CHAPTER 3: SITE SELECTION AND DESIGN

INTRODUCTION

3.1 This chapter provides a description of how the site has been selected and an explanation of how the turbine locations have been derived. It is divided into the following sub-sections:

- Site Selection
- Design Evolution
- Preferred Site Configuration

3.2 National planning policy on renewable energy (PPS22) identifies as a starting point that renewable energy developments should be capable of being accommodated throughout England and Wales in locations where the technology is viable and environmental, economic and social impacts can be addressed satisfactorily. It is important to emphasise that it is the responsibility of developers to ensure sites are technically and commercially feasible as stipulated in 'The Energy Challenge 2006':[1]

> *'PPS22 makes clear that regional planning bodies and local planning authorities should not make assumptions about the technical and commercial feasibility of renewable energy projects, and that possible locations for renewable energy development must not be ruled out as unsuitable in advance of full consideration of the application and its likely impacts. Planning policies, in Regional Spatial Strategies and Local Development Documents, should not place unjustified restrictions on renewable developments; they must be flexible to cope with technological and other change over time'*

3.3 The following initial site selection search evaluates the entire North Kesteven District having regard to the numerous constraints, both technical and environmental, that exist within the borough. The methodology assists in identifying sites that meet the criteria as described in PPS22.

SITE SELECTION

3.4 Ecotricity employs a two stage process when considering sites for wind energy development. **Stage 1: Site Identification** establishes that the site has the key essential criteria for wind energy and identifies various constraints that exist to development of a site having regard to four essential criteria in particular:

- Sufficient wind resource
- Adequate access
- Economic grid connection
- Procurement of a land lease.

3.5 Once a site has been identified as having potential for wind turbine development, the site progresses to **Stage 2: Site Specific Constraints** and is assessed against further technical criteria and through consultation with key stakeholders, statutory and non statutory bodies as described within **Chapter 2: Environmental Impact Assessment.** This stage assesses the constraints applicable to that location in particular, for example, ecological and telecommunication constraints.

3.6 Stage 2 also considers the optimum turbine layout, blade diameter and tower height for producing the maximum power output whilst having regard to the constraints on site.

3.7 **Table 3.1** provides a summary of the criteria which are assessed throughout the project in order to determine the suitability for a wind turbine development.

Table 3.1: Site selection considerations

Issue	Requirement	Method of Investigation
Average wind speeds	Greater than 6.2 m/s at height of 45m	NOABL data[2] – desktop study
Designated sites and development plan policies	Avoidance of sites within: designated landscapes, nature conservation areas and cultural heritage sites.	Desk top study (Local Plans and Ordnance Survey mapping) and site visit to determine the location and significance of any landscape designations and consultation with statutory bodies (i.e. Natural England, English Heritage). An analysis of the planning policy framework is also undertaken to ensure that the development complies with the development plan.
Telecommunications	Avoidance of sites that might give rise to electromagnetic interference such as fixed communication links which cannot be overcome with mitigation.	Consultation with Ofcom, fixed link operators, JRC, mobile phone companies, MoD (as listed in **Appendix 2.1**).
Landowner	Supportive of wind energy and prepared to enter into long-term land lease agreement.	In some cases, a land owner may approach Ecotricity to investigate site development opportunities. Otherwise, Ecotricity may approach landowners after investigating areas.
Residential amenity	Wind turbines need to be sited at a suitable distance from nearby properties to ensure residential amenity is not significantly affected by any effects such as noise or shadow flicker.	An independent noise assessment, including background noise monitoring is undertaken in accordance with the ETSU-R-97 methodology for the assessment and rating of noise from wind farms, set out in the companion guide to PPS22. Areas with potential to receive shadow flicker are mapped and the wind park layout is configured to minimise effects of shadow flicker.

[1] *DTI (2006). The Energy Challenge July 2006 Annex D. available at http://www.dti.gov.uk/files/file32017.pdf*

[2] *The Department of Trade and Industry wind speed database (NOABL) contains estimates of the annual mean wind speed throughout the UK for 1km squares. It comprises a map of the UK, to a 1km^2 resolution for which annual mean wind speed has been modeled using an air flow model that estimates the effect of topography on wind speed and contains estimates of the annual wind speed throughout the UK. This database is an industry-recognised tool for calculating the annual average wind speed at a height of 45m at onshore sites within the UK.*

More information can be found on the British Wind Energy Association internet site: www.bwea.com

Access	Suitable roads to, and on, the site for transportation, construction and maintenance, which are navigable by abnormal loads, by considering width and load bearing.	Desktop study, site visit and transport assessment if required. Wind farm components are large pieces of machinery and transportation to site makes unusual demands on the road system in terms of width and corner radii.
Electricity grid	Suitably located grid access point. These factors affect the economics of a project, and distance can be a limiting factor for small sites.	Consultation with grid operators, site visits and where needed a grid capacity study, to calculate the cost of the grid connection.
Radar, navigation, safety	No immitigable objections from Ministry of Defence, Civil Aviation Authority, National Air Traffic Services or airport/aerodrome operators. No conflict with existing infra-structure and development i.e. roads, railways and services.	Consultation with various bodies responsible for aircraft navigation and national defence, in line with paragraph 25 of PPS22. Mitigation measures can be implemented and technical studies undertaken if required.
Other	Any other considerations that may arise in the site investigation e.g. archaeology.	Desktop study and site analysis.

Stage 1: Site Identification

3.8 Given the pressing need for onshore wind energy development in the East Midlands area and the available wind resource in Lincolnshire, the North Kesteven District was investigated to seek potential sites for wind energy development using the technical criteria listed above.

3.9 A computerised GIS (Geographical Information System) approach was used to identify areas within the district at a strategic level, that might be suitable as a potential wind energy site, using the following criteria as filters (and shown within corresponding **Figures 3.1** and **3.2**):

- Suitable wind speed regime i.e. NOABL wind model of 6.2m/s at 45m AGL, or greater
- Residential housing buffer of 650m (there are no adopted housing buffers in England and Wales, this figure is used as an initial guide based on experience).
- Aviation constraints including visibility to radar and licensed airfield buffer
- Proximity of local 33kV grid
- Designated landscape areas
- Cultural heritage features
- Designated ecological areas
- Distance to appropriate access routes

Site identification – findings

3.10 The various plans within **Figure 3.1** and **Figure 3.2** show the areas within North Kesteven District that are affected by the constraints identified above. The results of the GIS study indicated that:

- Most of the area receives wind speeds in excess of 6.2m/s
- The majority of the district lies within 650m of residential housing
- There are a limited number of grid connection points in the form of the 33kV network which is extremely limited in the western part of the district
- There are no landscape designations including Areas of Outstanding Natural Beauty (AONBs) within the district, however there is a number of national cycle paths on the northern edge of the district.
- There are a number of Scheduled Ancient Monuments (SAMs) and five identified Historic Parks and Gardens within the district.
- Pockets of areas of conservation interest appear throughout the district, including six Sites of Special Scientific Interest (SSSIs) to the north and south east of the district.
- Good road infrastructure is required for the construction of a wind park, and there are several A and B roads that radiate out from Sleaford.

