10m standardised wind speed from measurements at greater heights, and questioned whether the procedures took account of atmospheric conditions. She drew attention in paragraphs 40-43 to the tight margins between the predicted noise levels at the ETSU limits (at night) at some dwellings and commented as follows: .

"ETSU-R-97 was written some time ago, when wind turbines were much smaller. …. Given that the technology has moved on so much, the effects of modern machines are likely to be different from those that prevailed some years ago. In the light of this it should be remembered that ETSU-R-97 is only guidance and should not be used inflexibly. Therefore, it is not unreasonable to consider relevant parts of other noise guidance". (50)

"British Standard 4142, used for industrial and commercial noise, whilst not appropriate for assessing wind turbine noise, is useful for indicating when complaints would be likely". (51)

7.24 The Inspector noted at (53) and (54) that the ETSU night time lower limit of 43 dB L_{A90} had been based on the 1980 WHO sleep disturbance criterion of 35 dB L_{Aeq}, but that this criterion had subsequently been reassessed at 30 dB L_{Aeq}. She also expressed concern about the undesirability of relying on noise conditions to ensure that noise limits were complied with:

"Relying solely on planning conditions to deal with excess noise exposure, should it occur, is unsatisfactory where predicted margins are tight, as in this case". (56)

"Even on the Appellant's results, the margins by which some properties meet the ETSU-R-97 limits are negligible. The methodologies employed are only designed to predict noise levels and cannot precisely state what the actual noise environment would be at any particular locations. Given the close proximity of schools, offices and particularly dwellings, these tight margins and uncertainties merit a cautious approach". (58).

7.25 I am aware that there is case law relating to these matters, resulting from planning decisions being considered in the High Court. I attach at Appendix 6 an extract from ,*Burnett-Hall on Environmental Law'* which refers to some of the decisions from which I quote. These judgments appear to me also to support the view that ETSU-R-97 is not 'the complete answer'.

7.26 I believe that these conclusions from Inspectors and the High Court lend support to my professional opinion that compliance with noise limits based on ETSU-R-97 does not, in itself, ensure that people living in the vicinity of a wind farm will not suffer disturbance and loss of amenity. The loss of amenity could be significant. Noise impact is therefore a matter that should be considered and weighed in the balance to be made between adverse effects and the benefits of the scheme, even in cases where it has been demonstrated, using predictions based on a 'candidate' turbine, that the wind farm can be operated within ETSU noise limits and where appropriate noise conditions could be applied on the permission.

7.27 I recognise that national policy on onshore wind has changed since the decisions to which I refer were issued. However, I do not see that the views expressed by Inspectors in those decision letters would conflict with current policy as set out in the NPPF or EN-3. EN-3 clearly permits some flexibility in the weight a decision-maker should give to the outcome of a noise assessment using ETSU-R-97. No policy document states that compliance with the ETSU-R-97 noise limits is the one and only relevant consideration, or rules out the use of additional guidance or standards in addition to ETSU-R-97.

7.28 As noted in 7.8 above, ETSU provides no means of assessing the significance of noise impact other than proposing a method of establishing noise limits that are at the upper limit of acceptability. An alternative or additional means of assessing noise impact is by comparing the level of the 'new' noise with the existing background noise. This is the principle of BS4142 [Reference 6 - CD 9.13] which is the Standard used in the UK for assessing the noise impact (in terms of the likelihood of complaints) of most types of industrial noise. The change in the noise environment resulting from a development does seem to me to be a relevant consideration and the 'new noise relative to existing background noise test' does, I believe, offer a useful guide to the potential noise impact of a wind farm development. I note that the Inspectors at the Matlock Moor and Princes Soft Drinks Appeals (see above) took account of the conclusions to be drawn from a 'BS4142 type' assessment. It is necessary to consider

the change in the noise environment caused by a development in order to judge compliance with the provisions in local and national planning policy on noise and amenity.

7.21 BS4142 indicates that where the level of a 'new' noise exceeds the background noise level (with the 'new' noise absent) by more than about 10dB, complaints concerning noise are 'likely'. An increase of around 5dB is 'of marginal significance' in terms of the likelihood of complaints. In BS4142, the 'new' noise is expressed as an L_{Aeq} (time-average) level, whereas wind farm noise levels are expressed as L_{A90} levels. For a wind farm, L_{Aeq} levels are about 2dB higher than L_{A90} levels: therefore in terms of L_{A90} levels (as used here) the BS4142 'marginal' and 'complaints likely' thresholds are around 3dB and 8dB respectively.

