Environmental Impact Assessment Report

Proposed Carrownagowan Wind Farm
Co. Clare

Volume I NON-TECHNICAL SUMMARY

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On behalf of

COILLTE
GROW · TRANSFORM · SUSTAIN

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1 INTRODUCTION

This document constitutes the Non-Technical Summary of the Environmental Impact Assessment Report (EIAR) prepared for the Carrownagowan Wind Farm project in Co. Clare. Coillte Cuideachta Ghníomhaíochta Ainmnithe (Coillte CGA), are seeking consent for the development from An Bord Pleanála (the competent authority).

This Non-Technical Summary (NTS) is the first volume of the Environmental Impact Assessment Report (EIAR). The other three volumes which comprise the EIAR are:

- Volume II: Main EIAR
- Volume III: Appendices
- Volume IV: Photomontages

The purpose of this Non-Technical Summary is to provide a concise overview, in non-technical terms, of the issues, impacts and mitigation measures highlighted by the Environmental Impact Assessment and presented in detail in the main EIAR, Volume II.

1.1 THE PROPOSED DEVELOPMENT

Coillte (The applicant) wish to develop a 19 No. turbine wind farm on the north-western slopes of Slieve Bernagh in Co Clare. This application is seeking permission for 19 No. turbines with a maximum tip height of 169m. The proposed turbines will have an expected yield in the order of 90 to 110MW with an operating life up to 30 years. The project is seeking a ten-year permission period to construct and make operational the proposed wind turbines and associated infrastructure (access roads, substation, borrow pits, deposition areas, meteorological mast and visitor cabin). To facilitate delivery of the turbine components, permission is also sought for works along the turbine delivery route in the townlands of Coolready and Drummod, south of Bodyke.

The proposed development, for which planning permission is being sought, is assessed within this EIAR as well as other project components not included as part of the current planning application. These include the grid connection and replacement forestry lands. The entire project is described below.

1.2 THE PROPOSED PROJECT

The EIAR considers the proposed development and all additional components of the project. The following list includes both the core wind farm elements of the project and the associated development components of the project.

Proposed Development

The development for which planning permission is sought in the planning application (the proposed development) consists of the following:

Core Wind Farm Elements:

- 19 No. Wind Turbines (blade tip height up to 169m).
- 19 No. Wind Turbine foundations and Hardstand areas.
- 1 No. Permanent Meteorological Mast (100m height) and foundation and associated hardstand areas.
- 1 No. Substation (110kV) including associated ancillary buildings. (electrical building including control, switchgear and metering rooms, and the operational building including welfare facilities, workshop and office) security fencing and all associated works.
- Upgraded Site Entrance.
- New and upgraded internal site service roads (8.4km of existing tracks to be upgraded and 11.4km of new service roads to be constructed).
- Provision of an on-site Visitor cabin and parking.

Associated Development Components:

- Underground electrical collection and SCADA system linking each wind turbine to the on-site project substation.
- Construction of new roadways and localised widening along turbine delivery route.
- 2 No. Temporary construction site compounds and additional mobile welfare units.
- 3 No. Borrow pits to be used as a source of stone material during construction.
- 3 No. peat /spoil deposition areas (at borrow pit locations).
- Associated surface water management systems.
- Tree felling for wind farm infrastructure.

In addition to the Proposed Development as described the following elements are assessed as part of the overall project: Underground 110kV cable for connection to National Electricity Grid and off-site replacement forestry lands at three sites, Ballard, Co Wicklow; Cooraclare, Co. Clare; and Trillackacurry, Co. Longford.

1.3 SITE LOCATION

The area of the proposed Wind Farm is located within forested lands on the northern slopes of Slieve Bernagh mountain, approximately 4 km northeast of the village of Broadford, 7km north-west of Killaloe and 2.5 km south of the village of Bodyke, at its closest point. Lough Derg lies approximately 4km to the east of the proposed development area (**Figure 1**).

The site planning boundary includes a total land area of 749.69ha which principally consists of conifer plantation, bogland, cutover bogland, and improved grasslands. The townlands within the wind farm site include Ballydonaghan, Caherhurley, Coumnagun, Carrownagowan, Inchalughoge, Killokennedy and Kilbane.

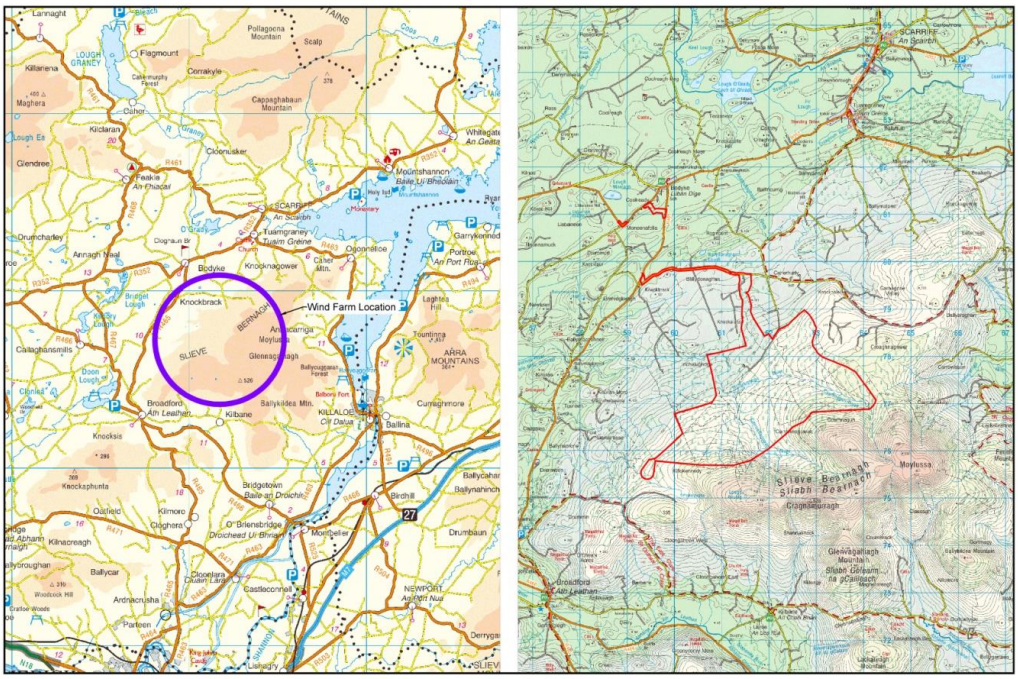


Figure 1 Site Location of Proposed Wind Farm Development

1.4 EIA STUDY AREA

It is to be noted that the EIA project area differs to that of the proposed development site as presented within the planning application statutory drawings. **Figure 2** shows the proposed development site per the planning application statutory drawings.

Figures 3 – 6 show the minimum extent of the lands considered as part of the environmental assessment. The EIA however takes account of the spatial limits of individual environmental components outside the EIA Project Area boundaries where an effect can be reasonably expected as described in the individual chapters.