3.11 It can be seen that the Heckington Fen Wind Park site, identified on each plan, meets all the necessary criteria to enable it to be progressed to Stage 2 and assessed further against a number of more localised constraints.

Stage 2: Site Specific Constraints

3.12 The Heckington Wind Park site identified in Stage 1 is further assessed against on-site constraints resulting in an area suitable for development, the 'Developable Area'. These constraints are identified throughout the EIA process, through consultation with numerous stakeholders, relevant guidance and independent assessments that form part of this Environmental Statement.

3.13 Some initial constraints present on the site are identified and buffer zones created around constraining features in which it is either not appropriate or not permissible to site the individual turbines. These buffer areas can be seen on **Figure 3.3: Site Specific Constraints** and are listed below:

- **Housing** – Buffered to 650m for 3rd party properties (there are no adopted housing buffers in England and Wales, this figure is used as an initial guide based on experience). Although Six Hundreds farm and Sadlands farm are within this area they are only used for agricultural purposes and are therefore un-inhabited.
- **Motorways/trunk roads** – Buffered to 175m (turbine height + 50m)[3]
- **Footpath** – Buffered to 45m (blade overhang distance)
- **Bridleway** – Buffered to 200m (recommended by the British Horse Society)
- **Watercourse** – Buffered to 45m (blade overhang distance)

[3] *Based on Highways Agency guidance 'Spatial Planning Advice Note: SP 12/09 – Planning Applications for Wind turbines sited near to trunk roads', 2009. http://www.highways.gov.uk/business/documents/Wind_Turbines_SP_12-09.pdf*

- **Gas Infrastructure** – Buffered to 137.5m (turbine height + 10%)
- **Duck Decoy –** constrained to ensure no infrastructure is placed within it's location.
- **Bat Roosts –** Buffered to 200m to mitigate impact

3.14 The 'developable area' remaining after the Stage 2 assessment is essentially what is left after the constraints has been considered. In **Figure 3.3** this is all the remaining white space left within the site boundary. This area is then used as a basis for determining initial turbine layouts and for carrying out further site studies within the EIA process.

Site Optimisation

Tools used

3.15 Once the site has been selected and a developable area created, a number of site-specific constraints are assessed in order to determine the optimum layout for the site, balancing maximum energy production against local constraints. In order to evaluate sites and optimise site layout, Ecotricity uses two industry standard computer modelling programmes, *WindFarm*[4] and *WAsP*[5].

- *WindFarm* is a programme capable of producing optimum turbine layouts based on set criteria e.g. prevailing wind conditions; maximum energy yield; minimum visual intrusion; minimum noise output and shadow flicker. The programme also produces photomontages that accurately plot the turbine positions onto photographs underlain with data representing the landscape (based on OS grid and contour maps). In addition, the programme produces plans showing zones of visual influence and noise contour which, together with the photomontages, enable turbine layouts to be accurately formulated having regard to local environmental constraints.
- *WAsP* is a statistical based programme capable of analysing and extrapolating wind flow data over complex terrain. *WAsP* is primarily concerned with analysis of wind data, estimation of the wind resource climate, wind park power production and net losses due to orientation and wake loss. *WAsP* is able to evaluate wind park design and surmise the gross/net energy production and evaluate wake loss. Wind parks can also be orientated to capture the predominant wind flows of the location.

Factors considered in optimisation

3.16 A number of key factors must be taken into account when designing the turbine layout for optimum power generation.

Wind shear

3.17 Whilst optimising turbine locations, it is also necessary to consider the potential effect of wind shear. Wind shear is a term that describes the relationship between the height of the turbines and the power output. Wind speed increases with height due to the reduced effect of friction of the ground caused by topography, buildings etc. The phenomenon of wind shear results in slower wind speeds at ground level due to this friction. As a result, wind speeds at turbine hub height will be greater than those modelled for 45m which is the height at which the DTI NOABL wind speed database calculates wind speeds.

Separation distance between turbines

3.18 The layout has been optimised to maximise the energy extraction from the wind. As such the turbines have been placed at distances apart that minimise internal park losses and avoid excessive wear and tear on the machinery. The prevailing wind direction has been used to align the orientation of the turbines to this end.

Power of the wind

3.19 In addition, the power in the wind increases to the third power of the wind speed (as a result, a doubling of wind speed will generate eight times the power). It is therefore important that the configuration considerations include height as the higher the turbine, the higher the power output.

Commercial feasibility

3.20 It should be noted that one of the key principles of PPS 22 states that local planning authorities should not make assumptions about the commercial feasibility of renewable energy projects. The definition of planning considerations, as set out in paragraph 11 of PPS1, are:

'...any consideration which relates to the use and development of land'

3.21 This appears to indicate that the economics or commercial viability of any particular renewable development project should **not** be considered as a valid planning consideration when determining planning applications.

Site Selection Summary of Results

3.22 The preceding figures have shown that the Heckington Fen Park site is suitable for wind energy development, taking into account a range of constraints. **Table 3.2** overleaf summarises these findings.

[4] *WindFarm Version 4.1.2.3, further details are available from ReSoft Ltd., 7 Church Lane, Flitton, Bedford, MK45 5EL, 01525 862616*

[5] *WAsP Version 9.00.0133, further details are available Wind Energy Department, Risø National Laboratory, P.O. Box 49, DK-4000 Roskilde, DENMARK, Tel: +45 4677 5000*

Table 3.2: Proposed Heckington Fen Wind Park site data

Issue	Requirement
Average wind speeds	6.2m/s at 45m (NOABL data)
Designated sites	There are no locally designated landscapes, ecological areas or SAMs within the boundaries of the site.
Fixed Microwave links	No immitigable fixed links cross the development site
Landowner	Landowner agreement has been obtained
Distance from homes	650m from third party properties
Access	The site has suitable access
Grid	33 kV Grid is close to the site
Radar, navigation, safety	No immitigable impact to the operation of aviation interests.

DESIGN EVOLUTION

3.23 The EIA process is an iterative one in which the results of studies and consultations throughout the development impact upon the design of the site which is constantly refined as the process progresses. The results of the studies and consideration of alternative designs are explored further within the individual chapters of this Environment Statement.

3.24 This section sets out those main layout options that have been studied for the Heckington Fen wind park site based on the initial identification of the developable area as defined in Stages 1 and 2 above, and various independent studies and consultations.

Alternative Layout 1

3.25 The evolution of the development has been described below whilst the alternative layouts are summarised in tables. The Layouts can also be seen in **Figure 3.4: Alternative Turbine Layouts**.