7.22 The Table below sets out the excess of predicted turbine noise above the night-time and quiet daytime background noise levels for the V90 turbine, at the wind speed for which the excess is greatest (6 m/s in all cases). Predicted wind turbine noise levels and background noise levels are taken from the tables on Figures SG1-SG11 in the TNEI Note of 7 August 2013. The 'excess' values in the last columns are rounded to the nearest dB, for clarity.

Table T 7.22 Predicted Wind Turbine Noise Levels vs. Background Noise Levels

Receptor	Predicted V90 turbine noise level L_{A90} dB @wind speed	Background noise level L_{A90} (all at 6m/s wind speed)		Excess turbine noise over background noise (L_{A90}-L_{A90})		Excess turbine noise over background noise (L_{Aeq}-L_{A90} as BS4142)	
		Night	Quiet Day	Night	Quiet Day	Night	Quiet Day
Peter's Farm	30.9 dB @ 6m/s	26.6 dB	32.3 dB	4.3 dB	-1.4 dB	6 dB	1 dB
Station Road	31.7 dB @ 6m/s	24.0 dB	32.1 dB	7.7 dB	-0.4 dB	10 dB	2 dB
Grange Farm	34.0 dB @ 6m/s	26.5 dB	33.9 dB	7.5 dB	0.1 dB	10 dB	2 dB
Spring Farm	38.1 dB @ 6m/s	28.0 dB	35.5 dB	10.1 dB	2.6 dB	12 dB	5 dB
Bungalow Farm	38.1 dB @ 6m/s	24.8 dB .	35.2 dB	13.3 dB	2.9 dB	15 dB	5 dB
Greatworth Hall	38.4 dB @ 6m/s	24.8 dB	35.2 dB	13.6 dB	3.2 dB	16 dB	5 dB
Greatworth	33.1dB @ 6m/s	24.2 dB	33.6 dB	8.9 dB	-0.5 dB	11 dB	2 dB
Manor Farm	33.9 dB @ 6m/s	26.3 dB	34.2 dB	7.6 dB	-0.3 dB	10 dB	2 dB
Stuchbury Hall Farm	36.8 dB @ 6m/s	28.0 dB	33.3 dB	8.8 dB	3.5 dB	11 dB	6 dB
Stuchbury Manor Farm	34.6 dB @ 6m/s	26.3 dB	34.2 dB	8.3 dB	0.4 dB	10 dB	2 dB
Ash Vale	35.4 dB@ 6m/s	28.0 dB	35.5 dB	7.4 dB	-0.1 dB	9 dB	2 dB

7.23 It is clear that the predicted wind turbine noise levels, even for the 'quieter' Vestas V90, although compliant with the derived ETSU-R-97 limits, would exceed the existing background noise levels at the nearest dwellings by significant margins. This is particularly the case at night at wind speeds around 6 m/s, when noise levels would equal or exceed the BS 4142 'complaints likely' level at all except two of the listed dwellings. During the daytime, noise levels would rate as 'marginal' at Spring Harm, Bungalow Farm, Stuchbury Hall Farmk and Greatworth Hall. In the following section I present my view on how these noise levels would be perceived by people living in or visiting the area.

8 The Noise Impact of the Development

8.1 In this section I give my professional opinion on how noise from this development, if permitted, would affect local residents and visitors to the area. Although I refer to numerical values of noise level, as far as possible I describe these effects in terms of how they would be experienced in the real world, reflecting the actual land use impacts of the development.

8.2 My assessment is based on the noise levels generated by the Vestas V90 candidate turbine, as tabulated in the TNEI Note of 7 August 2013.