Figure 2 Planning Application Area

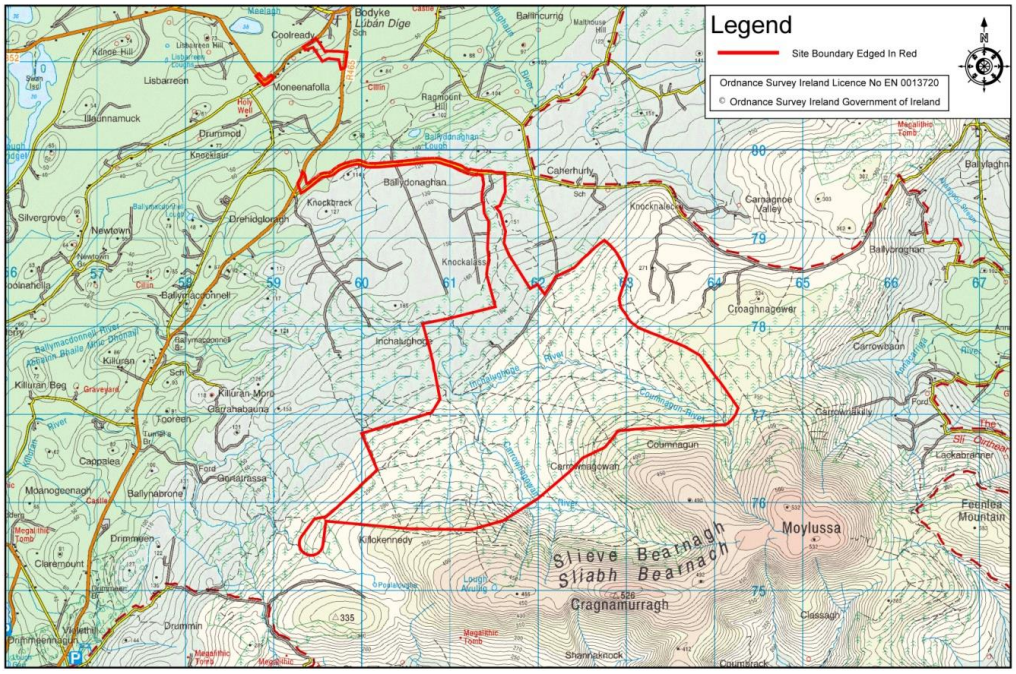


Figure 3 EIA Project Area

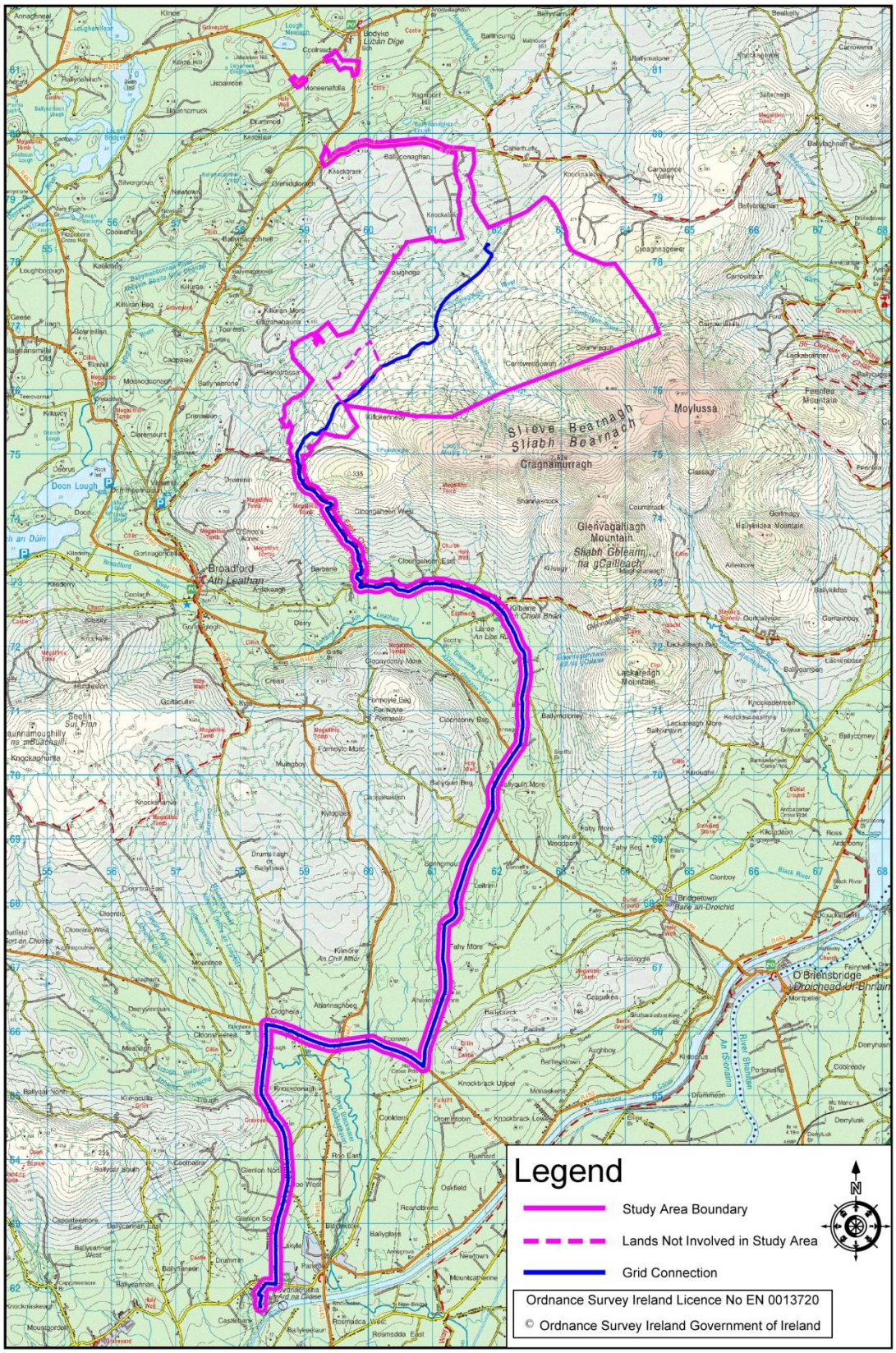


Figure 4 Replacement lands at Ballard, Co. Wicklow

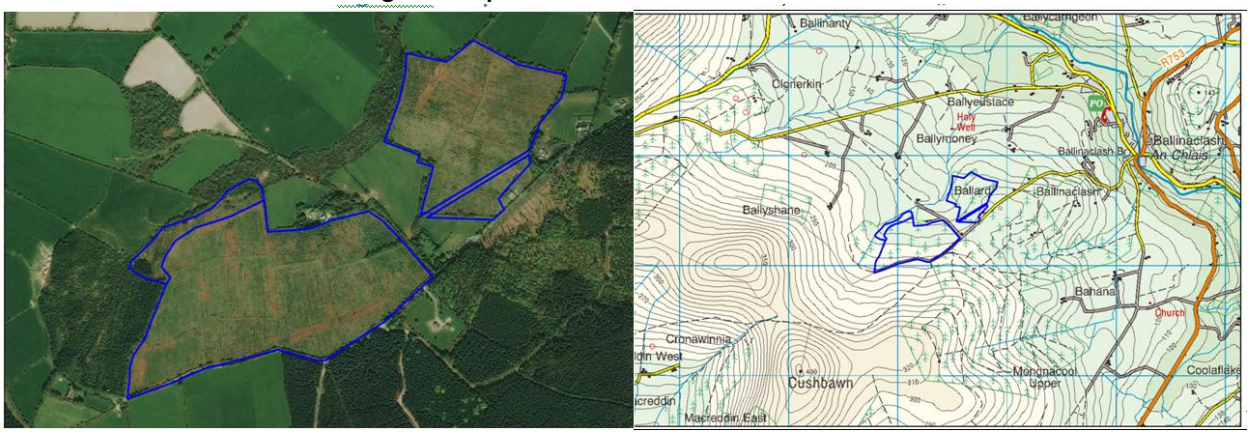


Figure 5 Replacement lands at Dangananella West, Cooraclare, Co. Clare

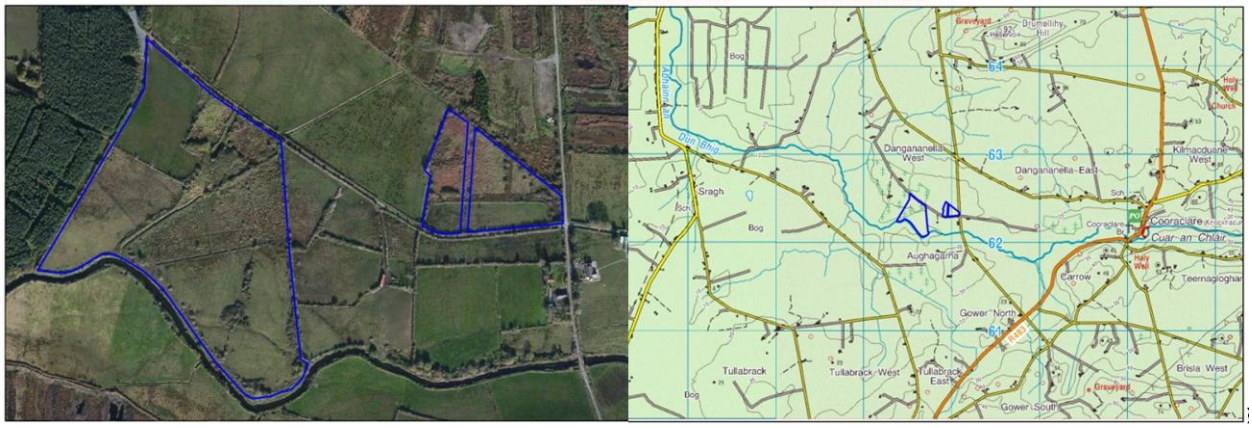


Figure 6 Replacement lands at Trillackacurry, Co. Longford

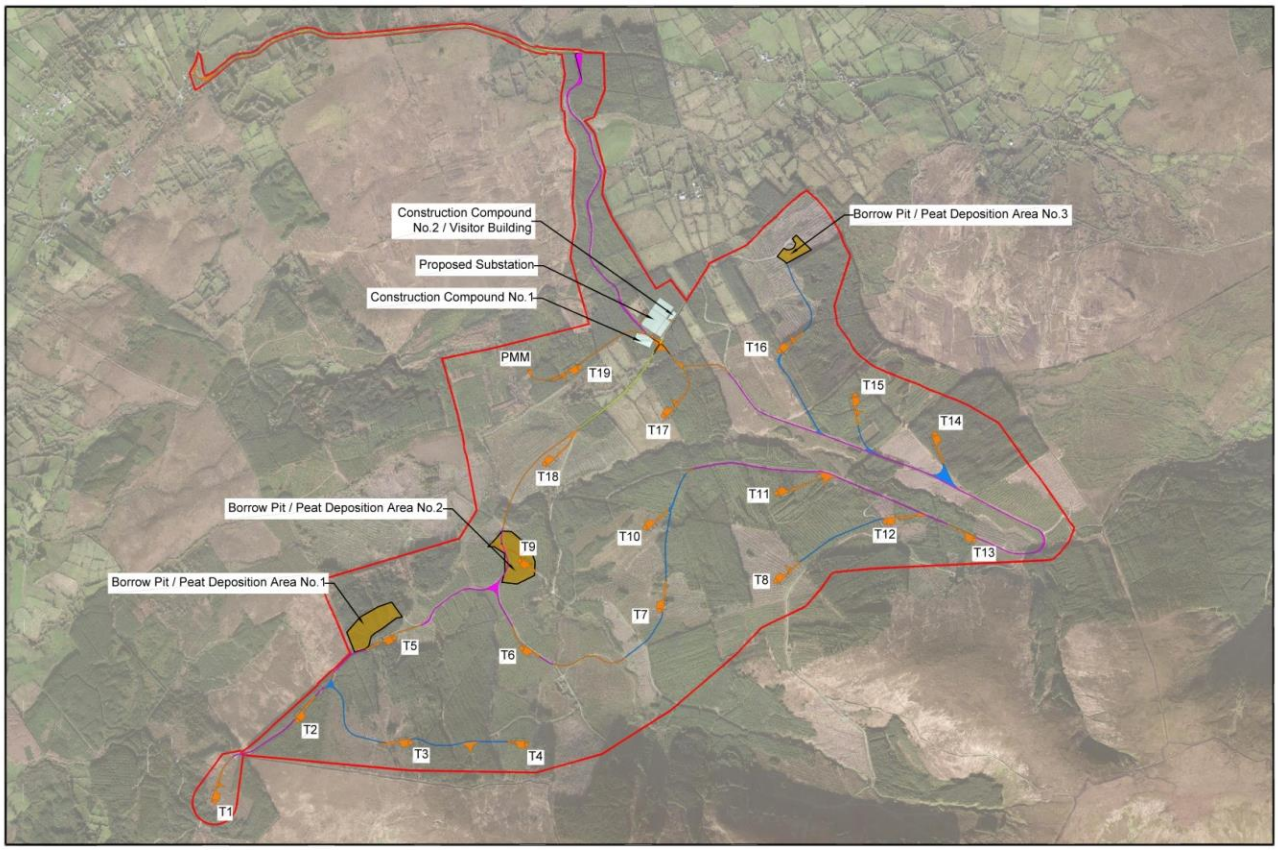
2 DESCRIPTION OF THE PROJECT

The Carrownagowan Wind Farm is being proposed to constitute a nineteen (19) turbine wind farm. Full details of the proposed development and project are provided in **EIAR Volume II Chapter 2** Project Description and Chapter 3 Civil Engineering.

2.1 PROJECT CONSTRUCTION

It is proposed to install nineteen (19) No. wind turbines each with a maximum tip height of up to 169 metres. Each wind turbine will have a reinforced concrete base pad foundation of approximately 24m in diameter and installed to a maximum excavation depth of approximately 3m below ground level. Each wind turbine will also have an associated turbine hardstand area and temporary laydown area adjacent to the foundation.

Figure 7 Site Layout (Refer to Planning Drawing 19107-5005-A for detail)



A permanent meteorological mast will be erected within the wind farm lands described above to monitor the local wind regime while the wind farm is in operation. The permanent meteorological mast is to be located west of T19. The meteorological mast will be up to 100m in height.

The development includes a 110kV substation within the wind farm lands described above for exporting power from the wind farm to the national electricity grid. The substation compound is to be located in the northern section of the site, within an area currently under forestry to the northeast of T19. The electrical equipment at the substation compound and buildings will include transformers, busbars, circuit breakers, cable supports, switchgear, panels and all associated cabling.

The individual turbines within the wind farm will be connected electrically by underground cables to a new 110kv substation to be constructed within the wind farm site. The Carrownagowan Wind Farm substation

will in turn be connected via an underground grid connection cable to the existing ESB owned 110kV substation at Ardnacrusha, County Clare which will allow the electrical energy generated from the wind farm to be exported onto the national grid.

