4 CONSIDERATION OF ALTERNATIVES

4.1 INTRODUCTION

This chapter of the EIAR presents a description of the reasonable alternatives studied by Coillte which are relevant to the project and its specific characteristics, and provides an indication of the main reasons for the option chosen, taking into account the effects of the project on the environment.

The reasonable alternatives studied are described and an indication of the main reasons for selecting the chosen option is provided, including a comparison of the environmental effects.

4.2 BACKGROUND AND SCOPE

Article 5(1)(d) of Directive 2011/92/EU as amended by Directive 2014/52/EU (the EIA Directive) states that the developer shall include:

d) "a description of the reasonable alternatives studied by the developer, which are relevant to the project and its specific characteristics, and an indication of the main reasons for the option chosen, taking into account the effects of the project on the environment";

Annex IV point 2 expands further:

> "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 project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects."

The EU Commission guidance "*Guidance on the preparation of the Environmental Impact Assessment Report"*[1] (2017) defines alternatives as: "*Different ways of carrying out the Project in order to meet the agreed objective'.* That guidance states *'The number of alternatives to be assessed has to be considered together with the type of alternatives, i.e. the 'Reasonable Alternatives' referred to by the Directive. 'Reasonable Alternatives' must be relevant to the proposed Project and its specific characteristics, and resources should only be spent assessing these Alternatives. In addition, the selection of Alternatives is limited in terms of feasibility. On the one hand, an Alternative should not be ruled out simply because it would cause inconvenience or cost to the Developer. At the same time, if an Alternative is very expensive or technically or legally difficult, it would be unreasonable to consider it to be a feasible Alternative.'*

Ultimately, Alternatives have to be able to accomplish the objectives of the Project in a satisfactory manner, and should also be feasible in terms of technical, economic, political and other relevant criteria.

The Draft EPA guidance "*Guidelines on the information to be contained in Environmental Impact Assessment Reports*" (2017) says:

1. See: http://ec.europa.eu/environment/eia/pdf/EIA_guidance_EIA_report_final.pdf

> *"It is generally sufficient to provide a broad description of each main alternative and the key issues associated with each, showing how environmental considerations were taken into account in deciding on the selected option. A detailed assessment (or 'mini-EIA') of each alternative is not required."*

That guidance also states that analysis of high-level or sectoral strategic alternatives cannot reasonably be expected within a project level EIAR.

The purpose of alternatives analysis is therefore principally to examine the different possibilities for meeting the Project's need and objectives and to determine whether or not the Project objectives can be met by different means that avoid, minimise, or mitigate potential significant environmental effects of the proposed Project.

During the project design process, alternative wind farm layouts and scales were fully considered in order to find the optimum design solution for the site with the least level of environmental impact. This chapter therefore outlines the site selection process, the process of design evolution for the proposed development, the reasonable alternatives considered during the project inception and design process including a comparison of the environmental effects and the principal reasons for proceeding with the current planning application. The following elements are considered further in this chapter:

The reasonable alternatives studied were as follows:

- Site Selection: Alternative Locations or Sites;
- Alternative Designs (Layout, Size and Scale);
- Alternative Processes (Sources of energy, construction methods); and
- Do-Nothing Scenario

4.3 ALTERNATIVE LOCATIONS OR SITES

4.3.1 Site Selection for Proposed Wind Farm

Coillte are custodians of 7% of Ireland's land with forests and land extending to over 441,000 hectares. Coillte's Land Solutions division seeks to add value to the business where lands have potential for additional uses. In recent times, renewable energy projects are one such land-use and Coillte has provided land to third party developers, for high quality wind farm projects. These include the following;

- Raheenleagh Wind Farm is a joint venture wind farm between Coillte and ESB, which is developed on Coillte land in Co. Wicklow. It is operational since 2016 and is now equally owned by ESB and Greencoat Renewables.
- Galway Wind Park is a cluster of four wind farms developed predominantly on Coillte land by SSE Renewables. Phase 1 (64MW) commenced construction in 2015 and is owned by SSE. Phase 2 (105MW) is a joint venture between Coillte and SSE.

In recent years, Coillte's strategy has been to lead the wind farm development process and take responsibility for bringing wind farm projects into construction and operation. The Carrownagowan proposal is such a project and initial site selection was focused on delivering a large wind farm.

Alternative locations were eliminated by Coillte in the early stages of site selection as the goal for this project was to deliver a large-scale wind farm in the range of (100 – 150MW). Furthermore, site selection, through a process of elimination, applies a screening process to available sites which considers environmental factors and effects and consequently identifies appropriate sites for development. A strategic project of a large-scale requires a large site in the first instance. Coillte reviewed its estate in 2014 with a view to identifying suitable sites for the development of wind farms.

The process of identifying a suitable wind farm site is influenced by a number of factors. At a macro scale: national and regional planning policy together with distance from designated sites; available grid capacity; cumulative impacts with existing and permitted wind farms, as well as other existing, permitted and proposed developments, and; available wind speeds in an area are all integral factors. Interrelated to this, the wind farm must, in non-environmental terms, be commercially viable to ensure it will attract the necessary project finance to progress to the construction phase and ultimately to deliver renewable electricity to the National Grid which is an objective of National energy policy.

4.3.2 Site Screening by Coillte

Phase 1 – Initial Screening

This stage in the selection process discounted lands that were not available for development under a number of criteria, as follows:

- Millennium Sites (these Coillte sites were planted and managed for the provision of a tree for every household in the country as part of the Millennium tree planting project)
- Committed Lands for other developments
- Life Site (a Coillte environmental designation – these former forested sites were cleared and are managed for biodiversity)
- National Parks
- Existing Wind Farm Development Sites
- Natura 2000 and Nationally Designated Sites (SAC, SPA, NHA, pNHA)

Additionally, Coillte reviewed relevant Development Plan and Renewable Energy Strategy provisions for these potential sites and only included sites characterised (at a minimum) “open for consideration” for wind farm development or with more favourable zoning of “acceptable in principle” or “strategic for wind development”. Furthermore, sites with Natura 2000 designations were excluded.

As the goal for this project was to deliver a large-scale wind farm in the range of (100 – 150MW) the size of the available site was considered and sites with less than 300ha were ruled out. Sites with an average wind speed less than 7m/s at 80m above ground were then ruled out, as they were considered potentially unsuitable for a commercially viable wind energy development.

Phase 2 – Grid Constraints

As part of the site selection process, it was necessary to consider the potential for grid connection, including in terms of distance to potential connection nodes and the grid capacity at the nodes, in the local area, to accommodate the connection.

Phase 3 – Screening

The next stage of screening screened out lands from further analysis due to the presence of the following:

- Sensitive Amenity or Scenic Areas designated in CDPs (at the time of the screening process)
- Tourist areas/sites/trails
- Lands utilised for other wind farm developments
- Telecommunications masts and links
- Relatively high residential density in vicinity
- Sensitive habitat/species of bird
- Watercourses and water bodies
- Land Ownership title Issues
- Unfavourable slopes and ground conditions

This stage of screening was generally applied using Coillte's in-house expertise and local knowledge. The application of the above criteria resulted in the selection of a site known as Carrownagowan, located on the north-western slopes of Slieve Bernagh in Co. Clare, as a candidate site to be brought forward for more analysis.

Sites that emerged from the site selection process, outlined above, include:

- Croagh, Co. Leitrim and Co. Sligo
- Glenard, Co. Donegal
- Bottlehill, Co. Cork
- Castlebanny, Co. Kilkenny

As well as the Carrownagowan site identified as part of this screening exercise, Coillte intend to bring forward all of the above sites for wind energy development, and have submitted an application for the Croagh site.

The alternative would be to bring forward a site that did not pass one or all of the above phases of the screening process. In that instance, there would be the potential for the construction and operation of a wind energy development to have an adverse effect on ecologically designated or sensitive areas and visually sensitive (scenic) or amenity areas. There would also be the potential for greater shadow flicker, noise and traffic impacts if the candidate site was located in an area with a higher number of residential dwellings. Third party land agreements would also be required to ensure a site of adequate size, (ie. a 300ha contiguous site area). In addition a site with an average wind speed less than 7m/s (at 80m above ground level) and/or not located within close proximity of existing grid infrastructure may not be economically viable.

At the end of the screening process, the Carrownagowan site was the preferred candidate site of scale to take through to the next stage of validation. Although of a smaller scale, a second candidate site was identified north of Carrane Hill on the Leitrim-Sligo border. Coillte have submitted an application for the development of the Croagh Wind Farm. The Croagh development could generate approximately 50MW of renewable carbon-neutral electricity. Potential large scale sites which did not emerge from screening as candidate sites are included in Table 4-1, which includes a comparison of environmental, ecological and planning constraints.