Noise during the Day

8.3 As shown on the Figures in the TNEI Note of 7 August 2013, wind farm noise levels at 4 dwellings (Spring Farm, Bungalow Farm, Greatworth Hall, and Stuchbury Hall Farm) would exceed the existing background noise levels over a range of wind speeds during the daytime amenity hours (evenings, Saturday afternoons and Sundays). Currently, residents living here will experience widely-varying ambient noise levels at these times, with a low background of distant traffic noise, varying levels of noise from wind in trees and other vegetation, punctuated by intermittent noise from passing vehicles, birdsong, and agricultural and domestic activities. Against this background, wind turbine noise would be audible at these dwellings as a relatively steady 'hum', which may exhibit a 'swishing' or 'pulsing' character. I believe that residents at these four dwellings in particular would be very aware of noise from the wind farm, when they were relaxing in the open areas around their houses during evenings and at weekends. I would expect the level and character of the noise to be such as to cause distraction, loss of concentration on other tasks (such as reading in the garden), and annoyance.

8.4 It is the case that wind farm noise would only attain the predicted levels at dwellings in downwind conditions, and it would be audible only over a certain range of wind speeds. For locations to the north of the site, such as Stuchbury Hall Farm, this would be when winds were from the south. I attach in my Appendix 7 a wind rose for RAF Wittering, which I believe provides a typical picture of the average annual distribution of wind speed and direction in eastern England. A rough analysis shows that southerly winds in the range of wind speeds 4-8m/s, which is the critical range here (the wind speed range for which wind farm noise would exceed the background noise

during the day), occur for about 30% of the time. For northerly winds, when dwellings to the south (such as Greatworth Hall and Bungalow Farm) would be affected, the corresponding figure is about 18%.

8.5 Wind turbine noise could be audible, during daytime amenity hours, outside dwellings within about 1 km of a wind turbine. It would be perceived as a low 'roar' or 'hum', possibly overlaid with a 'swish' character, and distinct from other commonplace noises in the area. At four dwellings – Spring Farm, Bungalow Farm, Greatworth Hall and Stuchbury Hall Farm – noise at some wind speeds during the daytime would be at the 'marginal likelihood of complaints' level in BS4142 for the above typical percentages of the time. These are clearly not trivial percentages, and since weather patterns often tend to change quite slowly, noise would be audible at the predicted levels for several days at a time.

Footpaths and Bridleways

8.6 Persons making use of the footpaths and bridleways closer to or crossing the wind farm site would experience higher noise levels. These public rights-of-way (PROW) and their positions relative to the wind turbine positions, are shown on my Figure 2. PROW AN10, AN36 AN9 and AN7 pass within approximately 100 metres of the base of a wind turbine, with separation distances of only about 50 metres between T1 and AN9 and between T3 and AN10. AN10 also passes within about 100 metres of T2, T3 and T4.

8.7 I estimate that noise levels on these footpaths, at the closest points of approach to the turbines, would typically be 51-54 dB L_{A90}, equivalent to 53-56 dB L_{Aeq}, with wind turbines operating in wind speeds around 8m/s. Noise levels would be constant at wind speeds from 8m/s upwards, and only about 3dB lower at a wind speed of 5m/s. At these close distances, the turbine noise would exhibit a characteristic rhythmic 'swish' (amplitude modulation) because of the directivity of noise radiated from the turbine blades.

8.8 These are high noise levels on footpaths in a rural area which currently provides a quite tranquil environment, certainly during the evenings and at weekends. From the ES (Table 6.4 – not updated by the TNEI Note of 7 August 2013) existing background noise levels during daytime amenity hours (measured at dwellings, but assumed similar to levels in open fields) are generally in the range 40-45dB L_{A90} at wind speeds

up to 10m/s. Background noise levels experienced by walkers on these footpaths, passing turbines in turn, would be elevated (compared with existing levels) by up to around 10dB when wind turbines are operating. Wind turbine noise would present a dominant source and would mask the commonplace country sounds such as birdsong. The loudness of noise levels of 53-56dB L_{Aeq} can be judged by comparison with the typical values on Table 2.1 in the ES (extracted from the PPS22 Companion Guide): a level of 55 dB(A) is represented by '*a car at 40mph at 100 metres'* and 60dB(A) as '*a busy general office*'. In my opinion noise at these levels, prevailing over a significant length of these footpaths, would severely detract from the pleasure of anybody using it, especially regular users who had previously enjoyed a more tranquil environment.

8.9 I note that the Reporter at the Rossie Inquiry [Reference 10 -CD 6.32] gave some weight to the effect of noise from wind turbines on common land and footpaths.