The underground grid cable between the Carrownagowan Wind Farm and the existing 110kV substation in Ardnacrushna is almost entirely confined to the existing road network, diverging slightly from it at water course crossings and at some joint bay locations. The full length of the Carrownagowan Wind Farm grid connection route is 25km.

It is envisaged that the project will commence in Quarter 3 of 2022 with an 18 month construction period followed by a 4-6 month commissioning period. The start date is dependent on planning being granted and funding and all permits being in place. Construction will typically occur within the hours: 07.00am – 7.00pm, Monday to Saturday inclusive or as otherwise conditioned as part of the consent. A permit for moving abnormal loads will be sought from An Garda Síochána for the delivery of oversized wind turbine components (i.e. blades, nacelles and towers).

During the construction phase, the number of on-site construction personnel will vary for each phase of the development. Overall, it is envisaged that the proposed development would generate employment for up to 100 persons during the construction phase to include site contractors, on-site vehicle and plant operators, engineers, materials delivery personnel, environmental personnel, health and safety personnel.

It is expected that the civil works for the grid connection route will require at least 10 personnel to complete the works. The electrical works will require less heavy machinery but more labour personnel, with typically 25 personnel to complete the works.

Access to the wind farm site will be gained from an existing entrance off the L-8221 Local road in the townland of Caherhurly. The existing site entrance on the L-8221 Local road will require widening on its eastern side to allow the long turbine component loads to turn south at this point. Following completion of construction phase most of the widened area will be removed and the boundary will be restored to provide a permanent 12m junction radius. Development works will be required on private third party lands adjacent to the public road network in order to accommodate turbine delivery. It is anticipated that delivery of turbine components would be from either Foynes Harbour or Galway Port.