Table 4-1 Consideration of large sites and potential for environmental effects

Site Location	Local Authority Zoning	Population / Noise / Shadow Flicker	Biodiversity / Natura 2000 Network	Land and Soil / Geotechnical Risk	Water / Hydrological Risk	Access to Grid	Turbine Delivery
Slieve Felim (Limerick/ Tipperary)	Partial preferred (in Co. Tipperary)	At acceptable setback (>600m from dwellings, or 4 x 150m tip height)	Slievefelim to Silvermines Mountains SPA, Keeper Hill SAC	Uplands with peat soils	Clare River to the north of the site	Limerick	Possible, close to motorway
Maghera (Clare)	Not normally permissible	At acceptable setback (as above)	Slieve Aughty Mountains SPA	Sloping uplands with peat soils; lakes	Lough Ea, Maghera Lough, watercourses	Ennis	Possible, close to motorway
Slieve Bloom (West of Keeper Hill)	Areas unsuitable for new wind energy development	At acceptable setback (as above)	Slievefelim to Silvermines Mountains SPA, Lower River Shannon SAC	Uplands with peat soils	Site watercourses draining to SAC, north and west of site	Limerick	Possible, close to motorway
Slieve Bernagh - Carrownagowan	Strategic for wind	At acceptable setback (as above)	Outside/adjacent Slieve Bernagh SAC	Uplands with peat soils	Drainage to east and west, mostly to the west	Ennis Ardnacrusha	Possible, close to motorway

In conclusion, alternative locations were eliminated by Coillte in the early stages of the project because they were not relevant to the project and its specific characteristics - delivery of a large wind farm in the range of 100-150MW. These sites were screened out from further consideration as they did not have favourable zoning in terms of the Local Authority plans for wind energy or in terms of designated Natura 2000 sites. Consequently the Carrownagowan site was further validated as outlined below.

4.3.3 Site Validation

Carrownagowan, as a candidate site, was further examined under the following headings in order to confirm its suitability for wind energy development. The main policy, planning and environmental issues considered for the validation of this wind farm site included:

- Local development plan policies;
- Obtainable, and economic, grid connection;
- Located outside areas designated for protection of ecological species and habitats;
- Consistently high average annual wind speeds;
- Adjacency of residential properties;
- Site topography;
- Access issues for turbine delivery and construction activities.

The above exercises, based on a number of key environmental, technical and policy-related criteria, determined that the proposed development site represented a suitable location for the proposed development in east Clare. The proposed development site has satisfied a number of key criteria required for successful wind energy development and these are presented in Table 4-2 below:

Table 4-2 Summary of Site Suitability Criteria

Suitability Criteria	Proposed Development Site
Wind Resource	Sites where the average wind speed at 80 metres above ground level was less than 7 meters per second were discounted. The predicted wind speeds at the site vary between 7.5m/sec and 10m/sec as shown in Sustainable Energy Ireland's Wind Atlas.
Proximity to Grid	There are two 110kV ESB Substations which can be considered for the Carrownagowan Wind Farm Grid Connection. These include Ardnacrusha 110kV Substation and Ennis 110kV Substation.
Compliance with Planning Designation	The Clare County Development Plan (2017 – 2023) contains the Clare Wind Energy Strategy as Volume 5. The Clare Wind Energy Strategy has designated these lands on the northwestern slopes of Slieve Bernagh as 'Strategic' for wind development and adjacent areas designated 'Acceptable in Principle' for wind development.
Avoidance of Environmental Designations	There are no Natura 2000 sites within the development footprint. The nearest site is the Slieve Bernagh SAC which is adjacent to the site. The site does not constitute high value habitat or a sensitive site
Separation distance from dwellings	A setback distance of four times the turbine tip height (676m) is possible and there is potential to increase this setback.
Site accessibility and scale	Primary site access can be achieved from the north along the L-8221 Local road. There are sufficient lands to develop a large wind farm.
Level of visual Impact	Assessment of the capacity to absorb the proposed wind farm development. The location on the north-western slopes of the mountain limit the visual impact to the east and northeast.

4.3.4 Choice of Location of Connection to National Electricity Grid

TLI Group was engaged to examine the various options available for a 110kV grid connection to an existing 110kV ESB Substation. A 110kV line is necessary for the 19 turbine wind farm as the output will be a minimum of 90MW. The two 110kV ESB Substations considered for the Carrownagowan Wind Farm Grid Connection were Ardnacrusha 110kV Substation and Ennis 110kV Substation.

Figure 4-1 Ardnacrusha 110kV Substation Location

Figure 4-2 Ennis 110kV Substation Location

These two substations were selected due to their proximity to the wind farm site.and a comparison of the environmental effects of the two substation options is provided in Table 4-3 below.

Table 4-3 Comparison of Environmental Effects of Substation Options

	Population / Noise	Traffic	Biodiversity	Land and Soil	Water	Cultural Heritage
Ardnacrusha 110kV Substation	Shorter route, shorter timeframe, less nuisance, along local roads	Local roads, diversions required	Less risks with shorter route along public road	Land available if required, land at substation is not restricted	Less potential risks with shorter route, potential for less stream crossings	Low risk in the public road network
Ennis 110kV Substation	Longer route, more works on busier road network, potential for greater nuisance	Substation surrounded by M18 motorway, slip road, regional road. Potential for diversions on busier network	Longer route more potential for disturbance to wildlife	Limited land at location would limit expansion options	Routes to Ennis are 35 -50% longer, with potential for more stream crossings	Low risk in the public road network

The analysis has indicated that the Ardnacrusha 110kV Substation is the preferred option for the Carrownagowan Wind Farm 110kV grid connection as opposed to the Ennis 110kV Substation. The main reasons for this decision on the chosen option are as follows:

- Capacity is available at Ardnacrusha but limited capacity is available at Ennis 110kV Substation;
- Substation expansion options available at Ennis 110kV Substation are limited due to location adjacent to motorway and regional road;
- OHL routes to Ennis Substation is > 50% longer in comparison to Ardnacrusha Substation;
- UGC routes to Ennis Substation is > 35% longer in comparison to Ardnacrusha Substation; and
- Increased project risks associated with the longer grid connection options to Ennis, i.e. potential environmental risks and landowner issues

4.3.5 Choice of Location of Grid Connection route

TLI was also engaged to identify and analyse 110kV grid connection options available for the Carrownagowan Wind Farm project to connect to the National Electricity Grid (NEG) at Ardnacrusha. As part of this process, a ranking of the various options available was completed to assist Coillte in their decision to pursue an Overhead Line (OHL) or an Underground Cable (UGC) option for the project. Twelve alternative grid connection routes were identified and assessed which included six OHL and six UGC options. The nature of the grid route study includes factors of location, scale (length) and design (OHL or UGC) and it was based on desktop analysis, site surveys, constraints analysis and design requirements. Environmental factors considered included Natura 2000 sites, NHAs, national monuments, watercourses, gradient and elevation changes, residential settlements, agricultural buildings, towns, villages and transport infrastructure.

The twelve options were ranked and the highest ranked and most favourable option at an early stage of the process was Option 1, an OHL from Carrownagowan to Ardnacrusha Substation using a western corridor. However, Coillte decided upon an UGC for the grid connection and thus the option ranked third, which was the preferred UGC route option, was chosen for the project.

Coillte opted for the UGC as despite the cost implication, there is less environmental effects involved in utilising the existing road network. It was considered that with an OHL, there is potential for visual and ecological impacts and uncertainty over ground conditions with respect to constructing the pylon bases. A high level comparison of environmental effects of all 12 routes is included in Table 4-4.