"Three of the proposed turbines would be only about 180 metres from the southern field (one of two fields comprising the common*). I consider that most people who use the common for recreation would perceive the visual impact as major and adverse. Additionally, noise levels would reach about 50dB, which many people would probably find annoying. In certain wind conditions, this would no longer be a peaceful place. I consider this to be a significant disadvantage of the proposed scheme". (30).*

"A footpath runs through part of the southern field, providing a link to Auchtermuchty. Two of the turbines would be about 400m from a section of this footpath. The impact on users of this footpath would be significant". (31).

8.10 Although in that case the Inspector was considering the impact on a common (publicly-owned land) of some historic interest, one feature of the site at Spring Farm Ridge is the network of footpaths crossing and bordering the site, such that it can be approached from several directions and walked round by a number of routes. This is rather different from the more usual situation where a single footpath may skirt or cross a wind farm site.

Noise at night

8.11 During the night, it can reasonably be assumed that people would be indoors, either sleeping or preparing to go to sleep. Therefore noise levels inside houses are the important consideration. A reasonable estimate of the difference between external

wind turbine noise and the noise within the house, with open windows, is 10dB [Reference 9, CD 9.9 – extract at MY Appendix 8]. Predicted wind farm noise levels outside at Stuchbury Hall Farm, Greatworth Hall, Spring Farm and Bungalow Farm are between 38.0 and 39.6 dB L_{A90} (equivalent to 40 – 42dB L_{Aeq}) at wind speeds from 8m/s upwards. Noise levels inside bedrooms with windows open would therefore be expected to be 30-32 dB L_{Aeq}. The 1999 World Health Organization Guidelines [Reference 5 – extract in my Appendix 4] recommends that noise levels in bedrooms at night should not exceed 30 dB L_{Aeq} to avoid sleep disturbance. BS8233 [Reference 7 – extract in my Appendix 5] identifies a noise level inside bedrooms at night of 30dB L_{Aeq} as being a 'good' standard, subject to the qualification that this criterion refers only to 'steady, anonymous noise'. Noise of a distinctive character would justify a more stringent criterion. Although primarily intended to provide guidance on design objectives for new dwellings, BS8233 provides further endorsement of the WHO target levels.

8.12 Apart from drawing attention to the relevant WHO/BS8223 guidelines, I am not qualified to give evidence on the potential for wind turbine noise to disturb sleep, as I am not an expert in sleep medicine. My only observation is that I believe that for a person lying awake at night a 'new' and distinctive noise, even at relatively low levels of around 30dB, but at a level of 10dB above the familiar background noise from other sources, has the potential to be very annoying and therefore cause difficulty in going to sleep. There would be some relief, when wind speeds were such that the turbines were not operating or in wind directions for which a dwelling was upwind of the wind farm. However, these periods of relief might serve only to increase the perceived adverse effects of the wind farm noise. People can become habituated to noise, if the noise is continuous or regular in pattern (such as traffic noise) and familiar or anonymous in character. However, in this case wind turbine noise, although present for much of the time, would vary in level depending on wind speed and direction and would sometimes be absent.

8.13 Currently, bedrooms in these houses would be very quiet, in the absence of occasional noise from domestic equipment such as refrigerators etc., even when windows are open. Typical internal background noise levels at wind speeds around 5-6m/s (for example) will be around 15 dB L_{A90} and would not exceed 20dB L_{A90} until wind speeds rose above 7-7.5 m/s. I note that ES Table 2.1 gives examples of 'indicative noise levels' and shows a noise level of 20 dB as being typical of a 'quiet bedroom'. Even with windows open, noise levels inside houses in this area at night will clearly be quiet

or very quiet, and I would expect residents to value the low noise levels they currently experience in bedrooms at night. With the proposed wind turbines operating in a wind speed of 7-8 m/s the wind farm noise level of 30-32dB L_{Aeq} in bedrooms with windows open would be the dominant noise. At all the dwellings identified in the ES, and others in their vicinity, I would expect wind turbine noise to be audible inside bedrooms over a range of wind speeds when these dwellings were downwind of the wind farm. Noise would be detected as a low 'roar' or 'hum', and a distinctive 'swish' character might be present.