Table 3.4: Turbine Layout 1 Summary

	Description
No. turbines	41 No, Enercon E82 2.3MW wind turbines
Hub height	79m
Rotor diameter	82m
Total height	120m
Summary Description	Designed to maximise electricity generation given an initial residential separation distance of 650m. Initial noise evaluations suggested that this layout would not however comply with government limits on expected noise.
Annual power output	Estimated: 228.98 GWh per annum [6]

3.26 The Enercon E82 turbine model is designed to maximise the capacity factor of a site using a large hub height and large blade diameter and was one of the largest and most efficient turbines readily available during the initial evaluation. Initial noise analysis suggested that this would not comply with the government limits on expected noise.

Alternative Layout 2

Table 3.5: Turbine Layout 2 Summary

	Description
No. turbines	28 No. Enercon E70 2.3MW wind turbines
Hub height	64m
Rotor diameter	71m
Total height	99.5m
Summary Description	This layout included for an extended distance to nearby properties in order to meet government guidance on noise limits based upon desktop analysis.
Annual power Output	Estimated: 156.37 GWh per annum[7]

3.27 This layout maximised the energy output whilst meeting the predicted noise limits set by government guidance. This was based upon a desk based noise assessment. This layout was submitted to DECC, under section 36 of the Electricity Act 1989, in 2009.

Alternative Layout 3

Table 3.5: Turbine Layout 3 Summary

	Description
No. turbines	23 No. Enercon E82 2.3MW wind turbines
Hub height	79m
Rotor diameter	82m
Total height	120m
Summary Description	This layout was chosen to maximize energy generation whilst complying with landscape characteristic as described in **Chapter 5: Landscape and Visual**
Annual power Output	Estimated: 128.45 GWh per annum[8]

[6] *Assuming average UK wind farm performance with a capacity factor of 27.7% (2005-2009 average figure from Digest of UK Energy Statistics, DECC)*

[7] *ibid*
[8] *ibid*

Preferred Site Configuration

3.28 The preferred site configuration that is being taken forward to a planning application is Layout 4. Layout 4 complies with all the constraints assessed within the Stage 1 and the Stage 2 site selection process, and seeks to mitigate unacceptable impacts (see **Figure 4.1: Proposed Site Plan** for turbine layout).

Table 3.6: Turbine Layout 4 Summary

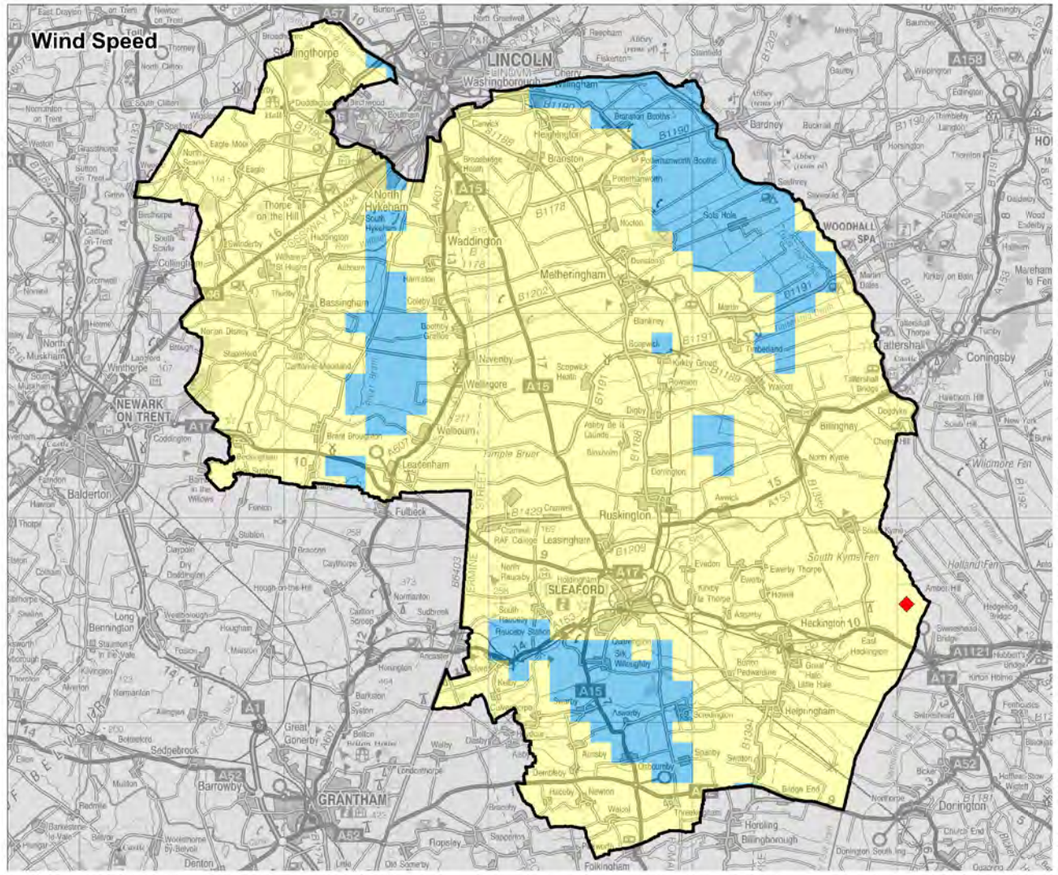
	Description
No. turbines	Up to 22 wind turbines
Rated Capacity	Up to 3.0MW
Hub height	Up to 80m
Maximum Capacity	Up to 54MW
Rotor diameter	Up to 90m
Total height	Up to125m
Summary Description	This layout meets the government guidance on limits for noise based upon a full background noise analysis. It also includes for an additional duck decoy constraint. The layout has also been designed to ensure the turbine locations comply with all constraints based upon any three turbine options outlined in **Chapter 4: Project Description** whilst incorporating the landscape characteristics as outlined in **Chapter 5 : Landscape and Visual**
Annual power Output	Estimated: 131.12 GWh per annum[9]