Two (2) No. temporary construction compounds will be set up upon commencement of the construction phase. The compounds will be used as a secure storage area for construction materials and will also contain temporary site cabins to provide welfare facilities for site personnel. Facilities will include office space, meeting rooms, canteen area and mobile sanitary facilities.

Three (3) No. proposed on-site borrow pit locations have been identified to provide the majority of the required fill material for internal roads, passing bays, hardstands, foundations and temporary compound.

A site surface water management system will be constructed on the site so as to attenuate run-off, guard against soil erosion and safeguard downstream water quality.

Felling of commercial conifer forestry is required within and around wind farm infrastructure to accommodate the construction of the turbine foundations, hardstands, access tracks, meteorological mast, turbine assembly and proposed 110kV substation.

To allow for forestry removed as part of the project, replacement forestry will be planted at off-site approved lands. Three No. locations have been identified as follows:

- Ballard in Co Wicklow
- Dangananella West Cooraclare in Co. Clare
- Trillackacurry, Co. Longford

The lands at each of these sites have been granted technical approval by the Forest Service for afforestation.

2.2 OPERATION

The proposed development is expected to have a lifespan of circa 30 years. Each wind turbine will be computerised to control critical functions, monitor wind conditions and report data back to a SCADA system.

During the operation of the wind farm, the turbine manufacturer, the Developer or a service company will carry out regular maintenance of the turbines. During the life of the project, it is envisaged that at least two permanent jobs will be created locally in the form of an operator or maintenance person. In addition, operation and monitoring activities may be carried out remotely with the aid of computers connected via a telephone broadband link. However, routine inspection and preventive maintenance visits will be necessary to ensure the smooth and efficient running of the wind farm and require a minimal presence.

2.3 DECOMMISSIONING

At the end of the estimated 30 year lifespan of the proposed development, the Developer will make the decision whether to repower or decommission the turbines. Any further proposals for development at the site during or after this time will be subject to a new planning permission application. If planning permission is not sought after the end of life of the turbines, the site will be decommissioned and partially reinstated with all 19 No. wind turbines and towers removed.

2.4 THE USE OF NATURAL RESOURCES

The majority of aggregate materials required for the construction of the roads, hardstands and the substation compound will come from rock extracted from three proposed on-site borrow pits. Material to be delivered to site will mainly consist of higher grade materials not available on site including limestone capping material for roads and hardstands and concrete for the construction of the 19 No. turbine bases, permanent met mast foundation and substation infrastructure.

Water needs for construction activities will be limited to concrete truck chute washing, wheel wash, dust suppression and sanitary facilities.

2.5 THE PRODUCTION OF WASTE

Soils and subsoils generated from excavation works will be retained on site and reused in bunding, landscaping and localised earthworks, with any excess material placed in the on site designated peat deposition areas. These are located at the borrow pits and excess material will be used for reinstatement.

Wastewater from welfare facilities on site will d rain to integrated wastewater holding tanks associated with the toilet units. The stored effluent will then be collected on a regular basis from site by a permitted waste contractor and removed to a licensed/permitted waste facility for treatment and disposal.

2.6 EMISSIONS AND NUISANCES

The anticipated residues and emissions likely to be generated during the project lifetime are summarised in **Table 1** below. These environmental effects have been identified, assessed and proposals for management of the anticipated nuisances and/or emissions are presented throughout relevant chapters of this EIAR.

Table 1 Emissions and Nuisances

Project Phase	Aspect	Potential Emission/Nuisance	Assessment Provided
Construction/ Decommissioning	Air	The main emissions to atmosphere during the construction stage of the project is from fugitive dust associated with the following activities: • Groundworks associated with the construction of the project infrastructure • Transportation and unloading of crushed stone around the site; • Vehicular movement over potentially hard dusty surfaces such as freshly excavated and constructed access tracks and crane hardstanding areas; • Vehicular movement over material potentially carried off site and deposited on public roads. The movement of machinery, construction vehicles and the use of generators during the construction phase will also generate exhaust fumes.	EIAR Volume II Chapter 14 Air and Climate
	Noise	Traffic flows, all construction activities including excavation, mechanical machinery and electrical equipment typically used for construction projects would generate noise emissions.	EIAR Volume II Chapter 10 Noise
	Water	Surface water runoff and discharges from construction working areas are likely during construction, although overall the quantity of surface runoff would not change overall as a result of the construction work. Occasional and low quantity discharges could arise from pumping in order to dewater foundation excavations. This would be discharged to the surface water management drainage system. Pollution sources could arise as a result of soil erosion or from oil/ fuel or chemical storage and use. Proposals for management of water quality and quantity from the proposed development are presented in EIAR Volume III: Appendix 3-1: CEMP.	EIAR Volume II Chapter 8 Water
	Traffic	The additional traffic, especially heavy goods vehicles associated with the construction phase, has the potential to cause nuisance to those using the local road networks	EIAR Volume II Chapter 15 Material Assets
Operational	Air	Due to the nature of the project no significant point source or diffuse air emissions would be produced during its operation.	EIAR Volume II Chapter 14 Air and Climate
	Noise	Potential noise nuisance from operational turbines and a proposed new 110kV on-site substation.	EIAR Volume II Chapter 10 Noise
	Water	No water emissions or pollution sources have been identified for the operational phase.	EIAR Volume II Chapter 8 Water
	Shadow Flicker	In certain conditions, the movement of wind turbine blades could give rise to shadow flicker nuisance at nearby residential receptors.	EIAR Volume II Chapter 11 Shadow Flicker

2.7 CUMULATIVE ASSESSMENT

The project was considered in combination with other relevant plans and projects that could result in cumulative effects. Land management practices in the wider area which are considered in combination with the effects of the project are agriculture, forestry and peat harvesting. However, the project will not interact with agriculture or peat harvesting as there are no active agricultural activities or peat harvesting at the site. There are no applications for large-scale commercial or industrial activities near Sliabh Bernagh. Minor domestic and agricultural development will not introduce potential for cumulative effects. All other wind farm developments were considered within 30km of the site. As the closest wind farm to Carrownagowan approximately 20km away, the likelihood of cumulative noise and shadow flicker effects is low. Cumulative impacts on the Shannon catchment area are unlikely as the other wind developments are already operational. The Landscape and Visual Assessment (Chapter 12 of Volume II) has included these developments in the cumulative assessment.

2.8 RISK OF MAJOR ACCIDENTS AND DISASTERS

It is considered that there is no risk for the project to cause major accidents and/or disasters or vulnerability of the project to potential disasters/accidents, including the risk to the project of both natural disasters and man-made disasters.

Given the temporary nature of the construction stage and the scale of the proposed project, as well as the environmental protection measures that will be implemented from the outset, the risk of disasters (typically considered to be natural catastrophes e.g. very severe weather event) or accidents (e.g. fuel spill, traffic accident or peat slide) is considered low.

In the case of the occurrence of a severe weather event such as flooding during construction, construction work will cease. Landslide susceptibility is covered within the Peat Stability Risk Assessment (Volume III, Appendix 9-2) and the Project has been designed using Mitigation by Avoidance to ensure no infrastructure is situated in deep peat and the outcome of the risk assessment was that landslide presented a Negligible to Low Level of risk to the Wind Farm Infrastructure.

During the operational life of the wind farm, particularly in the context of climate change, there is the potential for increased storm events and severe weather. Wind turbines are designed for specific wind parameters and will shut down during high wind speed events. Therefore, the potential effects of climate change on the operational development may involve curtailment where the turbines will be restricted from operation due to severe winds but does not present a likely risk of a major accident and disaster.