8.14 I note that in his proof of evidence to the previous inquiry, Mr Arnott (at Paragraph 5.3) presented a sample calculation of night-time noise inside bedrooms based on the assumption that windows were kept closed, providing a noise level difference between outside and inside of 21dB. I attach the relevant extract from Mr Arnott's proof in my Appendix 3. This is an unrealistic assumption: residents in rural areas cannot be expected to keep windows closed at all times in order to achieve satisfactory living and sleeping conditions.

8.15 The most affected houses would be Spring Farm, Bungalow Farm, Greatworth Hall and Stuchbury Hall Farm, where the excesses of wind farm noise above existing background noise levels would be 11-16 dB (Table T 7.22 above) at some wind speeds. However, wind farm noise would be audible inside bedrooms at night, when windows are open, at most dwellings within 1km of the site in some wind conditions and possibly at greater distances. I believe that some of these residents would find wind farm noise heard inside bedrooms at night to be annoying and distracting and that in some cases noise could cause difficulties in going to sleep.

8.16 Wind turbine noise would be distinguishable from other sources of background noise in the countryside, such as wind in vegetation, animal sounds, agricultural operations and birdsong, because of its frequency content and (when it occurs) continuous nature. Also, as explained in Section 9 below there is a risk that wind turbine noise will exhibit excessive amplitude modulation (blade 'swish' or 'thump').

Overall View on Noise Impact

8.18 My view, as justified above, is that the noise levels resulting from this development would result in a substantial adverse effect on residential amenity and quality of life, and the amenity of the local countryside, which many people would find unacceptable,

irrespective of whether noise levels could be contained within the appropriate ETSU-R-7 noise limits.

9 Other Noise Issues

Construction Noise

9.1 I cover the issue of construction noise (and, implicitly, decommissioning noise) in 5.1 and 5.2 above.

Low Frequency Noise and Health Effects

9.2 There has been widespread publicity (mainly in the press and on internet sites) suggesting that infrasound, low frequency noise and vibration from wind turbines could result in adverse health effects in people living in the vicinity. It is an issue often raised by members of the public and is obviously a matter for concern.

9.3 I am aware that there are public concerns about low frequency noise, infrasound and vibration from wind turbines and possible resulting adverse health effects, but there is no general, scientifically-informed agreement that such effects can result. Inspectors at planning appeals have heard extensive evidence on this matter and have in all cases reached the view that the possibility that low frequency noise from wind turbines could have any adverse effects on local residents does not justify refusing planning consent. I do not disagree with the statements concerning infrasound and low-frequency noise in paragraphs 3.2 in the ES.

9.4 However, I do not discount the possibility that wind farm noise may have *indirect* effects on health, resulting from annoyance and related stress and from sleep disturbance, although these are medical matters and I am not qualified to offer an expert opinion on them.

Amplitude Modulation

9.5 There is a risk that wind turbine noise will exhibit high levels of amplitude modulation ('AM' - a rhythmic 'swish' or 'thump') in some weather conditions. If this phenomenon

occurs, the potential for disturbance due to noise is considerably greater than if the noise is steady in level. The causes of excessive amplitude modulation are not understood, although it has been suggested that the problem is more likely to occur on flat sites where high wind shear (the difference between the wind speed at the top of the rotor 'arc' and the wind speed at its lowest point) is more likely.

9.6 The ES refers to AM in paragraph 3.3 onwards. These paragraphs refer to the 2005 'Salford Report' [CD 9.3] and to a subsequent government statement [CD 9.4].. This response is presumably intended to dismiss concerns about AM on the grounds that the UK government decided not to pursue further research into the phenomenon. This is hardly a helpful scientific opinion on the degree of risk that AM might occur here to the extent that noise impact will be further enhanced. AM is a matter of concern to the UK wind energy industry (and internationally), and RenewableUK (previously the British Wind Energy Association) are currently undertaking a research programme: the objectives of this research, as summarised in the Conference paper attached in my Appendix 9, are to investigate the causes of 'greater than average' AM and to establish the typical annoyance responses to noise which is amplitude modulated. I have been participating in this research: no results have yet been published.