Table 4-4 Comparison of Environmental Effects of Grid Connection Routes

Rank	Option	OHL / UGC	Length (km)	Population & Noise	Visual Impact	Traffic	Biodiversity	Land & Soil	Water	Cultural Heritage
1	1	OHL	16.41	Temporary construction noise, Avoids major residential areas	Potential visual effects, OHL to Ardnacrusha	Avoids major residential areas	Habitat / green field requirement. Avoids SAC, SPA, NHA	Third party land use, potential for issue with ground conditions, avoids steep gradient	Avoids SACs, NHA, OHL can cross over stream	Avoids all national monuments. Maybe unknown resources in Greenfield area
2	2	OHL	16.19	Temporary construction noise, close to a dwelling at one location	Potential visual effects	Avoids major residential areas	Habitat / green field requirement/passes through section of private forestry	Third party land use, potential for issue with ground conditions, some areas of steep gradient	Avoids SACs, NHA, OHL can cross over stream	Avoids all national monuments. Maybe unknown resources in Greenfield area
3	5	**UGC**	20.73	In local road network, avoids busy primary routes, best route in local roads	No visual effects	Avoids primary and busy roads	Less habitat impact with most in public road	All in access track and local public road to Ardnacrusha	Stream crossings can be designed to use directional drilling under stream bed	All in public road, unlikely to have effects
4	6	**UGC**	19.6	In local road network, temporary construction noise	No visual effects	Alternative middle section of route 5	Less habitat impact with most in public road	All in access track and local public road	Stream crossings can be designed to use directional drilling under stream bed	All in public road, unlikely to have effects

Rank	Option	OHL / UGC	Length (km)	Population & Noise	Visual Impact	Traffic	Biodiversity	Land & Soil	Water	Cultural Heritage
5	7	UGC	19.59	In local road network, temporary construction noise	No visual effects	UGC utilizes more primary roads than Option 5 and 6	Less habitat impact with most in public road	All in access track and local public road	Stream crossings can be designed to use directional drilling under stream bed	All in public road, unlikely to have effects
6	8	UGC	18.22	In local road network, temporary construction noise	No visual effects	UGC is required to cross a busy junction outside Ardnacrusha	Less habitat impact with most in public road	All in access track and local public road	Stream crossings can be designed to use directional drilling under stream bed	All in public road, unlikely to have effects
7	3	OHL	18.39	Avoids major residential areas	Potential visual effects	Avoids major residential areas	OHL passes through two SACs	Third party land use, potential for issue with ground conditions, avoids steep gradient	OHL can cross over stream, within SAC however	Avoids all national monuments. Maybe unknown resources in Greenfield area
8	4	OHL	16.83	Avoids major residential areas	Potential visual effects	Avoids major residential areas	OHL passes through larger sections of SACs	Third party land use, potential for issue with ground conditions, avoids steep gradient	OHL can cross over stream, within SAC however	Avoids all national monuments. Maybe unknown resources in Greenfield area

Rank	Option	OHL / UGC	Length (km)	Population & Noise	Visual Impact	Traffic	Biodiversity	Land & Soil	Water	Cultural Heritage
9	9	OHL	24.4	Preferred OHL to Ennis, Avoids major residential areas	Potential visual effects	Avoids major residential areas, but may impact traffic near town	Greenfield areas, potential for habitat loss	Third party land use, potential for issue with ground conditions, avoids steep gradient	Avoids SACs, NHA, OHL can cross over stream	Avoids all national monuments. Maybe unknown resources in Greenfield area
10	10	OHL	25.7	Potential visual effects, alternative to Ennis	Potential visual effects	Avoids major residential areas, but may impact traffic near town	Greenfield areas, potential for habitat loss	Third party land use, potential for issue with ground conditions, avoids steep gradient	Avoids SACs, NHA, OHL can cross over stream	Avoids all national monuments. Maybe unknown resources in Greenfield area
11	12	UGC	26.9	Uses primary roads to Ennis, disturbance to local community	No visual effects	Utilises primary roads, traffic disruption potential on busy routes	Less habitat impact with most in public road	All in access track and primary public road	Stream crossings can be designed to use directional drilling under stream bed	All in public road, unlikely to have effects
12	11	UGC	25.8	Uses local roads to Ennis, disturbance to local community	No visual effects	Utilises local roads, traffic disruption potential near Ennis town	Less habitat impact with most in public road	All in access track and local public road	Stream crossings can be designed to use directional drilling under stream bed	All in public road, unlikely to have effects

The preferred grid connection will consist entirely of underground cabling (UGC) utilising public local road networks, existing access tracks and private forestry access tracks, with the majority of the UGC to be installed within the public road network. The proposed UGC route is approximately 25km in length and runs in a northerly direction from the existing ESB Ardnacrusha 110kV substation to the proposed Carrownagowan Wind Farm substation location (Figure 4-3).

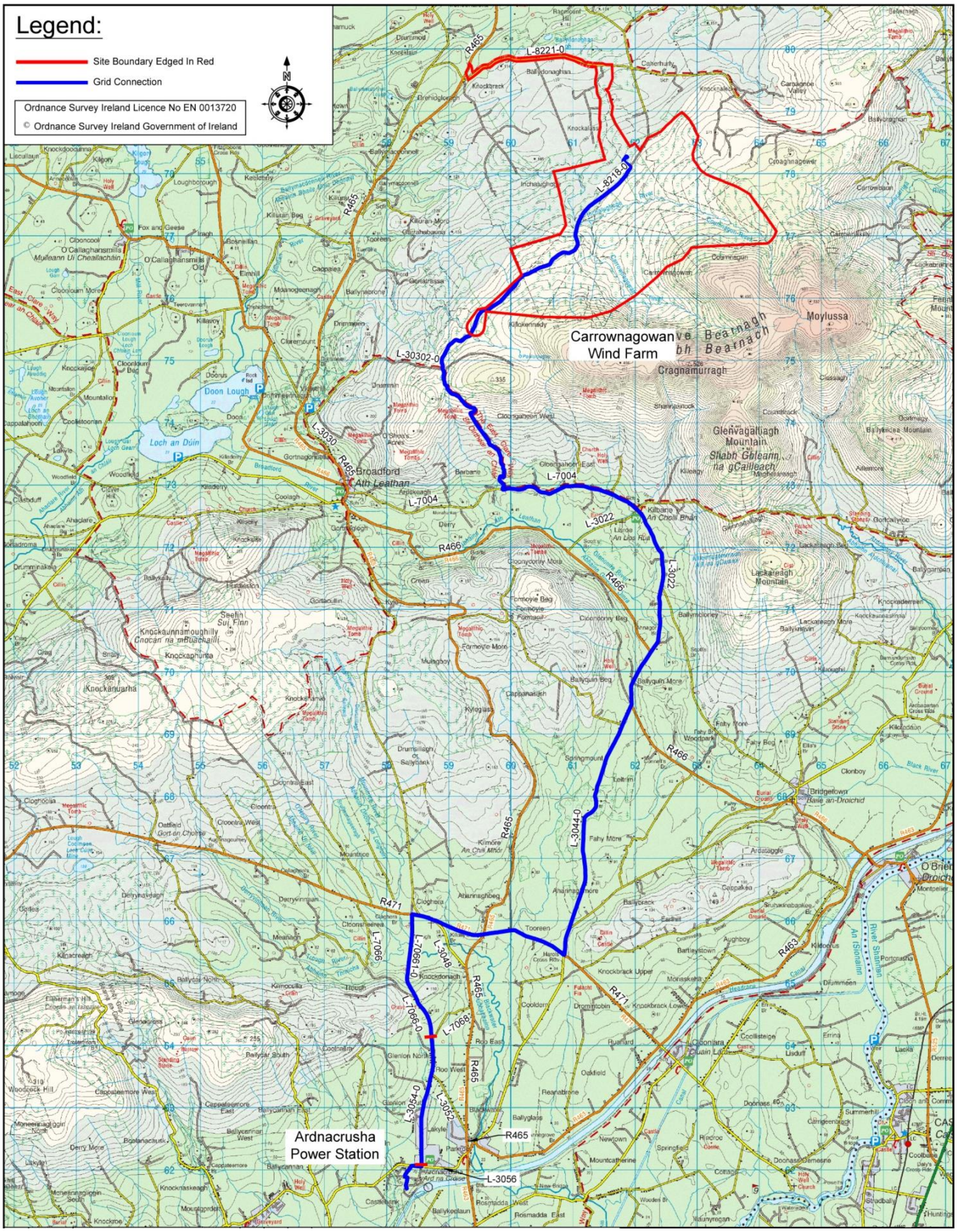


Figure 4-3 Chosen Option for Grid Route

4.4 ALTERNATIVE DESIGN

There are a number of drivers that will ultimately influence how a design layout for a project evolves. For wind farm development, this is usually concerned with location and placement of development components within a limited footprint at the site, which is largely defined by aspects such as noise, set-back from residential dwellings, habitat, access, grid connectivity and ground conditions, including slope, peat and drainage regime.

The EIA (Environmental Impact Assessment) process involved the completion of all baseline studies to generate environmental constraints that informed the design for the optimum wind farm layout. These studies were undertaken by the environmental, planning and engineering professionals that made up the Wind Farm Design team. Site investigations between 2018 and 2019 have informed the proposed development EIA and planning application.

The design process is an iterative process, resulting in the assessment of numerous design iterations (or revised designs) to ensure the identified environmental and engineering constraints are applied to successive layout designs. The design iterations, as reasonable alternatves, and the evolution of the final design, or final alternative, are outlined in Section 4.4.2 below. A comparison of environmental effects is presented in Table 4-5.

Coillte provided Malachy Walsh and Partners with excellent, high quality LiDAR data, obtained from a high density aerial survey. This allowed for detailed desk review of the site and the commencement of a detailed terrain model. Initial site reconnaissance field visits were carried out by a team of engineers and hydrologists from Malachy Walsh and Partners and Hydro Environmental Services. These initial field visits were to review existing drainage regimes, topography and slope on the ground, and to make a preliminary assessment of access for turbine delivery.

The preliminary layout began with a turbine arrangement across a larger site based on smaller turbine models. As the studies progressed in 2018 and 2019, the buildable area (footprint available for development components) evolved to minimise environmental effects. As the buildable area evolved and reduced in size, the layout evolved. The principal design layouts are presented below (section 4.4.2) to describe the evolution of the design in the consideration of alternative layouts.

Following consultation and baseline assessment of the site, the following key environmental issues were identified:

- Topography and Engineering
- Sensitive Habitats
- Bat Ecology
- Noise and nearest dwellings
- Ornithology
- Land, Soils and Peat
- Hydrology
- LVIA

This analysis of constraints identified environmental concerns, or the potentially significant environmental impacts, associated with the proposed wind farm development site. Environmental concerns consisted of constraints (e.g. peat stability risk zone) or setback distance (e.g. buffer from SAC). Buffers and set back distances are the principal tool used by wind farm designers when incorporating mitigation by design and avoidance. This can only be done when all the environmental sensitivities have been established across the project area. Buffers and set back distances derived from guidance documents, stakeholder input, studies (as outlined above) and project experience are then put in place.

Table 4-5 summarises the physical and environmental constraints which have informed the wind farm design:

Table 4-5 Physical and Environmental Sensitivities

Study Area	Design Constraint
Topography and Engineering	Ground areas with slope greater than 30^0 were deemed unsuitable for development. Areas with slope greater than 10^0 were deemed unsuitable for turbine locations. Slope, peat, existing roads, drainage, historical peatslide were all contraints.
Sensitive Habitats	Identification of habitat type within site and minimisation of infrastructure within ecologically valuable habitat such as Blanket Peat. Areas identified and avoided were included for biodiversity enhancement, not as mitigation or compensation. Review hydrological connectivity to bog, buffer of 150m applied to SAC.
Bat Ecology	86m felling buffer from centre of each turbine as recommended in Scottish Natural Heritage Guidelines (2019)
Noise and nearest dwellings	Apply a minimum distance from proposed turbine locations to nearest neighbours. A 750m buffer was applied to nearest houses. Draft Wind Energy Development Guidelines (2019) advise a setback of four times the blade tip height, which would be 676m. Preliminary noise model was completed, with 750m setback from receptors. The final design achieved a 1km setback.
Ornithology	Three years of bird survey were carried out over winter and summer seasons. This data was available during the design process. Identification of hen harrier breeding territory resulted in an applied buffer and an exclusion of an area to the northwest of the site.
Land, Soils and Peat	Identification of peat depths and rock outcrops. Avoidance of high peat slide risk and constructability risk areas. Identification of areas for borrow pits.
Hydrology (and the Water Framework Directive)	Siting of turbines and hardstands at minimum distance of 75m from watercourses, going beyond the buffer as recommended by Forest Service guidelines. The Irish Wind Energy Association, Industry Best Practice Guidelines (IWEA, 2012) state construction works should be kept 50m from watercourses where reasonably possible, with the exception of crossings which should be minimised. A buffer of 75m was applied in this design.
LVIA	Identification of Zones of Theoretical Visibility (ZTV) within 30km of the proposed development. Priority was given to minimisation of visual effects from the east and northeast after consultation with Clare County Council and a discussion on the views from Lough Derg. Wireframes were reviewed and scenic locations in surrounding areas.

4.4.1 Fine Tuning the Buildable Area

As the EIA progressed, further baseline field data was gathered, which resulted in the ongoing development of the digital terrain model to refine the buildable area for the placement of the wind farm infrastructure (Figure 4-4). Mapping of the environmental constraints, to focus on the buildable area, enables vigilant design of a wind farm development.

This includes the physical and environemtnal constraints outlined in Table 4-5 above. A huge focus was placed on the visual impact and in particular on the mitigation of impacts from the Lough Derg area. An early meeting with the Planning Department of Clare County Council requested a focus on views from this area to the east and northeast and from Killaloe.

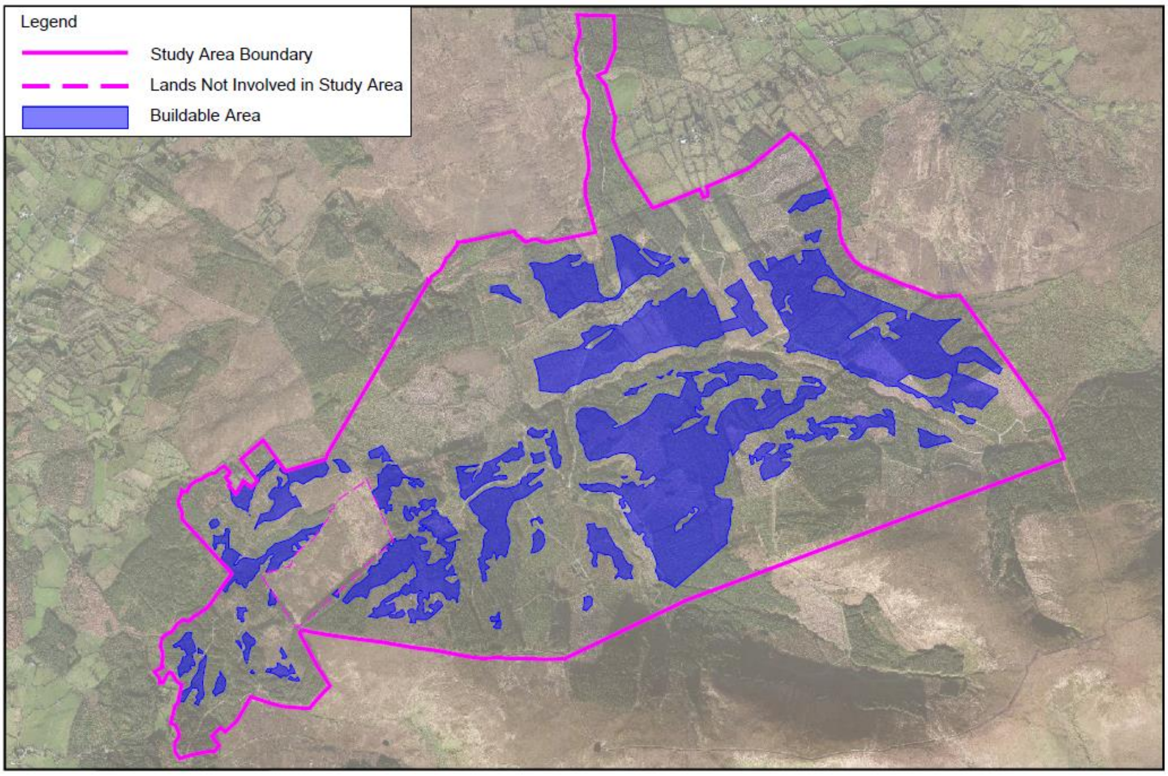


Figure 4-4 Unconstrained buildable area for turbines and hardstands

4.4.2 Evolution of Alternative Designs

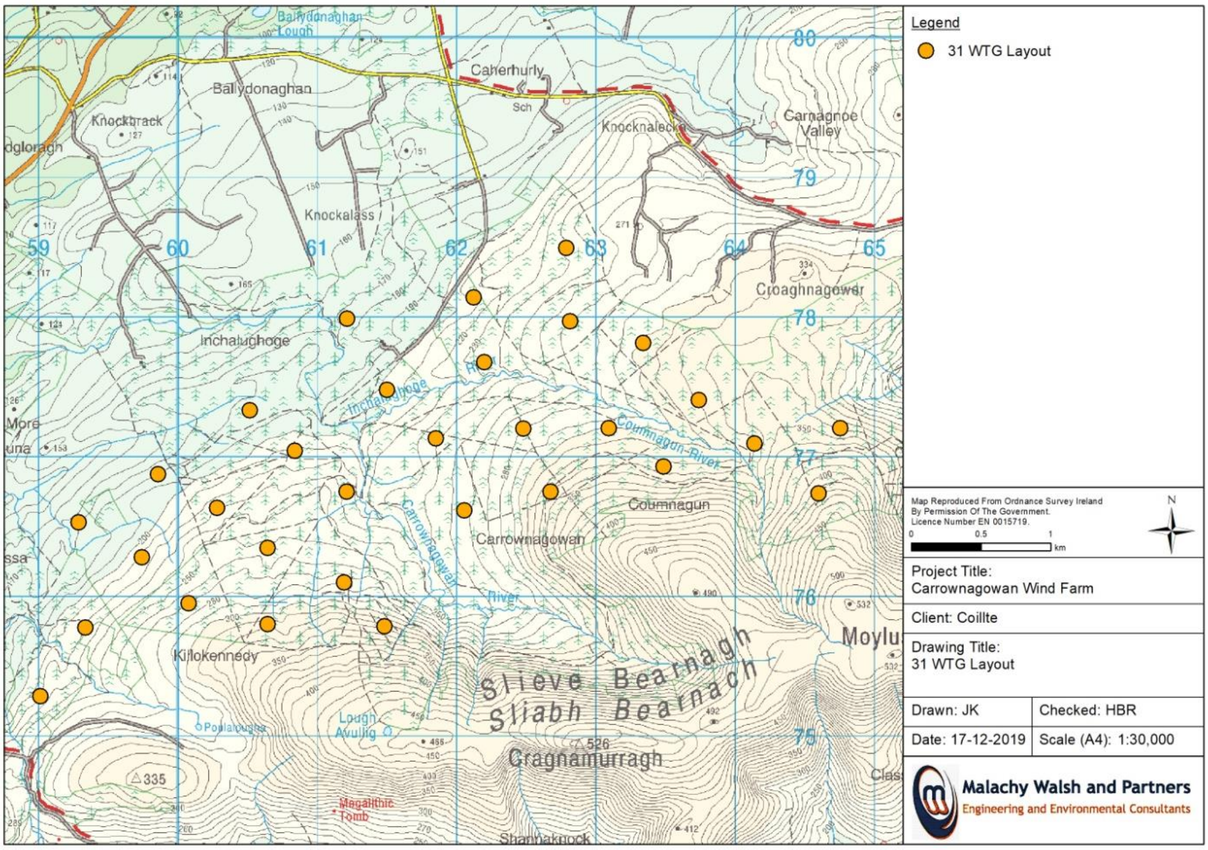
An intial indicative 31 turbine layout was proposed. The project commenced with an in-depth constraints analysis which produced a "buildable area" described in 4.4.1 where turbines could be constructed with standard engineering works and without significant environmental effects. The constraints led approach shrinks the site overall area available for the project by applying rules to exclude sensitive environmental factors, as well as areas sensitive to peat and ground slope to determine the buildable area.

The design evolution is described through six design iterations in the following sections. The iterations are listed in Table 4-6 below which presents a comparison of environmental effects as the layout, size and scale evolved. As outlined in the European Commission's 2017 Guidance, alternatives provide an opportunity to change the design in order to minimise the project's significant effects on the environment. Preventative action is the most effective way to avoid potential negative environmental effects and this avoidance has been achieved through the design process and the consideration of alternatives and through the review of the project design to minise environmental effects.

Table 4-6 Comparison of Environmental Effects of Design Iterations

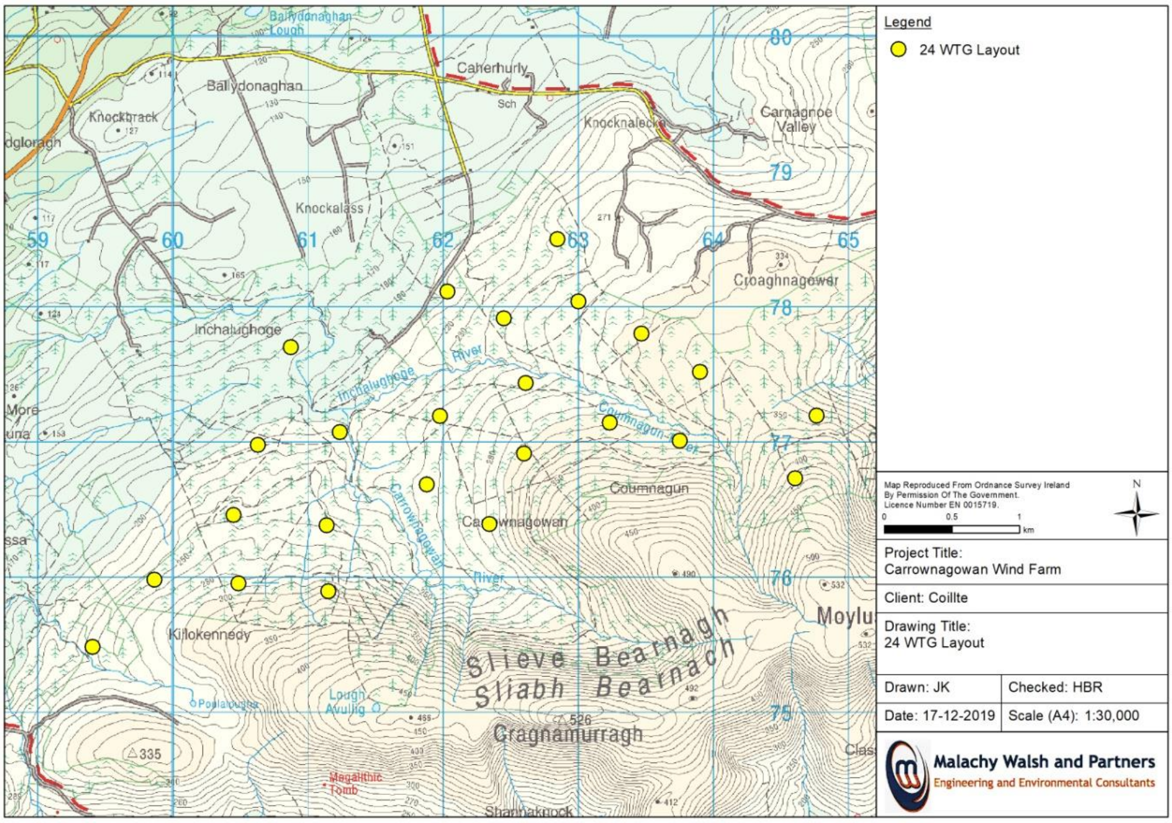
ITERATION	POPULATION AND HUMAN HEALTH	BIODIVERSITY	AIR AND CLIMATE CHANGE	LANDSCAPE AND VISUAL	WATER	LAND AND SOIL	NOISE, SHADOW FLICKER	CULTURAL HERITAGE	DESIGN IMPROVEMENT
31 Turbine Layout	Setback from dwellings approx 600m	Larger area across site	Large-scale project c. 100mw positive air and climate change effects	31 turbines (up to 150m)	75m buffer applied to watercourses from turbines and hardstands	Layout on peat <2m with varied, shallow slopes	Setback from dwellings approx 600m	No recorded monuments on site	(First Layout)
24 Turbine Layout (*re-design with larger machines*)	Setback increased to 750m	Reduction in turbine sites / reduction in area	Similarly, a large-scale project	Reduced visual effect with reduction to 24 turbines (up to 169m)	75m buffer maintained from turbines and hardstands	n/a	Setback increased to 750m	n/a	Reduced Population, Biodiversity, Visual, Noise effects
23 Turbine Layout (*re-design to 23 T with removal of eastern turbines*)	Setback 750m	Two eastern turbines no longer included, reduction in habitat/area, & exclusion of eastern catchment	Similarly, a large-scale project	Reduced visual effect from Lough Derg area with two eastern turbines removed	Reduced no. of catchments as eastern turbines no longer included	High slopes avoided and landslide area to the east avoided and buffered	A redesign, achieved a 23 turbine layout, with a lower noise level; Compliant with limits	n/a	Reduced Biodiversity, Visual, Water, Land and Soil, Noise effects
21 Turbine Layout	Setback 750m	Adjustments to protect local areas of valuable habitat	Similarly, a large-scale project	Reduced visual effect from Moylussa summit	n/a	Adjustments to layout to avoid pockets of deep peat	Redesign has lower noise level, remains compliant	n/a	Reduced Biodiversity, Visual, Land and Soil, Noise effects
20 Turbine Layout	Setback increased from to 1km	n/a	Similarly, a large-scale project	Visual optimisation of 20 positions	n/a	n/a	Setback now of 1km	n/a	Reduced Visual, Population, Noise effects
19 Turbine Layout (The Final Alternative)	1km setback to nearest dwellings achieved	Avoided sensitive habitat and hen harrier territories	Final layout achieves a large-scale wind project c. 100mw (at least 90mw)	Maintained reduced visual effects from east & north east (L. Derg) and Moylussa	75m buffer maintained	Low risk design achieved in terms of peat stability	1km setback plus compliance with current guidance.	No recorded monuments on site	**Chosen Option** **Reduced environmental effects**

4.4.2.1 Carrownagowan: 31 Turbine Layout



An indicative 31 turbine layout was presented based on knowledge of the land and site walkovers and the land requirements for smaller machines (up to 150m). Initial assessment of the layout involved a consideration of the size and scale of turbine models available at that time and those considered likely in the near future. It became apparent that many of the smaller models would not be available and manufacturers were moving towards larger more efficient machines.