2.9 ALTERNATIVES CONSIDERED

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

The wind farm has been designed following a step by step EIA process which informed and identified the buildable areas suited to turbines, roads and infrastructure based on avoidance of unsuitable areas and following the good practice of mitigation by design. More details on the project design and evolution can be read in **EIAR Volume 2 Chapter 3 and Chapter 4**.

Alternatives examined included alternative site layouts, alternative grid connections and alternative construction methods.

Six (6) alternative wind farm layouts were examined in order to find the most optimum design solution for the site with the least level of environmental impact.

The final site layout or final alternative (19 turbine layout) was determined based on multi-discipline inputs and consideration of topography, biodiversity, land and soils, hydrology, landscape, 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.

Further details on the alternatives examined can be read in **EIAR Volume 2 Chapter 4**.

3 ENVIRONMENTAL IMPACT ASSESSMENT

The main objective of the EIA process is to ensure that all direct, indirect and cumulative environmental effects of the project are anticipated. Where effects are identified as unacceptable, these will be avoided or reduced during the design process through the implementation of practical mitigation measures. The main chronological stages of the environmental assessment undertaken include:

- Carrying out baseline studies and collecting data on the existing receiving environment
- Assessing potential for significant environmental effects (impact assessment)
- Recommending or designing mitigation measures to avoid or minimize environmental effects

The EIA has been carried out in accordance with the relevant legislative requirements and guidelines including the 2017 European Commission guide; *Environmental Impact Assessment of Projects:* Guidance on the preparation of the EIA Report and Draft Guidelines on Information to be contained in environmental impact assessment reports EPA (2017). Specialist guidance as required under each of the environmental topics discussed hereunder has also been used where appropriate.

3.1 POPULATION AND HUMAN HEALTH

The scope of the assessment considers the effects of the construction, operation and decommissioning of the proposed project in terms of how the proposal could affect population and settlement, economic activity, employment, land use, amenities and tourism, and health and safety.

Settlement patterns in the greater region range from very large urban centres, to small community settlements, to relatively isolated farmsteads. The city of Limerick (population 94,192, CSO 2016) approximately 20km to the south, and the towns of Ennis (population 25,276, CSO 2016) approximately 27km to the west and Nenagh (population 8,968, CSO 2016) approximately 25km to the east, are the largest urban centres relative to the site of the proposed wind farm and are the major service and employment centres in the region.

The Project Area for the wind turbine development is located in a rural, lightly populated area. Settlement patterns typically comprise farmsteads and one-off residential dwellings distributed along the local and regional road networks that encompass the site and serve the area. The nearest urban settlements to the site of the proposed wind farm is the town of Killaloe/Ballina approximately 7km to the south east, and the villages of Bodyke approximately 2.5 km to the north and Broadford approximately 4 km to the southwest. Smaller population centres in the the general locality are the towns of Scarriff, Killaloe/Ballina, and Tulla, and the

villages of Bodyke, Broadford, O'Callaghan Mills, Tuamgraney and Kilkishen. These towns and small villages provide a range of local community facilities, including primary schools, sporting clubs, churches, general shops and post offices. There are 3 residences (only one of which is occupied) approximately 1km of the nearest proximal wind turbine and approximately 30 residential dwellings within approximately 1-2km of the site.

There are currently no defined recreational land-uses within or associated with the proposed development lands. While there are no tourist attractions pertaining specifically to the site of the proposed development, there are a number of recreational and cultural amenities in the vicinity of the site, and in the wider area including: Walking trails (East Clare Way) and Forest Walks; Cycling; Golf; Angling and water sport activities. East Clare area has a substantial tourism offering including activity tourism, specialised tourism, traditional music and cultural heritage (Holy Island). There is no potential for a significant impact on tourism or recreation land uses.

The development project will have a positive impact on employment at both the local and national level and in both the short and long term. It is the intention of the developer to encourage the main contractor to use local sub contractors, drivers, suppliers and materials as much as possible.

During operation, the proposed development would bring added benefit to the local community through the provision of a community benefit fund. Additionally, annual rates payments from the project will contribute substantial funds to Clare County Council over its lifespan, which will be redirected to the provision of public services within Co. Clare.

It is not likely that the proposed development would directly or indirectly result in any negative effect or reduction in existing economic activity of the area during any phase of the development. During the construction phase aggregates and concrete supply for road construction and foundations will be obtained from local quarries and suppliers, supporting the local economy.

Serious risks to human health and safety are not envisioned. The rigorous safety checks imposed on the turbines during design, construction, commissioning and operation ensures the risks to humans are negligible.

As with any development, the construction activities can cause a nuisance to the local community and are likely to pose temporary minor disturbances locally. The most notable of these disturbances relates to the generation of additional traffic on the local networks. Here noise and safety implications are also a concern. However, disturbances associated with the additional volumes of traffic will principally be confined to the construction phase and will cease on completion of works. The construction phase will be managed to minimise the impact on the human environment and the local residents. With the mitigation measures in place, no significant negative effects on the local human environment are expected.

There are no predicted adverse operational impacts associated with the proposed development which would result in significant negative effects on local society. The project will produce electricity in an environmentally-friendly manner thereby avoiding the risk of air pollution and thus benefit human health.

In terms of impacts to neighbouring lands and land-uses it is considered that the proposed development does not pose a significant risk to either existing or future land-uses. All existing land-use practices can co-exist with the proposed development. There will be no severance, loss of rights of way or amenities as a result of the proposed development.

Noise effects are not considered to be significant. The noise assessment shows that that predicted noise levels will comply with the noise limits set out in the current Wind Energy Development Guidelines and thus will not adversely impact on the quality of life of local residents and the existing relatively tranquil environment in which they live.

The development has the potential to give rise to shadow flicker impacts on surrounding dwellings. The modelling undertaken, assumes a worst-case scenario, and has determined that within 1.36 km of the development, two properties could theoretically experience potential shadow flicker, one of which is unoccupied and uninhabitable. Shadow Flicker Control Measures (SFCM) that will be designed for any relevant turbine to ensure that shadow flicker does not occur.

The visual factor of the development is perhaps the most intrusive aspect. Given the size of the turbine structures and their proposed position along an upland area, a visual effect is unavoidable. The extent of intrusion will vary in degree and significance according to viewing distance, the numbers and parts of turbines visible, the number of viewers affected and of course public perception. The landscape assessment demonstrates that the proposed development would not have a significant negative visual effect in terms of local population or key tourism and recreational amenities.

3.2 BIODIVERSITY

The biodiversity of the proposed development site and environs is described in terms of designated sites, habitats, flora, fauna and biological water quality. Mitigation measures are specified to ensure that significant impacts on these features do not occur. Studies and reporting were in line with best practice and recently produced guidance. The Information on the existing environment was obtained using publicly available information sources and by field surveys.

The proposed wind farm is situated between three blocks of the Slieve Bernagh Bog which is an area protected as a Special Area of Conservation (SAC). The SAC is located to the south, the north-east and the north-west of the proposed wind farm. The development site is located within 15km of a number of other protected areas; nine SACs, four Special Protected Areas (SPAs), seven Natural Heritage Areas (NHAs) and thirteen proposed Natural Heritage Areas (pNHAs). A number of these designated sites are linked by surface water features draining the site.

The majority of the proposed development site is located in the Bunratty-Ballymacdonnell River sub-catchment, while the western edge of the proposed development site is located within the Bunratty-Killuran sub-catchment. The Bunratty-Ballymacdonnell and the Bunratty-Killuran are sub-catchments of Owenogarney (Ratty) River within the regional Shannon Estuary North catchment. The northeastern edge of the proposed development site (c 2.5km^2), near Croaghnagower, is located within the Graney Anamullahgaun subcatchment, within the regional Lower Shannon catchment.

The conifer plantation which overlies the majority of the site is of low ecological value with reduced biodiversity and has degraded adjacent bog habitats. The most important habitats at the site are upland blanket bog, raised bog and wet heath. These habitats have been evaluated as being of county Importance due to the European level of protection afforded to them. Several small streams drain the site.