9.7 At 3.3.2 the ES suggests possible factors which might indicate that enhanced AM is more likely on a particular wind farm site, and concludes that the proposed development does not exhibit any of the listed 'characteristics' Since the causes of enhanced AM (which are multiple) are not fully understood, this list of 'risk factors' must be viewed as being speculative, and discussion about whether or not they apply to the Spring Farm Ridge site is therefore of little assistance. All that can be said is the well-documented occurrences of significant AM have so far been limited to relatively few UK wind farm sites and in the current state of knowledge it is not possible to quantify the risk of AM occurring at this site. Although (statistically) the risk of its occurring at any particular site may be small, if it does occur the effects on local residents (in terms of loss of amenity) can be very substantial.

9.8 Because there is no established procedure for measuring or assessing AM, and no defined 'dose-response' relationship, devising a planning condition to address AM presents major difficulties. 'AM' Conditions have been imposed by Inspectors on at least two occasions [Den Brook - CD 6.2 and Swinford - extract in my Appendix 10] although at other appeals [e.g. Batsworthy Cross - CD 6.15] such conditions have been judged to fail the 'tests' of Circular 11/95, being considered by the Inspector to be

either unnecessary or insufficiently precise. A condition of the Swinford type (my Appendix 10), which essentially requires an assessment to be made on a subjective **basis** and relying on information available at the time of the event and applying then-current good practice, might be imposed here. There is a reasonable prospect that the state-of-knowledge will have advanced within 1-2 years to the extent that the severity of AM can be objectively assessed, and its causes adequately understood to enable the characteristic to be mitigated, such that a condition of this form would be effective.

10 Conclusions

10.1 I have reviewed the noise assessment for the proposed wind farm at Spring Farm Ridge, Helmdon, as set out in the Appendix G of the Environmental Statement (ES) dated September 2010, Chapter 12 of the Further Environmental Assessment (FEI) dated February 2012, and the TNEI Note of 7 August 2013. I reach the following conclusions:

10.2 I do not consider that noise from construction and decommissioning activities should present any obstacle to planning permission, subject to appropriate controls. I am aware that there are public concerns about low frequency noise, infrasound and vibration from wind turbines and possible resulting adverse health effects, but there is no general, scientifically-informed agreement that such effects can result. Therefore my evidence relates only to the assessment of the levels of wind turbine noise, as measured on the dB(A) scale, likely to be audible at dwellings in the vicinity of the site, and the effects of these levels of noise on residential amenity and the amenity of the local countryside.

10.3 I am currently awaiting a response from Mr Arnott of TNEI to attempt to clarify two issues:

- The values of Sound Power Levels assumed for the Vestas V90 2.0MW turbine now adopted as the ‘candidate’ for the purposes of noise assessment.

- The necessity for and effect of carrying out directional analysis on the background noise data to derive appropriate noise limits for receptors to the south, south west and south east of the site.

Depending on the outcome of these discussions, which may lead to revisions to the assessment, I may need to provide supplementary evidence.

10.4 The noise assessment as presented relies wholly on a comparison between predicted wind farm noise levels, at local dwellings, with noise limits derived from measurements of existing background noise levels using the procedure in the ETSU-R-97 Report. I do not consider that sole reliance on such a comparison is sufficient to consider the potential effects of wind farm noise on residential amenity in rural areas where background noise levels can be very low.

10.5 Even if it is agreed that noise from the wind farm would not exceed noise limits properly derived using ETSU-R-97, this would not mean that there would be no adverse noise impact in this rural area. This is because the ETSU noise limits do not represent the threshold of no substantial adverse noise impact but only an upper limit of absolute acceptability: the ETSU procedure provides only a 'pass/fail' test. Clearly noise levels cannot change from being 'of no consequence' to 'unacceptable' once a particular threshold is passed. It follows that there must be some adverse impact at noise levels below such a threshold. These impacts could be substantial, as they would be in this case, to the extent that many people would find them unacceptable. I have made comparisons between predicted wind turbine noise levels and existing background noise levels, including using the principle of British Standard 4142, to provide a measure of this adverse impact.

10.6 Inspectors at other inquiries have given weight to this consideration, even in cases where it was not disputed that the ETSU limits would be complied with, and have expressed the view that material loss of amenity can result even in situations where noise levels are 'ETSU-compliant'.

10.7 National policy does not state that compliance with ETSU-R-97 limits should be the one and only test of whether the noise impact of a proposed wind farm is acceptable in reaching a planning decision.