4.4.2.2 Carrownagowan: 24 Turbine Layout

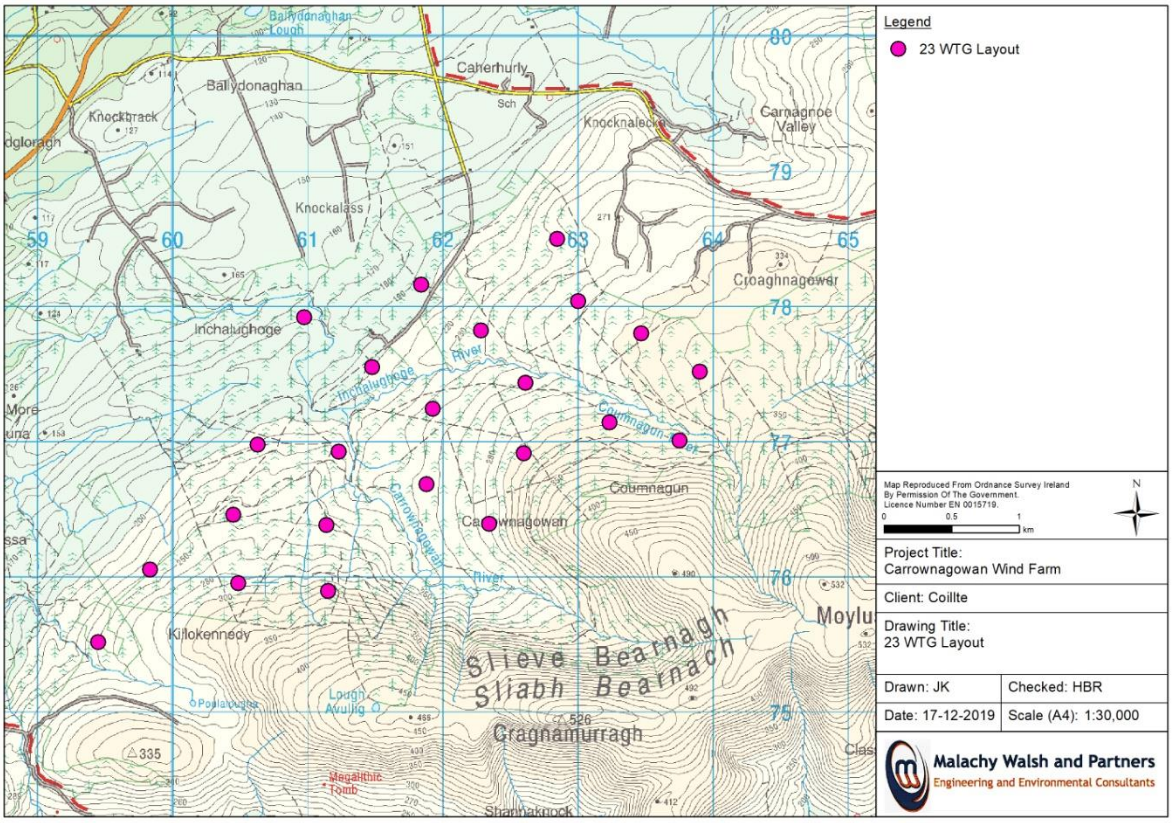


The reduction of the 31 turbine layout to the 24 turbine layout was a result of considering a turbine of a tip height of 169m and applying the required ellipses to optimise the wind resource, based on the available land and the potential for access to the proposed individual turbine sites which is constrained by the delivery of the larger turbine components.

Watercourse buffers of 75m were maintained for the turbines and hardstand areas and a setback to nearest houses of 750m was applied.

A preliminary desktop modelling exercise was undertaken using computer software in order to locate noise sensitive receptors (NSR) which may be affected and to identify suitable locations at which to monitor background noise. The 24 turbine iteration of the wind turbine layout was input into the software using noise data for the candidate turbine representative of the type that could be installed on the site, relevant to the chosen dimension envelope of a maximum tip height of 169m. To allow maximum flexibility in turbine selection, the loudest turbine under consideration, the Nordex N133 4.8 MW, was modelled for the 24 turbine layout.

4.4.2.3 Carrownagowan: 23 Turbine Layout



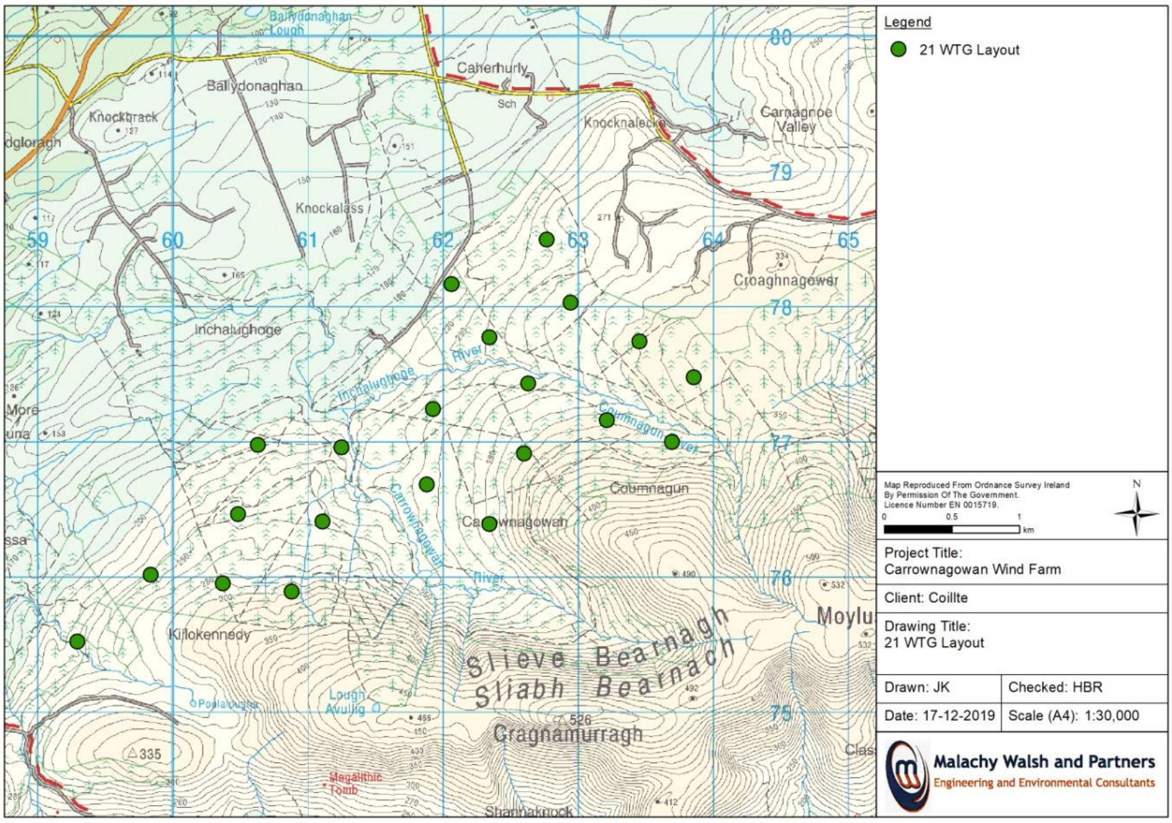
The 23 turbine layout reduced the proposal by one turbine overall but significantly relocated the 23 turbines proposed within the site based on a fine tuning of the buildable area from a digital terrain model, generated from high density LiDAR data. The terrain model generated was used by the engineering team to define the ground surface gradients and the acceptable slope where turbines and their associated hardstands could be constructed safely and with minimum environmental risk.

In the 23 turbine layout, two easterly turbines of the previous (24 turbine) layout were dropped which satisfied constraints including;

- Excess gradient – Avoided.
- Hydro-connectivity to the eastern cathment (including freshwater pearl mussel) – Avoided; no longer within catchment.
- Reduced visual impact from Lough Derg area and vistas to the east– Reduced.
- Area of historic landslide – Avoided (by over a half a kilometre).

Although two turbines were dropped from the east, further layout optimisation within the buildable area, which factored in all constraints, yielded a 23 turbine layout. Therefore only one turbine was lost between these two ieartions (24 turbines and 23 turbines).

4.4.2.4 Carrownagowan: 21 Turbine Layout



The 21 turbine layout represented a further evolution as baseline data from the field was collated and analysed, in particular peat data and feedback from the ecologists studying the site biodiversity.

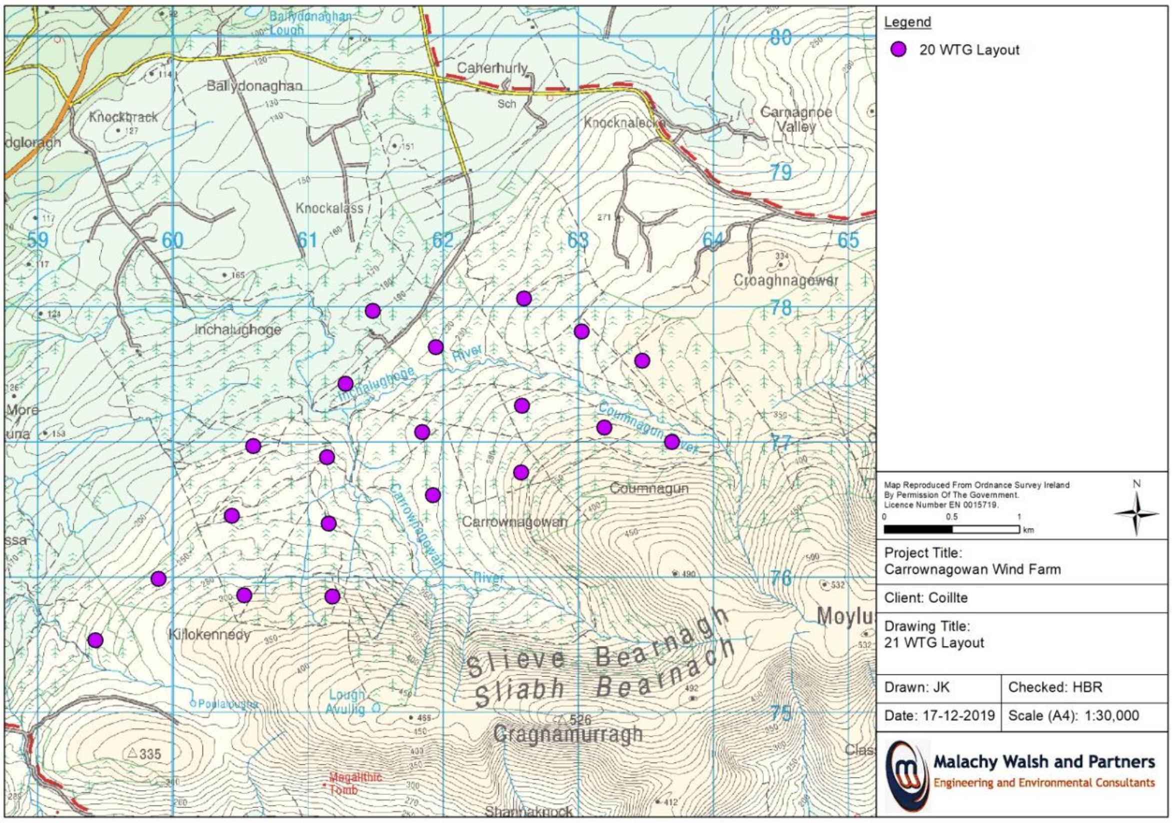
The alternative 21 turbine layout was designed taking account of constraints including;

- Areas of deep peat – Avoided.
- Noise modelling results – Reduced effect.
- Biodiversity value areas – Avoided.
- Visual impact – Reduced effect.

In this iteration, as the layout was adjusted for reasons of peat, habitat or noise, the last check was the visuals to ensure the improvements for the east and north east were maintained. Further improvements to visuals were possible in this layout such as bringing turbines down slope.

As a result of feedback from community engagement, the visual impact from the summit of Moylussa (end of the boardwalk at the top) was also reduced in the 21 turbine iteration. This was accomplished by bringing turbines down slope, as aforementioned.

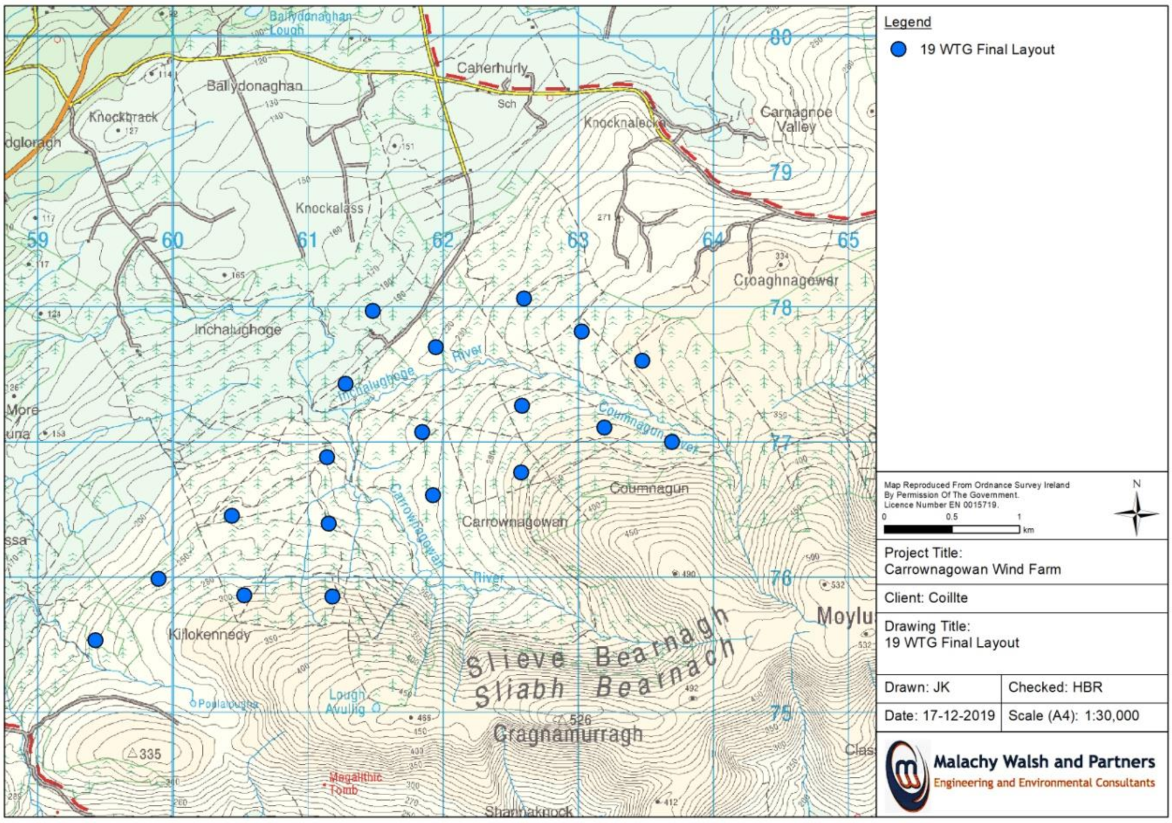
4.4.2.5 Carrownagowan: 20 Turbine Layout



The 20 turbine layout increased the setback to the nearest residences of the local population from 750m to 1km and optimised the layout for visual impact. Coillte commenced local engagement very early in the project before the engineering design and environmental assessment was underway. In reviewing the 21 turbine layout and the noise assessment, a decision was taken to increase the setback. Both the 21 turbine layout and the 20 turbine layout complied with the 2006 guidelines for noise, and the separation distance was over the four times the tip height, as referred to in the Department circular on the preferred draft approach to the revision of the Wind Energy Development Guidelines. Coillte's goal was to deliver a well-designed wind farm, cognisant of the local community.

The 20 turbine layout allowed for minor re-positioning of the turbines in line with a final Visual Optimisation exercise to ensure the best positions within the buildable area of the site, while maintaining the reduced effects for views from the east and northeast, and from Moylussa.

4.4.2.6 Final Carrownagowan Layout: 19 Turbine Layout



The final alternative layout, which is the final layout for the proposed Carrownagowan Wind Farm, the subject of this application, includes 19 turbines. The final design change was to remove one turbine to increase the size of a biodiversity exclusion zone to the northwest of the site. This exclusion zone is for hen harrier and a precautionary decision was made to increase the distance between the proposed development and a hen harrier breeding territory. There was no further revision to the remaining 19 turbines at this point. The proposed development consists of 19 turbines; T1 (southwest) to T19 (north).

The final layout represents the best design for the site conditions, following an iterative approach of design optimisation by the engineering and environmental members of the project team. This approach took account of all emerging baseline environmental information during the EIA process, to enable a shrinking of the buildable area. There was also close collaboration with Coillte's design team including their Wind Resource Analyst throughout the design process. Design changes were also communicated to the local community by Coillte during regular workshops.

The final proposal, as selected, meets the following criteria:

- Proximity to suitable National Electricity Grid connection point at Ardnacrusha;
- Suitable wind resource;
- 1km distance from neighbouring residential dwellings to turbines;
- Avoidance of designated conservation areas;
- 75m distance from watercourses;
- Avoidance of archaeological and architectural heritage sites;
- Avoidance of environmental constraints such as sensitive habitats, deep peat;

- Site and land accessibility;
- Land availability – Coillte's estate and third party agreements in place.

As a result of the application of the design rationale of developing a buildable area based on the minimisation of environmental effects, the most optimum wind farm layout for the Carrownagowan site is proposed.

4.5 ALTERNATIVE PROCESSES

In terms of alternative processes relevant to wind energy generation, this includes alternative sources of energy generation. Currently, Ireland's dominant energy source is fossil fuel derived from oil, gas, coal and peat. Alternative renewable energy sources include solar, hydro and biogas, yet none of these are a viable option for the Carrownagowan site, particularly in the delivery of a large capacity renewable energy development. At current estimates, the Carrownagowan Wind Farm project will provide an additional 90-100 MW of renewable electricity to the National Electricity Grid.

4.5.1 Alternative Mitigation Measures

Alternative mitigation measures are not applicable as the mitigation measures recommended in this EIAR are considered standard best practice and are the measures proven on sites and in previous projects. Furthermore, the design approach which favours mitigation by avoidance is a positive limiting factor to mitigation options at a later stage.

4.5.2 Alternative Construction Methodology

4.5.2.1 Internal Access Roads

The primary objectives when designing the new internal access roads was to utilise existing tracks where possible and to locate infrastructure where ground conditions are suitable. Maximum use has been made of existing roads, however the proposed development, will require new service roads within the site and in particular as spurs to the turbines. The proposed wind farm will use 8.4km of existing forestry tracks, and a further 7.6km of new excavated roads and 3.8km of new floated roads will be constructed within the proposed development site. Table 4-6 below presents a comparison of the three internal access options.

New excavated roads will be constructed using site won stone aggregate obtained from the proposed on-site borrow pits and placed over a layer of geogrid, after excavation to formation level.

Floating roads will be required in areas of deeper peat that could not be avoided in the design of the access road layout. The use of floating road methods will minimise the excavation of peat and reduce interference with the existing drainage regime in these areas of the site. Geogrid will be placed over the vegetation on the existing surface to be traversed with the floating road.

The proposed development will utilise all three internal access road options, utilisation of existing access roads was applied where possible. Depending on existing environment, new roads will be constructed as cut and fill or floated design.

Table 4-7 Comparison of Environmental Effects of Internal Roads

Environmental Factor	Utilising Existing Roads	Construction of new roads – cut and fill	Construction of new roads – Floated
Population and Human Health	No Effect	Additional traffic during construction phase, import of materials	Additional traffic during construction phase, import of materials
Biodiversity	No Effect	Forestry felling requirement	Forestry felling requirement
Ornithology	No Effect	No Effect	No Effect
Air and Climate	No Effect	Emissions during construction phase	Emissions during construction phase
Lands and Soils	No Effect	Removal of overburden	No Effect
Water	No Effect	Increased surface runoff	Increased surface runoff
Noise	No Effect	Construction phase noise	Construction phase noise
Landscape	No Effect	Screened by existing vegetation and nearby forestry and will allow for no visual impact on surrounding receptors	Screened by existing vegetation and nearby forestry and will allow for no visual impact on surrounding receptors
Cultural Heritage	No Effect	No Effect	No Effect
Shadow Flicker	No Effect	No Effect	No Effect
Material Assets	Additional traffic during construction phase.	Additional traffic during construction phase.	Additional traffic during construction phase.

4.5.2.2 Turbine Delivery Route

A Turbine Delivery Route Assessment was carried out from Foynes and Galway Ports to the site and both were found to be viable options to deliver turbine components to the site utilising the public road network (**Volume III, Appendix 3-7**). Two alternatives were considered along the route at Bodyke Village. Early in the design process, it was decided to seek 3rd party land to avoid Bodyke village, based on avoiding impacts to the local village population.

Table 4-8 Comparison of Environmental Effects of Turbine Delivery at Bodyke Village

Environmental Factor	Route through Bodyke Village	Route in Coolready, south of Bodyke
Population and Human Health	Temporary disturbance, nuisance, minor widening works	Avoids the village, avoid disturbance and nuisance, works in 3rd party land
Biodiversity	No Effect	Forestry felling requirement
Ornithology	No Effect	No Effect
Air and Climate	Emissions during minor works	Emissions during construction phase, at a remove from village
Lands and Soils	No Effect	Removal of overburden
Water	No Effect	Designed drains for runoff, no watercourses at Coolready site
Noise	Noise during works and delivery through village, to local receptors in village	Construction phase noise, delivery vehicles away from village
Landscape	No Effect	Some screening by existing vegetation, new temporary road area visible locally at the site, no effect on surrounding receptors
Cultural Heritage	No Effect	No Effect
Shadow Flicker	No Effect	No Effect
Material Assets	Additional traffic during construction phase through village	Traffic through village avoided

4.5.2.3 Borrow Pits

Three on-site borrow pits are proposed as a source of stone and aggregate materials for the development. The only other potential alternative is to import the material from authorised quarries outside of the site. A comparison of environmental effects is presented in Table 4-8 below.

The preferred alternative is to develop and utilise on site aggregate resources over importation where feasible due to:

- The advantages of reduced traffic volumes on the public road network and associated reduced public disruption, noise and air quality effects.
- The advantages that on-site borrow pits provide suitable repositories for deposition of surplus excavated peats and soils.

Table 4-9 Comparison of Environmental Effects of Material Sourcing

Environmental Factor	On-site Borrow Pits	Imported Material
Population and Human Health	Volume of traffic on public road networks kept to a minimum	Increased public disruption due to increased traffic volumes on public road networks associated with import of materials
Biodiversity	Loss of habitat	No loss of on-site habitat
Ornithology	No Effect	No Effect
Air and Climate	Vehicle emissions	Increased effect due to vehicle emissions
Lands and Soils	Ground surface disturbance. Provision of suitable deposition areas for surplus excavated peats and soils	Alternative engineered storage facilities required on site for deposition of surplus excavated peat and soils or else transported off-site.
Water	No effect	No Effect
Noise	No effect	Off site Noise emission
Landscape	No effect	No effect
Cultural Heritage	No effect	No effect
Shadow Flicker	No effect	No effect
Material Assets	Volume of traffic on public road networks kept to a minimum	Additional traffic on public road networks.

4.6 DO NOTHING SCENARIO

Should the Carrownagowan project not be developed, the project will not contribute to Ireland's renewable energy infrastructure and it will not contribute to Ireland's renewable energy targets. In a do nothing alternative, this site would not contribute to Ireland's commitment to meet its EU and national emissions targets.

A do nothing scenario would result in the continuation of commercial forestry operations at the entire site, in the absence of wind farm infrastructure in parts of the site. In the do-nothing scenario, no new development will take place, and the present character of the forestry land-use will remain with alternating felling and replanting. Note that in the do nothing scenario, where the wind farm is not developed, the identified off-site bare replanting sites would be planted by Coillte, as afforestation licences have been granted by the Forest Service.

4.7 CONCLUSION

This chapter presents a description of the reasonable alternatives studied by the developer. The alternatives examined included alternative site layouts, alternative grid connections and alternative construction methods, which are relevant to a proposed large scale wind farm project and its specific characteristics.

The proposed development has been designed to minimise potential environmental effects and to maximise wind potential on site.

The final site layout (19 turbine layout) was determined based on multi-discipline inputs and consideration of topography, biodiversity, land and soils, hydrology, landscape, visual and engineering constraints and assessments. The development, as proposed, is the preferred option as it results in the least effects on resources and receptors while meeting the project objectives of a large scale renewable wind energy development.

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