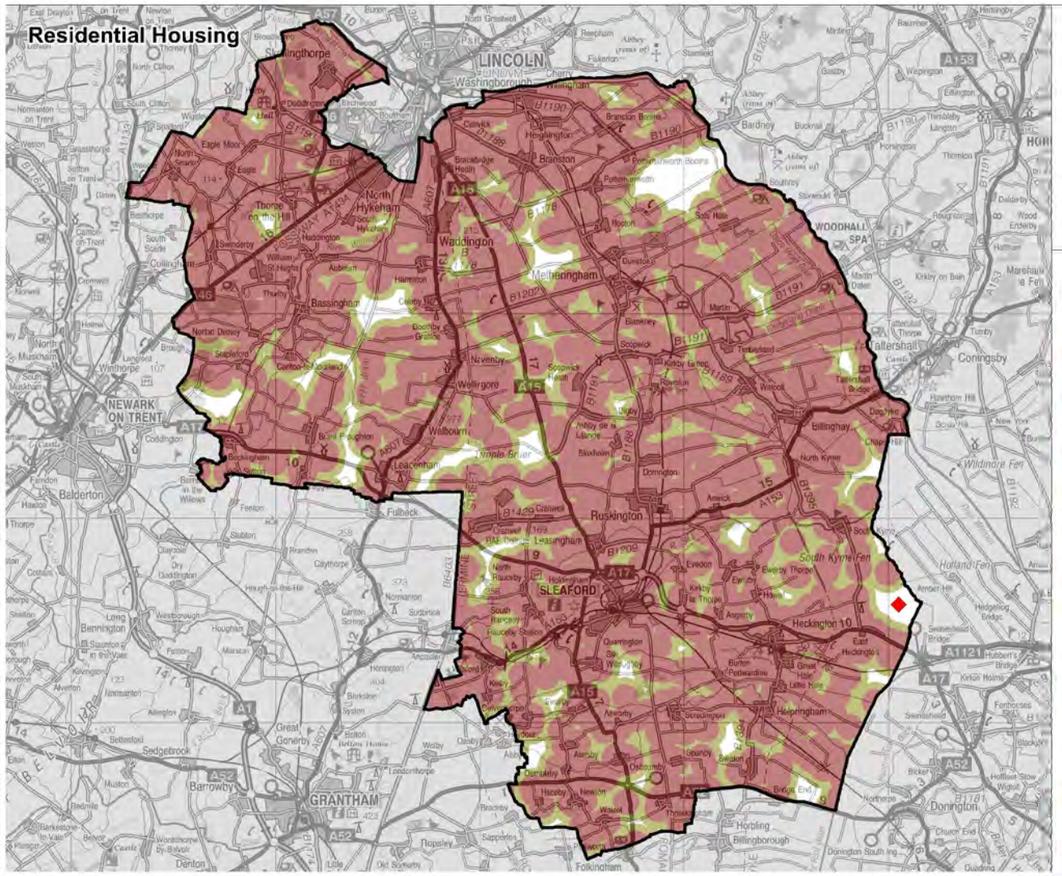
3.29 This layout has been determined after discussions with the various statutory consultees and other stakeholders and offers a balance between energy generation and any potential significant environmental effects. The assessments which are presented within this Environmental Statement are considering the environmental implications of the proposed layout 4.

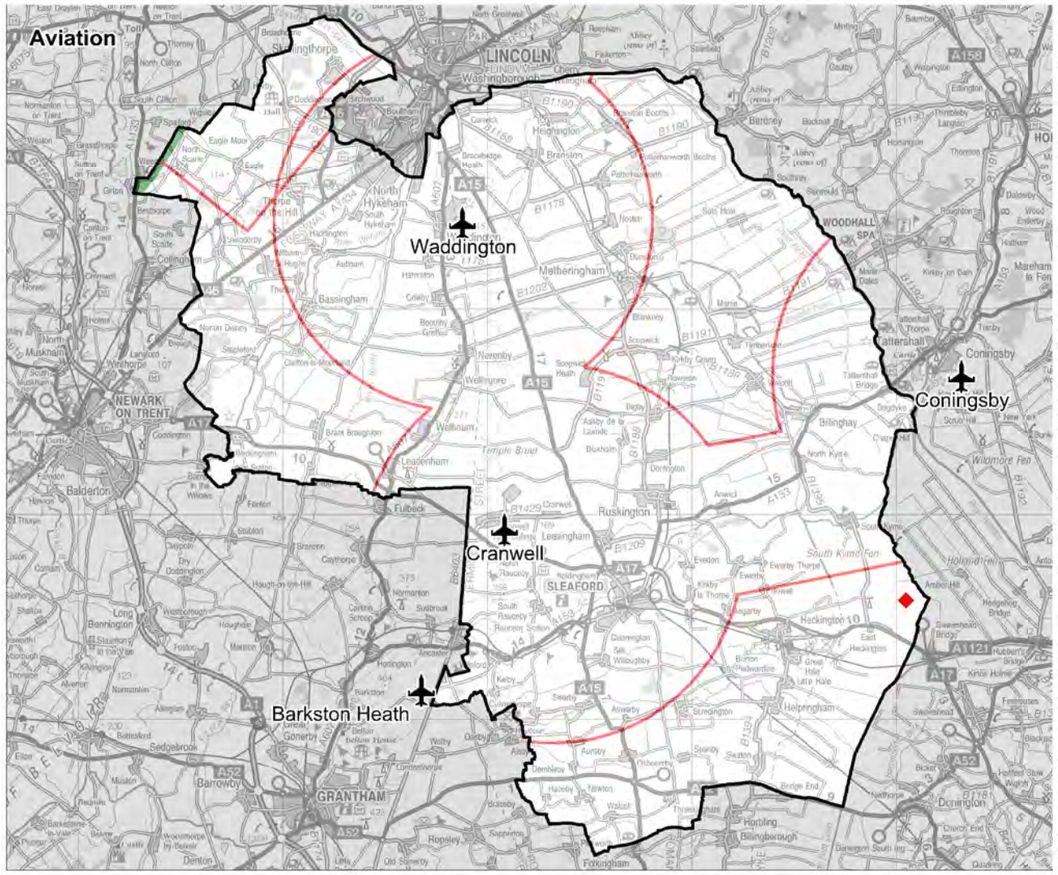
3.30 Once the developable area on the site had been satisfactorily fixed upon, site specific micro-siting assessments using *WindFarm* and *WAsP* were carried out to determine the exact layout of each turbine within the developable area. Where other potential micro-siting impacts were considered neutral or not significant, turbine locations were moved as far away as possible from residential properties. In doing so, a distance of approximatly1,000m, between the nearest turbine location and the closest third party property has been achieved. An initial internal noise modelling assessment indicated that this distance between turbines and third-party residential properties would also be compliant with noise limits at potentially sensitive receptors (see **Chapter 10: Noise** for results of detailed noise assessment).

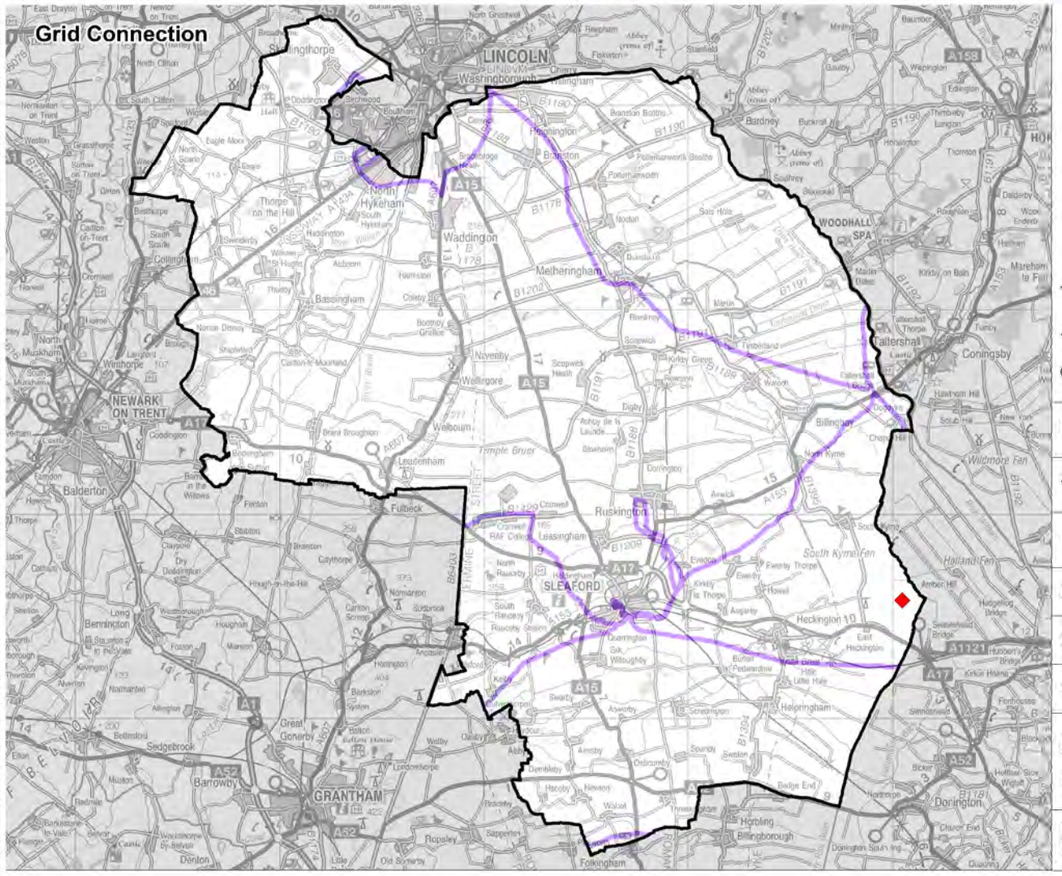
3.31 The following chapters document the assessment of the potentially significant environment effects of this site configuration whilst also describing the evolution of the site design where applicable.

[9] *ibid*









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Legend

- Site Location

Wind Speed
NOABL Wind Speed at 45m AGL (m/s)
- 1.4 to 6.2
- Above 6.2

Residential Housing
- 650m Housing Buffer
- 1km Housing Buffer

Aviation
- Retford/Gamston Licensed Airfield 17km Consultation Zone
- RAF Airfield
- Military Aerodrome Traffic Zone

Grid Connection
- 33kV Grid

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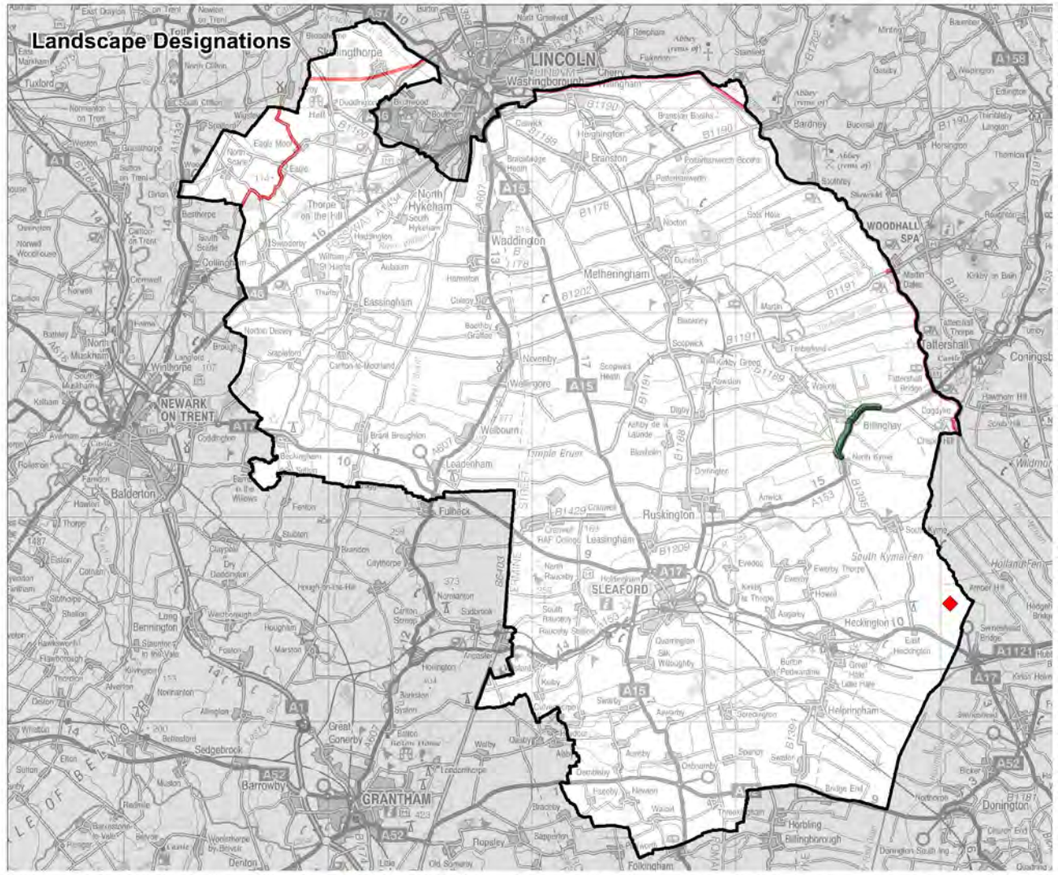
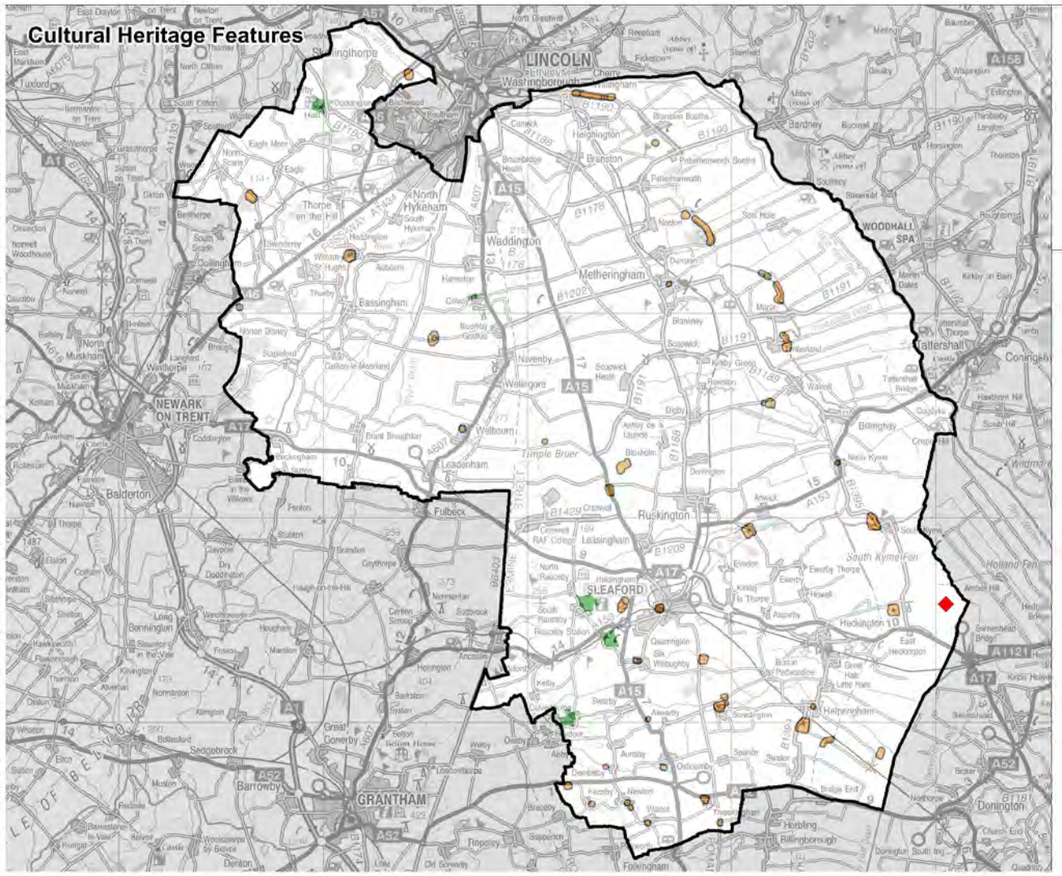
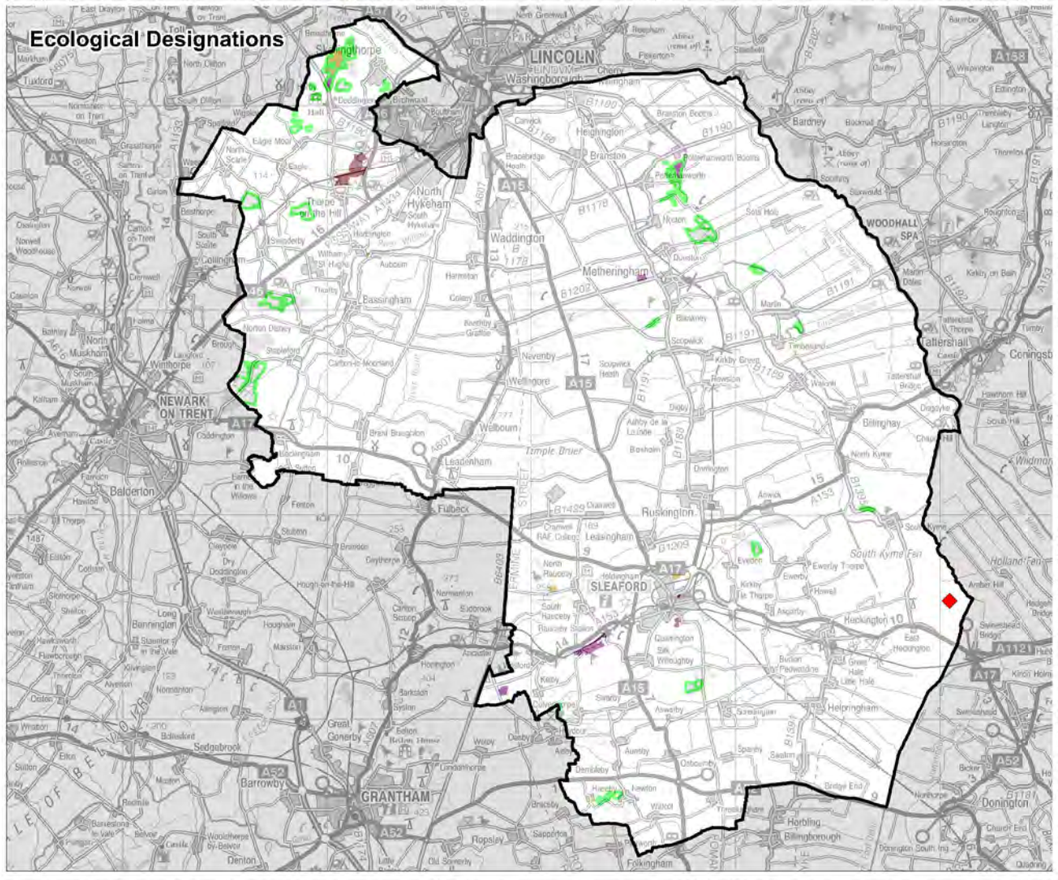
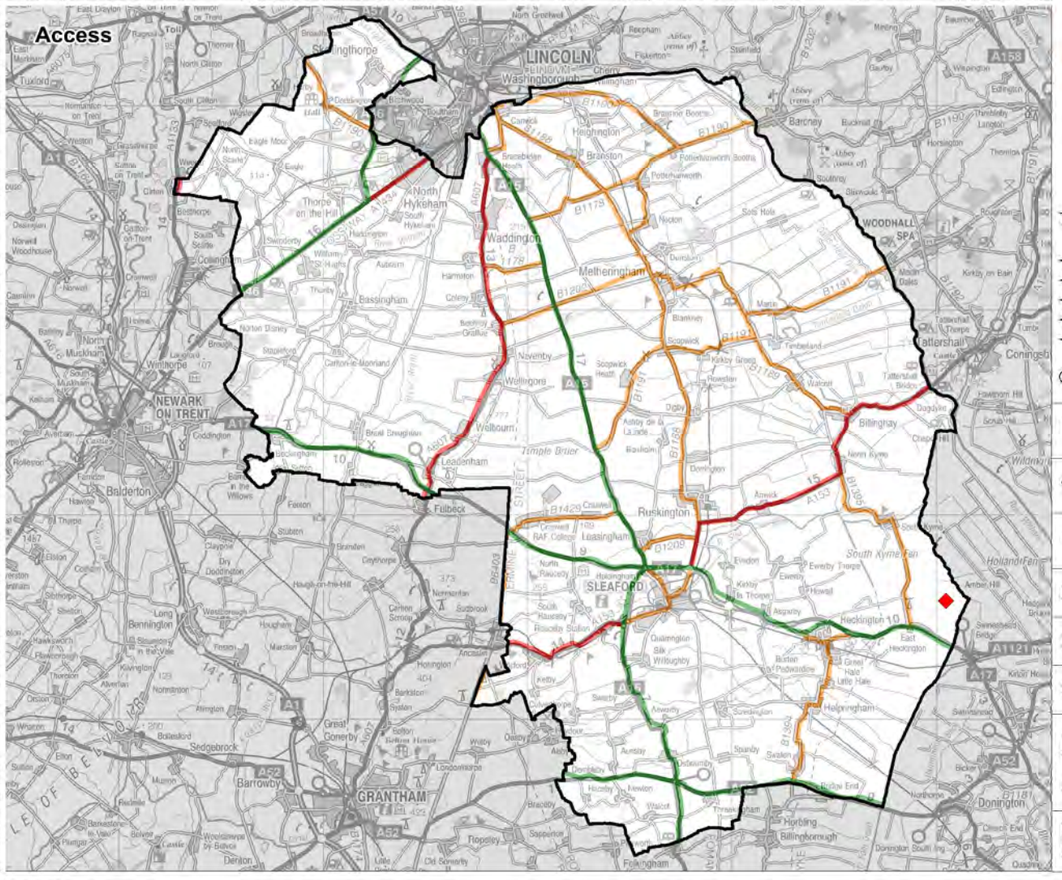
Figure: 3.1
Title: North Kesteven District Technical Constraints

Heckington Fen Wind Park
Environmental Statement









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Legend

- Site Location

Landscape Designations
- National Cycle Route
- Access Land

Cultural Heritage Features
- Scheduled Ancient Monument
- Historic Park and Garden

Ecological Designations
- Site of Special Scientific Interest
- Woodland Trust
- Local Nature Reserve
- Ancient Woodland

Access
- Primary Route
- Main Route
- Secondary Route

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Figure: 3.2
Title: North Kesteven District Environmental Constraints

Heckington Fen Wind Park
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- Site Boundary
- Remains of Duck Decoy
- 45m Footpath Buffer
- 45m Building Buffer
- 45m Watercourse Buffer
- 50m Extended Watercourse Buffer
- 200m Bat Roost Buffer
- 137.5m Gas Pipe Buffer
- 1km Housing Buffer

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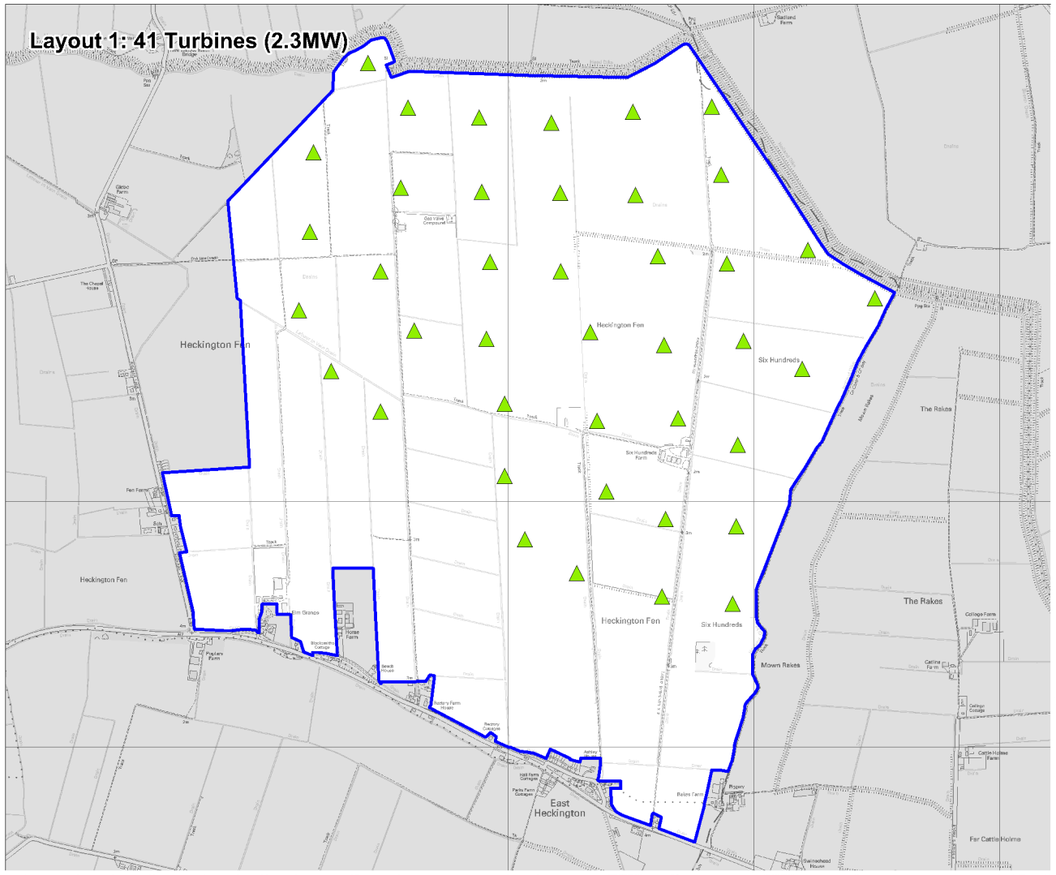
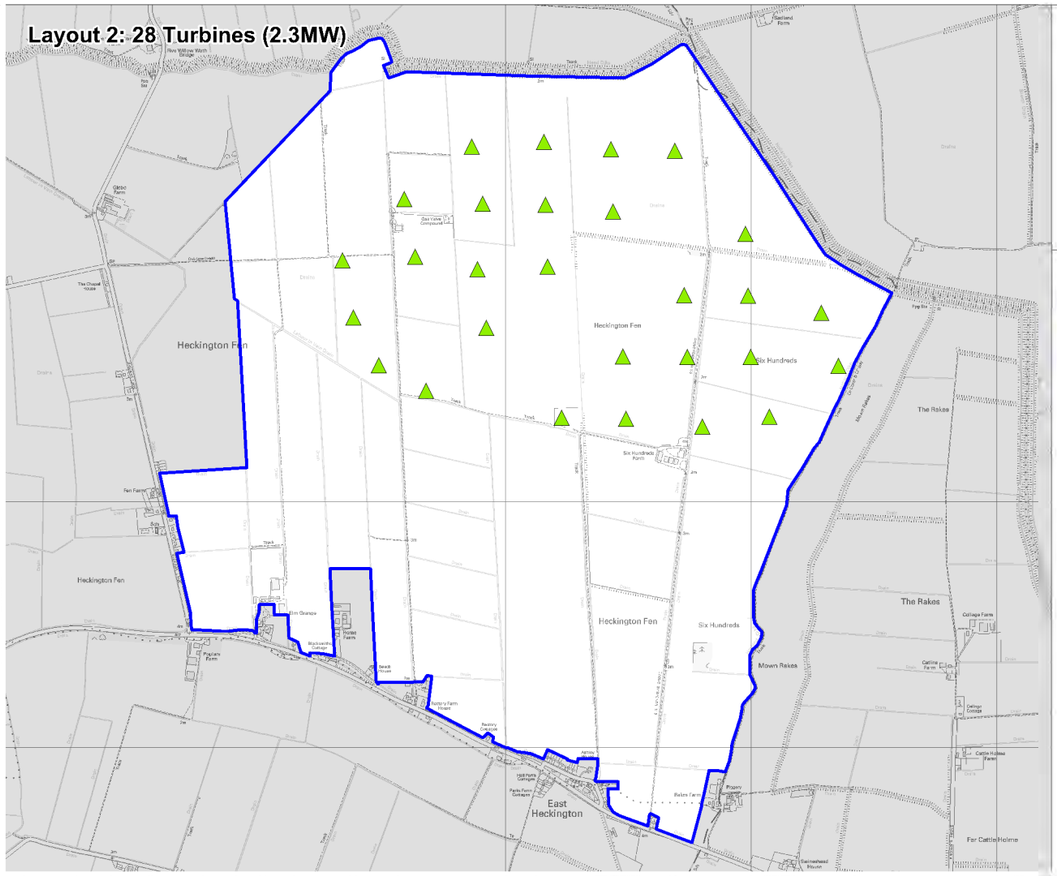
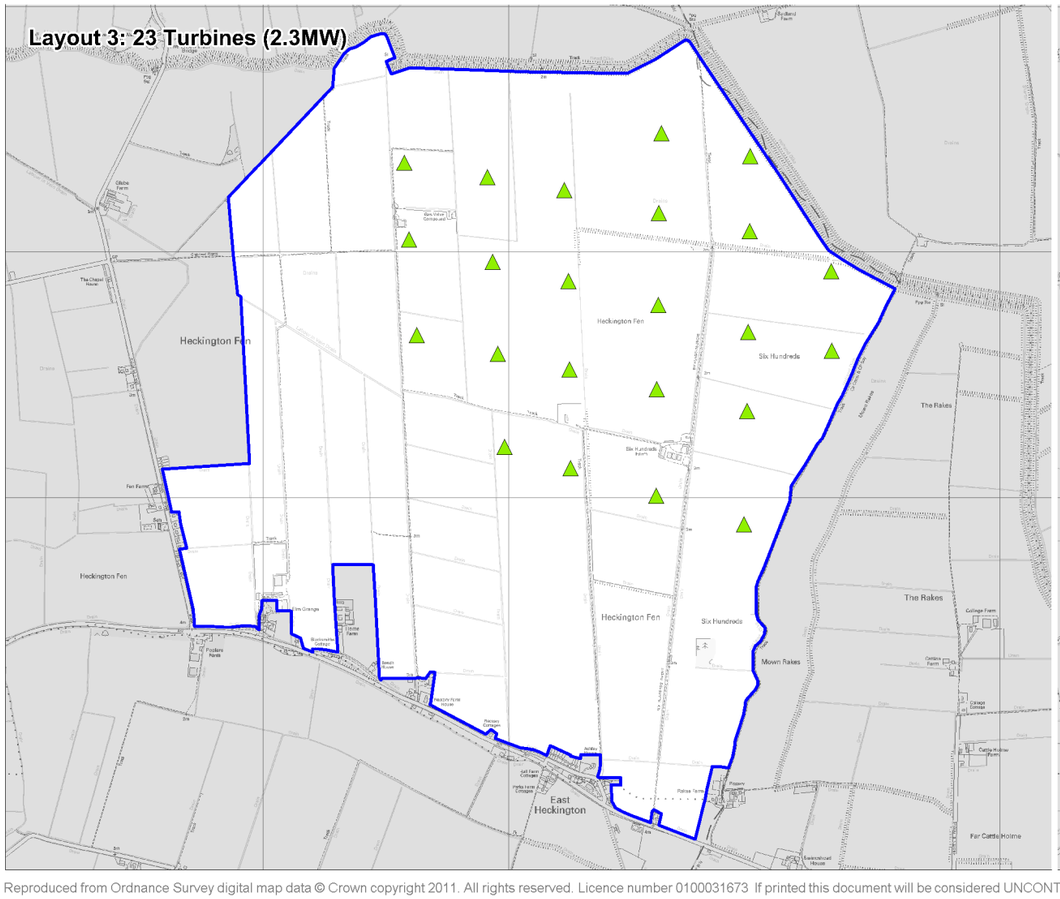
Figure: 3.3

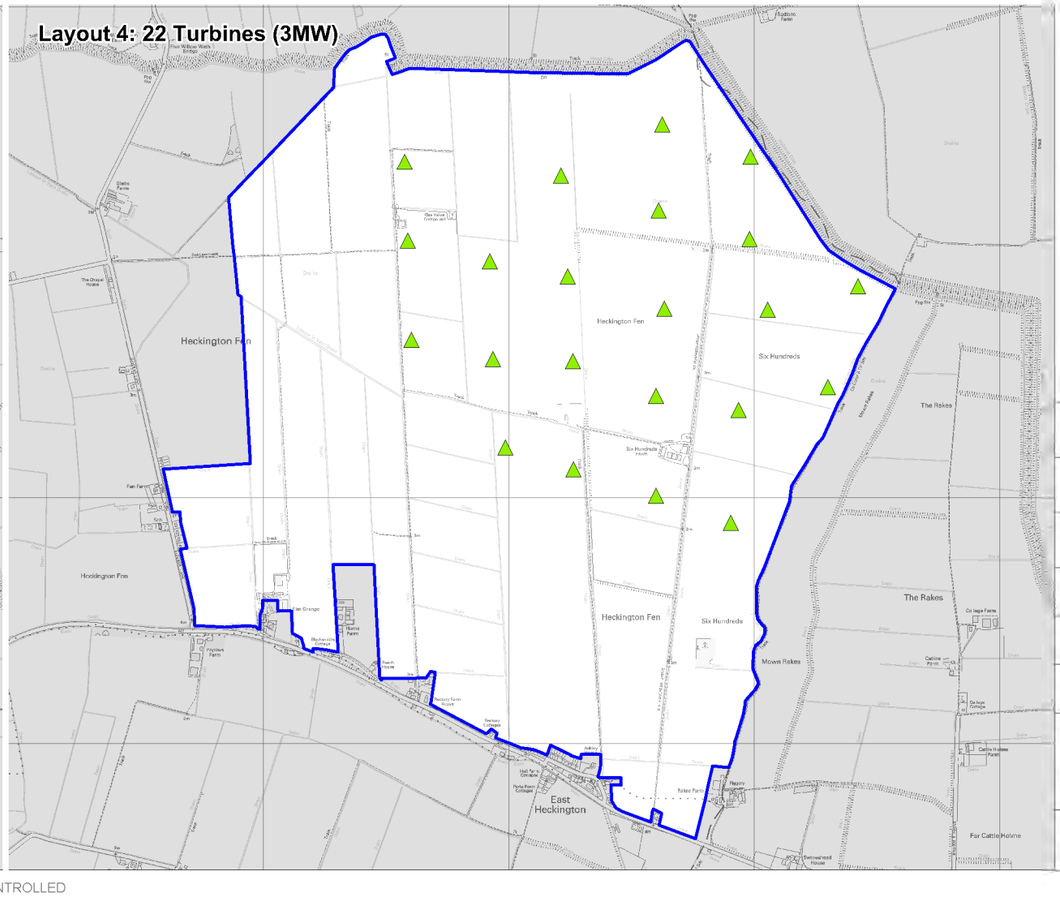
Title: Site Specific Constraints

Heckington Fen Wind Park
Environmental Statement









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Legend

- Site Boundary
- Turbine Location

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Figure: 3.4

Title: Turbine Layout Options

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