10.8 It is clear that some residents in the vicinity of the proposed Spring Farm Ridge wind farm would experience a significant increase in background noise levels in this currently tranquil area. Wind turbine noise would be clearly audible outside dwellings in some wind conditions during daytime amenity hours (evenings, Saturday afternoons and Sundays). At night, wind turbine noise would be audible in bedrooms, when

windows are open, at a level significantly higher than the background noise level from other sources. At four dwellings in particular, noise levels in bedrooms at night are likely to equal or exceed the WHO recommended limit to avoid sleep disturbance. Residents would suffer a substantial loss of amenity.

10.9 Users of the footpaths and bridleways near to and crossing the site would experience high levels of wind turbine noise which would greatly detract from the pleasure of using these rights of way.

10.10 There is a risk that the wind turbine noise would exhibit enhanced amplitude modulation (a pronounced ‘swish’ or ‘thump’), audible at dwellings. The causes of amplitude modulation are complex and not fully understood, and the risk of its occurring cannot be quantified. The occurrence of enhanced amplitude modulation would result in wind turbine noise being more noticeable and intrusive than steady noise of the same level of the same measured noise level. There are significant difficulties in framing a condition to address enhanced amplitude modulation although such a condition could be imposed if permission is to be granted.

10.11 I conclude that the development as proposed would have substantial adverse effects on the amenity of the area and the quality of life of people living in the vicinity, by way of noise. In my opinion many residents and visitors to the area would consider the impact of noise to be unacceptable.

11 References

1. '*Planning practice guidance for renewable and low carbon energy'*. Department for Communities and Local Government. July 2013. [CD 2.5]

2. *The Assessment and Rating of Noise from Wind Farms.* Report ETSU-R-97. Energy Technology Support Unit (ETSU). 1996. [CD 9.1]

3. ISO 9613: 1966*. Acoustics – Attenuation of sound during propagation outdoors. Part 2: General method of calculation.* [CD 9.6]

4. Article in Institute of Acoustics Bulletin Volume 34 (2). *Prediction and Assessment of Wind Turbine Noise*. [CD 9.2]

5. *Guidelines for Community Noise* Ed Berglund, Lindvall & Schwela. World Health Organization, Geneva, 1999.

6. BS 4142: *Method of Rating industrial noise affecting mixed residential and industrial areas.* British Standards Institution, 1997. [CD 9.13]

7. BS8233: 1999 *Sound Insulation and noise reduction for buildings - Code of Practice.*[

8. *Good Practice Guide to the Application of ETSU-R-97 for Assessment and Rating if Wind Turbine Noise.* Institute of Acoustics. May 2013. [CD 9.12]

9. *The Measurement of Low Frequency Noise at Three UK Wind Farms. Department of Trade and Industry.* Report by the Hayes McKenzie Partnership. Contract Number W/45/00656/00/00. URN Number:06/1412. 2006. [CD 9.9]

10. Wind Farm Appeal Decision – Rossie, Fife. Ref. P/PPA/250/675 [CD 6.32]

11. Wind Farm Appeal Decision – Goveton, Devon. Ref. APP/K1128/A/08/2072150 [CD 6.33]

12. Wind Farm Appeal Decision – Nantglyn. Ref. APP/R6830/08/2074921 [CD 6.34]

13. Wind Farm Appeal Decision – Den Brook. Ref. APP/Q1153/A/06/2017162 [CD 6.2]

14. Wind Farm Appeal Decision – Grise. Ref. APP/H0928/A/09/2093576 [CD 6.35]

15. Wind Farm Appeal Decision – Matlock Moor. Ref. APP/R1038/A/09/2107667 [CD 6.36]

16. Wind Farm Appeal Decision – Moorsyde. Ref. APP/P2935/A/08/2079520 [CD 6.37]

17. Wind Farm Appeal Decision – Princes Soft Drinks. Ref. APP/W4705/A/09/2114165 [CD 6.38]

18. Wind Farm Appeal Decision – Swinford. Ref APP/F2415/A/09/2096369

19. *Comparison of predicted and measured wind farm noise levels and implications for assessments of new wind farms.* T. Evans and J. Cooper. Proceedings of ACOUSTICS 2011, 2-4 November 2011, Gold Coast, Australia.[CD 9.11]