The proposed development site is of no particular value to bats or terrestrial mammals. It is an exposed, windswept, upland, poorly drained area with low carrying capacity for most fauna. Bat densities were found to be low. Bats, badger, pine marten, red squirrel and otter were evaluated as being important at a local scale

due to their occurrence and/or conservation status. There was some evidence of badger, red squirrel and pine marten but populations of no greater than local importance were recorded. The ecological value of the site for these fauna is low given the marginal/suboptimal habitats present. Otter was not recorded. The watercourses within the site are headwater streams considered too small to support important aquatic communities. The importance of watercourses increases as they flow away from the proposed development site and become larger, capable of supporting significant numbers of salmon and trout.

A total area of 1.09ha peat habitats will be lost due to the construction footprint potential secondary impacts on adjacent peat habitats could arise in the absence of appropriate mitigation. Potential impacts on fauna relate primarily to habitat loss and disturbance, and collisions with proposed turbines in the case of bats. Impacts to aquatic receptors are related to water quality and pathways with source pollutants. Cumulative impacts related to climate change, water quality deterioration, agriculture and forestry could exacerbate potential impacts associated with the proposed development.

General best practice construction mitigation measures will be followed, including working according to a Construction and Environmental Management Plan (CEMP) which has been prepared. A Surface Water Management System forms an integral part of the project design as do a suite of avoidance measures including buffers and set back distances from watercourses, ecologically valuable habitats and designated sites.

The works will be supervised by an Ecological Clerk of Works (ECoW) who will review all method statements and monitor the construction phase to ensure that all environmental controls and mitigation is implemented in full. The project ecologist will be awarded a level of authority and will be allowed to stop construction activity if there is potential for adverse environmental effects.

It is considered that the proposed development will not result in significant effects on habitats, flora and fauna at the local level given the design of the project and the mitigation measures proposed.

3.3 ORNITHOLOGY

Bird surveys were completed for the project over four consecutive years, between the winter of 2016/17 and summer 2020. Birds identified using the site and surrounding areas included raptors (birds of prey), waders and other waterbirds, swans, gulls, ducks and songbirds (passerines). The most important bird species using the site included hen harrier, which nest in young forestry on Slieve Bernagh. Other important species regularly using the site included sparrowhawk and kestrel. The type and nature of the upland peatland habitats, in the site and wider locality, has been considerably modified by commercial conifer plantation forestry and this accounts for the occurrence of specialist species including redpoll, crossbill and siskin.

Hen harriers are ground nesting birds that breed in peatland (bog and heath), young conifer plantations and other upland habitats. Young or pre-thicket conifer plantation (first and second rotation) may be used by breeding hen harriers. However, extensive peatland habitat such as that available outside the wind farm site in Slieve Bernagh is essential for hunting. Closed mature forestry is of no value to the hen harrier for either nesting or hunting.

The wind farm project could affect important bird species in a number of ways including the loss of hunting and breeding habitat to accommodate the wind farm infrastructure. Given the future availability of young forestry at the site and surrounds as well as the availability of peatland habitats in the greater area, it is considered that the loss of potentially suitable hen harrier nesting and hunting habitat, mainly young forestry, during the construction phase will not be significant. The construction of the wind farm may disturb the hen harrier who may in turn avoid the wind farm area. The disturbance effect of construction would be considered significant were hen harrier to nest within 500m of works. Birds may also avoid the wind farm when it is

operational. Based on observations and studies from other wind farm developments and the estimated effective habitat loss as a result of displacement from the site and surrounds, the effect of displacement on hen harrier during the operation of the wind farm is not considered to be significant. The effect of the project on other bird species including peregrine, merlin, golden plover, red grouse, woodcock, sparrowhawk, kestrel and buzzard were not considered to be significant.

Mitigation has been put in place to ensure that breeding hen harrier will be protected during the construction phase. A total of 42ha of commercial forestry land situated outside of the wind farm site will be improved for hen harrier by permanently felling the trees and rehabilitating the peatland habitats to provide good hunting and potential nesting habitat, which will reduce the displacement effect of the operating wind farm.

The assessment concluded that the Carrownagowan Wind Farm will not have a significant residual effect on birds.

3.4 LAND AND SOILS

The lands and soils environment for this site have been assessed for impacts associated with felling and construction works. The geology of the site comprises blanket peat overlying subsoil deposits which in turn are underlain by weathered and solid bedrock. Comprehensive site investigation works, including field mapping of exposures, peat depth probing and augering and trial pit excavations were undertaken to assess the geology of the site for constructability purposes.

The geology of the site has been investigated comprehensively using peat probing and trial pitting. Overall peat depths recorded during the peat probing investigation ranged from 0 to 4.0m with an average of 1.31m. Of the total number of peat depths taken (~744 no. peat depths, with 790 no. probes completed in total), 62% were below 1.5m with 85.8% were below 2.0m. The peat depths at the site are relatively shallow.

Construction of the wind farm infrastructure will require the removal of blanket peat, subsoils and possibly rock to create competent foundations. Excavation of bedrock from proposed on-site borrow pits (3 no.) along with suitable off-site aggregate sources will provide appropriate construction material for access roads, turbine bases and general hard-standing construction. Removal of blanket peat, subsoils, and bedrock represents a permanent direct impact on the geology of the site.

During the construction phase sources of contaminants (such as oil based substances or other hazardous chemicals) will not be stored at the site except where this is done within safely bunded areas that safely contain all spillages and prevent the migration of contaminants into soil, peat and bedrock. Refuelling will be completed using a double skinned fuel bowser (twin walled, in case the outer wall (skin) of the bowser was ruptured accidentally) with spill kits on the ready in case of accidental spillages. The risk is considered to be low once mitigation measures are implemented.

The peat stability assessment undertaken at the site shows that the site has an acceptable margin of safety and is suitable for the proposed wind farm development. A number of control measures are given in the peat stability assessment to manage all risks associated with peat instability that will make the site safe to work on.

A Peat/Spoil Management Plan has been prepared for the development which details management of peat during construction works and long-term storage thereafter. Peat removed during the excavation works will be stored appropriately as close as possible to the extraction area. Working of these peat harvesting sites over the years has shown that this is the most environmentally sensitive and stable way of handling and storing of excavated peat.

No significant impacts on the land, soil and geology of the site of project will occur during construction, operation, or during decommissioning phases.

Our assessment confirms there will be no cumulative effects on land soil and geology environment as a result of the project and other existing, approved or proposed projects.

3.5 WATER

As part of the assessment, water quality and field chemistry, and river and stream flows were measured. Continuous monitoring and event monitoring was undertaken.

Within the proposed development site, there are numerous manmade drains that are in place predominately to drain the existing forestry plantations. The wind farm is designed to integrate the proposed wind farm infrastructure with the existing forestry drainage, and natural drainage of the proposed development site, in a manner that avoids water quality and flooding impacts in downstream rivers and streams. The water quality of the local rivers is typically very good.

During each phase of the proposed development (construction and operation / maintenance and decommissioning) a number of activities will take place on the proposed development site, some of which will have the potential to significantly affect the hydrological regime or water quality at the proposed development site or its vicinity. These potential impacts generally arise from sediment input from runoff and other pollutants such as hydrocarbons and cement based compounds.

Mitigation by design and management will be used to reduce the likely significant impacts. Surface water drainage measures, pollution control and other preventative measures have been incorporated into the project design to minimise significant negative effects on water quality and downstream designated sites. A 75m stream buffer was used during the layout of the proposed development, to avoid sensitive areas and watercourses, except where watercourse crossings are required. There will be no direct discharge to any natural watercourse within the wind farm development. Visual inspections, including daily/weekly/monthly and event-based water quality monitoring, will be completed during the construction phase to maintain surface water management system.

There are a number of water schemes locally. 2 no. Group Water Schemes are situated north of the proposed development site. Bodyke GWS is situated ~3.3km north-northwest of the proposed development site, as well as Raheen Road GWS ~4.2 km northeast of the proposed development site. A third GWS at Ogonnelloe is located approximately 7 km northeast of the proposed development site. The mapped zones of contribution to these existing sources are remote from the proposed wind farm site and given the separation distances from the development site, the changes in topography, and also the significant surface water drainage regime (that flows in a westerly direction) between the wind farm site and the Boydyke and Raheen Road GWSs, there is no potential for impacts at these existing sources as a result of the proposed wind farm development. Also, there is no part of the proposed wind farm development anywhere upstream of the Ogonnelloe GWS, and therefore there is no potential for impacts at this scheme as a result of the proposed wind farm development.

Slieve Bernagh Bog SAC is located on land south, south-east, east and north of the proposed wind farm site. A hydrological buffer zone has been applied to the designated site (Slieve Bernagh Bog SAC) and no wind farm development is proposed within this buffer. The designated site can be considered very sensitive in terms of potential hydrological impacts. However, the buffer separation distance to proposed wind farm infrastructure, and also the slopes of the ground, and existing intermediate drainage and fire breaks separate the hydrology of the surrounding bogs from the wind farm site. As such, there is no potential for significant impacts on the hydrology of the SAC as a result of the proposed wind farm development.

The proposed wind farm footprint is not located in an area that is susceptible to fluvial flooding from rivers/watercourses. Preventative measures also include fuel and concrete management and a waste management plan which will be incorporated into the Construction and Environmental Management Plan (Refer to Appendix 3-1 of Volume III).

During the operational phase drainage control measures will ensure that surface runoff from the developed areas of the proposed development site will continue to be of good quality and will therefore not impact on the quality of down-stream rivers and streams. The existing forestry drainage system at the proposed development site will also be utilised to ensure all water leaving the proposed development site will be good quality. No significant impacts on surface water quality are anticipated during the operational phase.

Once the proposed mitigation measures are implemented, the proposed development presents no significant impacts to surface water and groundwater quality during the construction, operational and decommissioning phases. No significant cumulative impacts on any of the regional surface water catchment or groundwater bodies are anticipated from the development.

3.6 AIR AND CLIMATE

The potential effects of the proposed development on local air quality and climate have been assessed. The effects of construction, operation and decommissioning have been considered.

Representative Environmental Protection Agency (EPA) ambient air quality data has been used to characterise the existing air quality in the area. The air quality for the region where the Drumnahough Wind Farm is proposed (Rural West AQIH Region 6) is currently ranked as '2 - Good'. The nearest air quality station to the site is in Letterkenny. The air quality index characterised by this station was classified as 1 'Good'.

There is the potential for dust nuisance to occur during the construction phase. However, considering the separation distance to nearby dwellings, in addition to strict adherence to best construction practices, the impact on local air quality will not be significant.

Once operational, there will be no direct emissions to the atmosphere from the proposed development. The electricity generated will displace electricity that would otherwise have been generated by burning fossil fuels. The CO_2 offset by the proposed development will further assist Irelands CO_2 reduction commitments under the Paris Agreement and the Climate Action Plan 2019.
The Drumnahough Wind Farm is fully aligned with current energy and climate policy, aims and objectives, which primarily seek to increase the production of electricity from renewable sources.

There will be some CO_2 losses associated with the turbine life (manufacture, construction and decommissioning), and the disruption of the natural on-site natural sink resources. However this will be quickly repaid once the wind farm is operational. The calculated CO2 payback period is under 2 years.

The potential effects of the proposed development on local air quality and climate have been assessed. The effects of construction, operation and decommissioning have been considered.
Representative Environmental Protection Agency (EPA) ambient air quality data has been used to characterise the existing air quality in the area. The air quality for the region where the Carrownagowan Wind Farm is proposed (Rural West AQIH Region 6) is currently ranked as '2 - Good'. The nearest air quality station to the site is in suburban Limerick. The air quality index characterised by this station was classified as 1 'Good'.

Regarding climate change and global warming, according to the World Meteorological Organisation (WMO) *Statement of the State of the Climate 2019*:

Global mean temperature for January to October 2019 was 1.1±0.1°C above pre-industrial levels. 2019 is likely to be the 2nd warmest year on record. The past five years are the five warmest years on record, and the past decade, 2010-2019, is the warmest decade on record. Since the 1980s, each successive decade has been warmer than any preceding decade since 1850.

There is the potential for dust nuisance to occur during the construction phase. However, considering the separation distance to nearby dwellings, in addition to strict adherence to best construction practices, the impact on local air quality will not be significant. The movement of machinery, construction vehicles and the use of generators during the construction phase will generate exhaust fumes. Standard best practice is adhered to during the construction phase in order to minimise fugitive dust emissions in particular.

Once operational, there will be no direct emissions to the atmosphere from the proposed development. The electricity generated will displace electricity that would otherwise have been generated by burning fossil fuels. The CO_2 offset by the proposed development will further assist Irelands CO_2 reduction commitments under the Paris Agreement and the Climate Action Plan 2019.

The Carrownagowan Wind Farm is fully aligned with current energy and climate policy, aims and objectives, which primarily seek to increase the production of electricity from renewable sources.

There will be some CO_2 losses associated with the turbine life (manufacture, construction and decommissioning), and the disruption of the natural on-site natural sink resources. However, this will be quickly repaid once the wind farm is operational. The calculated CO_2 payback period is 2 years.

It is not expected that any negative impacts to air quality or the climate will occur during the operational phase, therefore no mitigation measures are required.

3.7 NOISE

Potential noise and vibration effects during construction and operation of Carrownagowan Wind Farm were assessed. The main sources of noise from a wind turbine include aerodynamic noise (rotating blades in the air) and mechanical noise (gearbox – if not a direct drive system – and generator).

Construction noise will occur during excavation and earth moving, laying of roads and hard standings, transportation of materials and erection of the wind turbines. The construction phase will be phased and temporary. The decommissioning phase works will be similar in magnitude to the construction phase.

The Wind Farm is to be developed in a rural area of county Clare, designated for wind farm development. The land use in the immediate area is mainly agricultural and forestry related. This also applies to the works areas of the turbine delivery route.

The main sources of noise in the area include traffic on the local and regional road network, and machinery involved in working agricultural land and forestry. Natural noise sources include wind borne noise in vegetation and water in streams and rivers.

The construction phase entails the building of the wind farm infrastructure including, roads, hard standings, turbine bases, drainage system, substation, control buildings, and borrow pits, and also the turbine delivery route works areas. The noise from construction activities has been assessed and is predicted to result in a temporary, short term, negligible to minor adverse impact.

The predicted operational noise assessment demonstrated that predicted noise levels will comply with the noise limits set out in Wind Energy Development Guidelines. The significance of impact is assessed against the noise limits in the 2006 DoEHLG Wind Energy Guidelines. As these thresholds are predicted not to be exceeded then no significant impact is concluded.

Decommissioning is likely to result in less noise than during construction, and therefore be associated with minor effects at most which is not significant.

There will be no cumulative construction activities with other development. There will be no cumulative operational effects with other development.

To reduce the potential effects of construction noise mitigation measures are outlined as follows:

- Activities that may give rise to noise at the surrounding properties and heavy goods vehicle deliveries to the site will be limited to the hours 07:00 to 19:00 Monday to Friday and 07:00 to 14:00 on Saturdays.
- Turbine deliveries will only take place outside these times with the prior consent of the Council and An Garda Síochana.
- All construction activities shall adhere to good practice with all equipment maintained in good working order.

As the proposed turbines are predicted not to exceed DoEHLG noise limit criteria in standard operating mode mitigation measures are not required.

Once operational, the noise levels from the turbines will not exceed planning limit criteria for the protection of residential amenity.

Residual effects section outlines the degree of environmental change that will occur after the proposed mitigation measures have taken effect. Mitigation measures as discussed above will aid reduction in the potential noise and vibration effects during construction. Operational noise levels are acceptable in terms of the relevant guidance for the assessment of windfarm noise, and therefore considered not significant.

3.8 LANDSCAPE

Landscape and Visual Impact Assessment (LVIA) is a tool used to identify and assess the significance of and the effects of change resulting from development on both the landscape as an environmental resource in its own right, and on people's views and visual amenity. The significance of the effect is a judgement based on the sensitivity of the receptor, combined with the magnitude or degree of change. This process is the same for landscape and visual effects. The assessment of landscape and visual effects included a desktop study, review of the proposed development drawings and visualisations, and a number of site visits.

The proposed wind farm project is located within forested lands on the northern slopes of the Slieve Bernagh mountains, approximately 4 km northeast of the village of Broadford, 7km north-west of Killaloe and 2.5 km south of the village of Bodyke, at its closest point.

The site of the proposed development is a commercial forestry plantation, with smaller areas of cutover bog, bogland, and improved grassland. To the south and south-east lies the peaks of Cragnamurragh and Moylussa, which are mainly open moorland and coniferous plantation, while to the north the land consists of coniferous plantation and bogland, sloping towards the village of Bodyke. To the east of the Slieve Bernagh Hills, the land

slopes towards Lough Derg. Across Lough Derg the Arra Mountains rise to a height of approximately 450 metres OD at Tountinna.

To the east of the Sliabh Bernagh uplands, the land is lower in elevation with some drumlins while to the north the land is generally low lying with scattered lakes and settlements. The lands to the north in the vicinity of Tulla are generally less than 100 metres in elevation, with drumlins, and the elevation increases north of Feakle where the Slieve Aughty range runs east-west on both sides of Lough Graney, from east of Crusheen. Further north, the Slieve Aughtys extend into south Co Galway.

The landscape effects of the proposed development were considered in the context of the site and immediate vicinity, and the effects on the wider landscape. The landscape effects at operational phase (when the turbines are constructed) are considered to range from Moderate on the landscape character of the site and immediate surrounds, and will range from Negligible to Moderate in other areas of the landscape in the wider vicinity. This varies depending on visibility of the turbines.

The effects on the sensitive landscape character to the east of the site, (LCA 8 Lough Derg Basin) which is a scenic area including and around Lough Derg, partly subject to a Heritage landscape designation, with several scenic routes, are considered Slight, neutral effects on the landscape character. The effect of the proposed development on the landscape character to the north-east of the site in the vicinity of Mountshannon to Tuamgraney, and the surrounding Lough Derg shoreline and Holy Island, is considered to have Slight, adverse effects.

Visual effects have been assessed using a combination of tools, including Zone of Theoretical Visibility (ZTV) maps and Photomontages, combined with several site visits. 27 Viewpoints were chosen to represent a range of receptors, which included selection from a wider list of locations, some of which had theoretical visibility but no actual visibility.

Several settlements, including Kilbane, Broadford, Ogonelloe, Killaloe/Ballina, O' Briensbridge, Nenagh and the majority of Tulla are will not have visibility of the proposed development as indicated on the ZTV (Zone of Theoretical Visibility) map, so no visual effects will occur. Where the ZTV does show theoretical visibility from some settlements, these may in reality be much less due to screening by built form.

A total of 27 viewpoints were selected and photomontages produced from these viewpoints. Visual effects range from Not Significant to Significant, depending on the viewpoint, and a number of views showed no visibility. The quality of the visual effect ranges from neutral to adverse.

The view which was considered to have Significant visual effects is view 7, which represents an area north of the site near Bodyke village. This location is in close proximity to the turbines, where the visual effects are likely to be pronounced. This represent viewers on the local roads as well as local residents, nearby dwellings and receptors on the eastern side of Bodyke village.

Views of the sensitive landscape east and north-east of the site on the shores of Lough Derg are represented by a high number of viewpoints. Visual effect ranges considerably through this area, in general visibility is greater from the north east of the area. Significance of effect ranges from Moderate to Not Significant, where visibility occurs. Effects include Slight-Moderate, adverse effects (Viewpoints 2,3,) to the northwest, Moderate and neutral (Viewpoint 14) Slight adverse (Viewpoint 4) and Slight, neutral (Viewpoint 17) and Not Significant, neutral (18,22).

Due to the distance between the proposed development and the other wind farms, (the closest turbines are approximately 20 km) it is not considered that there will be any likely significant cumulative effects on the landscape character.

More localised cumulative effects, at the site level, may arise where forestry operations are ongoing on and around the windfarm site. These are likely to impart a Low degree of change as the forestry operations are ongoing, and result in a Not Significant, localised visual effect in the vicinity of the site.

Cumulative visual effects are defined in the GLVIA as one of two types – combined in combination, and combined, in succession.

The photomontages 1-27 allow for the assessment of combined (in combination) visual effects. This arises where two or more developments are/would be visible in the viewer's arc of vision at the same time without moving their head. There are no other turbines other than the Carrownagowan turbines, visible in any of the photomontages, so these effects do not occur.

Combined – in succession – visibility arises where the viewer has to turn their head to see the various developments – actual and realised.

This may occur in several views, namely Views 11,13,14,17 19 and 22 as indicated on the Figure 12.13 Cumulative ZTV. above. At these viewpoints, it is possible that the observer could turn their head and obtain a view of other turbines – in a different direction. The closest permitted turbines are those at Castlewaller which are approximately 20 kilometres from the proposed wind farm. It is considered that the likely effect of any visibility from these locations would impart a Low magnitude of change to the view and would not be significant.

3.9 ARCHAEOLOGY AND CULTURAL HERITAGE

The Archaeology, Architecture and Cultural Heritage assessment has been discussed under four sections. The first is the proposed Project, which covers the wind farm and turbine delivery areas as well as the associated grid connection route. The remining three cover the replacement lands at Cooraclare, Co. Clare; Ballard, Co. Wicklow; and Trillickacrry, Co. Longford. This chapter of the EIAR determines, as far as reasonably possible from existing records, the nature of the heritage resource within the footprint of the Project and replacement lands and within the receiving environments using appropriate methods of study. The predicted impacts of the Project and replacement lands was then assessed against the baseline environment.

A range of both direct and indirect impacts to the archaeological, architectural and cultural heritage resource have been identified during the construction and operational phases of the proposed project and replacement lands.

There are no recorded monuments located within the footprint of the proposed project, therefore there are no predicted impacts to the recorded archaeological resources during the construction phase. Construction impacts to the setting of BH 5, Ford Edward which is a Protected Structure, will be indirect and moderate adverse, however, these impacts are reversible following the completion of construction.

Construction of the proposed grid connection will have a direct imperceptible impact on one designed landscape, that at Ballyquin House (DL 3). Construction works at Turbine Delivery Area 2 will have a direct moderate negative on the designed landscape of St. Catherine's (DL 4).

A number of Areas of Archaeological Potential (AAP 1–3, 5–7) will be directly impacted by the construction of access roads across the proposed Project (AAP 8 and 9). This will result in slight negative impact to the

townland boundaries located within these AAPs. Should any archaeological remains be located within these AAPs, impacts may range from moderate to profound direct negative, depending on the nature and significance of the archaeological features.

There are no known archaeological or architectural heritage assets located within the boundary of the replacement planting lands at Cooraclare. There is one recorded monument, a ringfort (AH 57), located within the boundary of the Ballard replacement lands and the zone of notification for one recorded monument, a ringfort (AH 60), extending partially in to the boundary of the Trillickacurry replacement lands. As per the Code of Practice between Coillte and the Department of Culture, Heritage and the Gaeltacht, no planting will be undertaken on or within an exclusion zone around the monuments, therefore there will be no direct impact on the monuments.

The site of a vernacular structure is located at Cooraclare (CH 282). The planting of forestry in these areas may have a direct significant impact on any below ground remains that may survive.

A number of Areas of Archaeological Potential will be directly impacted during the reforestation of lands at Cooraclare and Ballard (AAP 10 and AAPs 11 – 12 respectively). