Chapter 3

Site Selection & Design

CHAPTER 3

3 SITE SELECTION & DESIGN

3.1 INTRODUCTION

This Chapter of the Environmental Impact Assessment Report (EIA Report) contains a description of the land within the site boundary (the Site), the consideration of alternatives and site selection process, and the design process and evolution that led to the final design of the proposed Troston Loch Wind Farm (the Development).

The Electricity Works (Environmental Impact Assessment) (Scotland)[1] Regulations 2017 state in Schedule 4 paragraph 2 that an EIA report must include:

> *'A description of the reasonable alternatives (for example in terms of project design, technology, location, size and scale) studied by the developer, which are relevant to the proposed development and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects.*'

This chapter explains why the Site has been selected and summarises the layout options that were considered by the Applicant during the evolution of the Development.

This Chapter of the EIA Report is supported by the following figure provided in Volume 2a EIA Report Figures:

- Figure 3.1: Site Design Evolution.

3.2 SITE DESCRIPTION

3.2.1 Location

The land within the site boundary (the Site) which contains the turbines and associated infrastructure covers an area of 437 hectares (ha), centred on National Grid Reference (NGR) 268500, 589500, approximately 7 kilometres (km) west of Moniaive, Dumfries and Galloway as shown on Figure 1.1, and wholly located within the administrative boundary of Dumfries and Galloway Council (the Council).

There are a number of watercourses within the Site and two waterbodies, Troston Loch and Mackay's Loch. The majority of the watercourses drain into the Black Water, which forms the southwest boundary of the Site. Black Water flows westwards meeting the Water of Ken. A small area in the very north of the Site lies within the catchment of the Stroanshalloch Burn, which drains eastwards joining the Craigdarroch Water and then the Cairn Water.

The topography of the Site and immediate vicinity is complex. The elevation of the Site itself ranges from approximately 380 metres (m) above ordnance datum (AOD) in the northeast of the site near Troston Loch and falls to 250 m AOD in the south and southwest of the site. A string of hills form the northwest boundary of the Site consisting of Bennieloan (360 m AOD), College Hill (350 m AOD) and Lochlee Hill (352 m AOD). The Site is in turn surrounded by generally higher hills than those within the Site itself, particularly to the north, east and south.

No public roads are located within the Site, although there are number of existing good quality forest roads. The northernmost boundary of the Site runs adjacent to the B729 for a short section.

Moniaive is the closest settlement to the Development at 7 km to the east, while St John's Town of Dalry is 8 km south west and Carsphairn is approximately 11 km to the

[1] The Scottish Government (2017). Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017. http://www.legislation.gov.uk/ssi/2017/101/pdfs/ssi_20170101_en.pdf (Accessed 14/11/18)

west. There are a number of dispersed properties surrounding the Site, predominantly to the east and north, although none are located within 1 km. There are no residential properties within the Site. Current OS mapping and aerial photography shows a farmhouse within the site labelled as Troston; it should be noted that the farmhouse has been demolished.

An aspirational Core Path runs through the centre of the Site along the existing track network linking the B729 with the former Troston farmhouse and onwards to the existing Core Path network to the south of the Site.

3.2.2 Land Use

The Site predominantly comprises of commercial coniferous plantation at varying degrees of maturity. Much of the Site has recently been felled and either comprises of clear fell or young plantation.

The Site also comprises smaller areas of improved and marshy grassland predominantly at lower elevations in the southeast, which is currently used for livestock grazing.

The Site features a relatively extensive network of access tracks, the majority of which have been constructed to serve the forestry operations, however they also serve the agricultural activities in the southern section of the Site.

3.2.3 Designations

There are no statutory designated sites within or immediately surrounding the Site.

The following designations are located within the surrounding area (all distances are approximate and directions given in relation to the Site Boundary):

- 5 Scheduled Monuments within 5.0 km;
- 6 Listed Buildings within 5.0 km;
- Cleugh Site of Special Scientific Interest (SSSI) 5.7 km west;
- Water of Ken Wood SSSI 8.7 km southwest;
- Stenhouse Wood SSSI 9.0 km east;
- Upper Nithsdale Wood Special Area of Conservation (SAC) 9.0 km east;
- Hannaston Wood SSSI 9.2 km south;
- Thornhill Uplands Regional Scenic Area (RSA) 1.5 km east;
- Galloway Hills RSA 5.0 km west; and
- Fleet Valley National Scenic Area (NSA) 26.0 km south.

The above designations are discussed as necessary within the relevant technical chapters.

3.3 SITE SELECTION

The selection of an appropriate site which has the potential to support a commercial wind farm development is a complex and lengthy process. It involves examining and balancing a number of environmental, technical, planning and economic issues. Only when it has been determined that a site is not subject to major known environmental, technical, planning or economic constraints is the decision made to invest further resources in developing the proposal and conducting an EIA.

In accordance with the EIA Regulations the design alternatives need to be studied with key reasoning, taking into account the potential environmental effects. The Site was selected as a suitable site for wind farm development by the Applicant because it met the following criteria:

- A sufficiently high annual mean wind speed across the Site;
- Viable grid connection in close proximity to the Site;

- Suitable road access, subject to a degree of road upgrade;
- A limited wind turbine zone of theoretical visibility, especially to the populated areas and transport routes;
- The Site is sufficiently distant from the nearest residential properties to ensure compliance with ETSU-R-97 noise limits, as well as to reduce adverse residential visual amenity and shadow flicker effects; and
- The Site itself does not support any international or national ecological, landscape or cultural heritage designations.

3.4 SITE DESIGN

The design of a wind energy development is driven by the key objective of positioning turbines so that they capture the maximum energy possible within a suitable area determined by environmental and technical constraints.

The key constraints to onshore wind farm site design which need to be taken into account during the design process include:

- Visibility from sensitive receptors, including nearby properties and landscape designations;
- Presence of sensitive habitats and protected species;
- Presence of sensitive ornithological species;
- Presence of watercourses, private water supplies and related infrastructure;
- Presence of cultural heritage features;
- Proximity to noise sensitive receptors;
- Presence of peat;
- Ground conditions and topography; and
- Key recreational and tourist routes.

The studies undertaken for the Development indicate that the key site constraints are:

- Areas of steep slope unsuitable for construction;
- Watercourses, waterbodies and drains;
- Consideration of wind conditions across the Site;
- Areas of deep peat and other sensitive habitats;
- Visibility to key visual receptors including nearby properties and settlements as well as statutory and non-statutory landscape and visual designations; and
- Proximity to recorded sensitive ornithological receptors.

These constraints were identified through desk study, site survey and analysis including consideration of the responses received from consultees during the EIA process, predominantly at scoping.

The principles of the design strategy were to maximise the number of turbines and wind energy capture, whilst minimising significant adverse environmental effects. Therefore, some of these constraints were given a 'hard' constraint value in design that was not breached and others were assigned a 'soft' constraint value that could be impinged with sufficient justification that effects were still acceptable. This led to a comprehensive process of constraints mapping. This EIA Report and its conclusions constitute the outcome of the application of the design principles adopted for the Development.

Embedded mitigation was used to minimise any predicted environmental effects, and where applicable to a specific technical assessment, such mitigation is detailed in the relevant chapter within this EIA Report. This was particularly relevant to the avoidance of direct effects e.g. on known protected species. By employing an iterative design process, undertaken in conjunction with the EIA process, a number of potential effects were avoided completely.

3.4.1 Site Specific Environmental Constraints

The specific environmental factors considered in the design of the Development are set out below, with their influence on the design discussed.

3.4.1.1 Landscape and Visual

SNH guidance Siting and Designing Wind Farms in the Landscape - Version 3a (2017)[2] notes that '*Design is a material consideration in the planning process and good siting and design helps to produce development which is appropriate for a landscape whilst delivering renewable energy*'.

In accordance with this guidance, the landscape and visual impact of the Development has been a key consideration from an early stage in the feasibility studies and design process. Landscape architects have worked closely with the project team to achieve a scale and a design that minimises the potential landscape and visual effects while maintaining economic viability. The landscape and visual effects have been a focus of discussions with the Council following the scoping process. Several design workshops were undertaken which sought to eliminate any unacceptable landscape and visual effects.

A particular design strategy was to create a balanced layout and avoid the higher ridgeline along the northeast boundary of the Site, from which there would be extensive visibility from the Craigdarroch Water Valley and Moniaive to the east.

Whilst visibility from the Craigdarroch Water Valley has not been wholly eliminated, the design process has sought to 'push' the turbines to the west of the ridgeline, which reduces the prominence of turbines while establishing a balanced composition of turbines reflecting the local landform.

In addition the design strategy for the Development has taken into account the following objectives:

- To provide a turbine layout with a simple form, which relates to the landscape character of the site and its surroundings;
- To create a turbine layout that reflects the scale of the landscape in which it is located;
- To ensure that the design and layout of the turbines expresses the function of the development as an energy generator as clearly as possible by avoiding complexity and visual confusion;
- To achieve a balanced composition of the turbines against the landscape and skyline;
- To create a turbine layout which is cohesive with the existing and consented wind energy developments in close proximity;
- To create a design that takes account of the relevant national, regional and local policy and guidance;
- Minimising turbine construction and impact to the Dumfries and Galloway Regional Scenic Area;
- To reduce visibility to nearby residential receptors as much as possible; and
- To respond to the various constraints identified.

The landscape and visual effects are fully assessed within **Chapter 6 – Landscape and Visual Impact Assessment**.

3.4.1.2 Ecology

Both desk-based surveys and site visits were undertaken as part of the ecology baseline studies which were key to informing the final design of the site. Desk-based surveys

[2] Siting and Designing Wind Farms in the Landscape - Version 3a https://www.nature.scot/siting-and-designing-wind-farms-landscape-version-3a (accessed 14/11/2018)

determined the nearby ecological designations and identified historical information relating to the ecological resources within the study area and Site. Site surveys included the following:

- Extended phase 1 habitat survey;
- National Vegetation Classification (NVC) survey;
- Otter survey;
- Bat habitat suitability survey;
- Bat activity survey;
- Great Crested Newt habitat survey;
- Water vole survey;
- Fisheries survey;
- Red squirrel survey; and
- Badger survey.

The purpose of these surveys was to identify sensitive habitats and species within the site that should be avoided and subsequently ensure the Development could be designed sensitively to the ecological receptors located within and nearby the Site.

The final layout was informed by the aforementioned surveys, which ensured that the Development avoided the most sensitive habitats, including areas of deep peat and highly sensitive Groundwater Dependent Terrestrial Ecosystems.

Where there are any unavoidable effects on the less sensitive areas of the Site generated as a result of the final Development design, mitigation is proposed.

A key area of note is around the former Troston Farmhouse where there was a higher concentration of sensitive habitats; subsequently turbines and associated infrastructure were removed from this area.

The effects on ecological receptors are fully assessed within **Chapter 7 – Ecology**.

3.4.1.3 Ornithology Receptors

Surveys have been undertaken over a number of years on and around the Site. Whilst there is relatively little activity within the Site, surveys included the following:

- Winter, Spring, Summer and Autumn Flight Surveys;
- Winter bird surveys; and
- Breeding bird surveys.

In addition to the field surveys, desk-based studies and consultations were undertaken which also informed the assessments.

The results of the ornithology assessments fed into the site design process; of note are known sensitive ornithology receptors within 500 m of the Site, and suitable set back distances have been adopted to avoid disturbance either during construction or operation.

The effects on ornithological receptors are fully assessed within **Chapter 8 – Ornithology**.

3.4.1.4 Water Environment

During the EIA process desktop and site based surveys were carried out to inspect and identify all water features including private water supplies within the area with potential to be impacted by the Development.

The aim of the design process was to achieve a layout that avoids effects on sensitive hydrological receptors including private water supplies. All turbines and infrastructure with the exception of access tracks and the edge of one crane hardstanding have been located a minimum of 50 m from any watercourse or waterbody. The arrangement of

access tracks has been designed to limit the number of watercourse crossings where possible or to re-use existing crossing points. The locations of private water supplies have been determined, which have influenced the track arrangement.

The effects on the hydrology environment are fully assessed within **Chapter 9 – Geology, Hydrology and Hydrogeology**.

3.4.1.5 Archaeological Features

There are no designated heritage features within the Site, however there a number of non-designated features which have been established through a desk based assessment and site walkover. The design has sought to avoid such features, as well as taken consideration of indirect effects to designations in the wider area.

The effects on cultural heritage features are fully assessed within **Chapter 10 – Cultural Heritage and Archaeology**.

3.4.1.6 Noise Sensitive Receptors

A key consideration in the design of the Development was the proximity of the turbines to nearby residential properties, and the noise levels that the Development may generate both in isolation and with known cumulative developments. A background noise survey was undertaken at two residential properties to determine the existing noise levels around the Site. These locations and assessment methodology were agreed with the Environmental Health Officer (EHO) of the Council.

Results from the background noise survey informed the noise assessment, and the turbines were sited in locations that would ensure the Development would not generate noise emissions that would exceed ETSU-R-97 limits.

The effects on the noise environment are fully assessed within **Chapter 11 – Noise**.

3.4.1.7 Peat

A peat depth survey was undertaken across the Site where it was established that the majority of the Site is not underlain by peat, however pockets of deep peat do exist particularly along the southeast boundary. The design process sought where possible to avoid disturbance to deposits of deep peat.

The effects of the Development on peat deposits are fully assessed within **Chapter 9 – Geology, Hydrology and Hydrogeology.**

3.4.1.8 Public Rights of Way

Although not currently recognised as a formal public right of way, an aspirational Core Path runs through the Site, linking the B729 with the former Troston Farmhouse and onto Knocksting where it connects with the wider Core Path network. A setback distance of the tip height plus 10 % has been applied in line with best practice.

The effects on the path and other recreational features are fully assessed within **Chapter 14 – Socioeconomics, Recreation and Land-use**.

3.4.2 Site Specific Technical Constraints

Specific technical factors considered in the design of the Development are set out below, with their influence on the design discussed.

3.4.2.1 Wind Resource

A key element to the design process is the wind resource of the Site; the availability of wind resource is affected by various issues such as wind speed, the prevailing wind direction, and local topography. The wind resource was modelled across the Site which fed into the design process. As a rule the more elevated areas of Site received the

greatest wind resource, which required balancing against the increased landscape and visual effects at higher elevations as discussed in Section 3.4.1.1.

3.4.2.2 Turbine Spacing

The spacing of the turbines is a key consideration in wind farm layout design; turbines need to be arranged a minimum distance apart such that turbulence from a specific turbine does not unduly affect the operation of a turbine which is downwind. The spacing for turbines needs to be larger in the prevailing wind direction and will vary from site to site and between different turbine models. The spacing is directly proportional to the size of the wind turbine rotor, whereby the larger the rotor the larger the spacing between turbines, and the fewer turbines that may be accommodated within a specific area.

The spacing chosen for the Development has been selected based on modelling assumptions and is designed to maximise the energy yield from the Development whist keeping fatigue loads, caused by turbulence, within the turbine manufacturer's design tolerances.

3.4.2.3 Topography and Ground Conditions

The suitability of ground conditions was considered during the design of the Development, which principally considered areas of steep slope and peat.

Where gradients of greater than 14% were identified, these areas were not considered suitable for wind turbines. This restricted much of the area within the northeast of the Site where steep slopes are present. The presence of steep slopes also presented a key element to the design of the site infrastructure including access tracks and hardstanding areas.

As noted in Section 3.4.1.7 the presence of peat has been assessed and avoided where possible both from an environmental and technical perspective.

3.5 DESIGN EVOLUTION

The final layout as presented in the EIA Report has been the subject of a number of iterations and refinements which mitigate by design predicted adverse effects as far as reasonably practicable. The resultant proposal balances the environmental and technical constraints, whilst producing an economically viable project. Design changes made as a consequence of the key constraints are considered to be mitigation which is 'embedded' in the design.

The key iterations are described below, and are shown in Figure 3.1 which demonstrates how the layouts have evolved throughout the EIA process.

3.5.1 Initial Feasibility – July 2011 – 20 to 21 Turbines – Tip Height – 121 m

The initial feasibility layout maximised potential turbine numbers using all unconstrained land established during the feasibility study. This represented the largest potential wind farm within the Site while adhering to all constraints known at the time.

The turbine geometry reflected typical tip heights at the time of the study.

3.5.2 Scoping Layout – June 2017 – 15 Turbines – Tip Height 149.5 m

The Scoping layout provided the key update from the initial feasibility layout and ongoing works since 2011. The turbine tip height and general dimensions were increased to reflect current trends in wind turbine technology and market requirements. A large turbine spacing was employed to allow flexibility in turbine choice and to allow for revision following subsequent wind data analysis. The increased turbine spacing is reflective of the larger turbine dimensions and was a key factor to the reduction in

turbine numbers from the initial feasibility layout. The following key known constraints were adhered to:

- Separation distances of 6 x 4 rotor diameters between turbines based on 128 m rotor diameters, assuming a south-westerly prevailing wind, in order to reduce issues associated with wind turbulence;
- 50 m buffer to known watercourses and waterbodies to reduce the likelihood of impacts as a result of pollution events, principally during construction;
- 165 m buffer to the aspirational Core Path within the Site;
- Avoidance of areas of slope in excess of 14%;
- 165 m buffer to public roads; and
- 75 m blade over-sail buffer on the site boundary.

3.5.3 Final Layout – 14 Turbines – Tip Height – 149.9 m

3.5.3.1 Turbines

A number of iterations took place between the scoping layout and the final layout, taking into account the constraints identified during environmental surveys. Comments from consultees, in particular those relating to landscape and visual aspects, provided key elements of the overarching design strategy.

It was determined that the spacing between the turbines needed to be slightly reduced, to allow for greater flexibility to avoid on site constraints.

The tip height was slightly increased by 0.4 m to allow for greater flexibility in turbine choice, without exceeding 150 m tip height.

The tip height of 150 m has been partially informed by the requirement of the Civil Aviation Authority that all wind turbines in excess of 150 m to tip to be installed with visible aviation lighting, consisting of a medium intensity (2000 candela) red light. This brings about notable changes to the landscape and visual impact at night and it was decided early on in the process that this limit would not be exceeded, negating the requirement for visible aviation lighting.

3.5.3.2 Infrastructure

The final layout incorporates infrastructure elements not present on the scoping layout, including the access tracks, substation compound, temporary construction compound, borrow pits and site entrance. The design rationale for these elements is outlined below.

Access Tracks

The Site contains a strong internal network of forestry tracks, and reusing these wherever possible has been a key design criteria. This is reflected by over 60 % of the access tracks associated with the Development consisting of upgrading tracks rather than establishing new track. This is notably higher than is typically achievable for a wind farm of this size and has reduced the number of new watercourse crossings required.

The Site topography presents a key element to the track design, whereby gradients of above 14% are not suitable.

Substation Compound

The substation compound is required to be on a relatively flat area and avoid known constraints. In order to reduce electrical losses and minimise unnecessary cabling, a relatively central location with respect to the turbine locations is preferred. This has dictated the final location, located to the south of the ridge of hills along the north and

east of Site which limits visibility of the substation building from the receiving environment.

Temporary Construction Compound

The location of the construction compound was determined by fulfilling the need to be relatively close to the Site entrance, being on relatively flat terrain and avoiding environmental constraints. A further constraint which became apparent during the design process was to locate the compound sufficiently far from any turbine location as a health a safety precaution due to the presence of large cranes lifting turbine components.

Borrow Pits

The borrow pit locations have been selected to avoid known environmental constraints and were identified following a review of where extractable rock of suitable quality is found. One borrow pit is on the site of an existing quarry, while the second is in an area with rocky outcrops. In addition both borrow pits are on the existing track network.

Access Junction

The location of the access junction, whilst entirely suitable, has to some degree been dictated as the only location of the Site with direct frontage to the public road network. The design of the junction has been based around receiving abnormal loads from the west and to ensure sufficient sight lines for vehicles to safely exit the Site.

3.6 SUMMARY

Various economic, technical and environmental factors were all considered in the iterative design process. These were informed through a variety of baseline surveys and consultation with a range of stakeholders.

The final design assessed in this EIA Report has been carefully developed taking these factors into account.

The final design is considered to meet the balance of increasing the renewable energy generation capacity of the Site whilst minimising the introduction of new environmental effects.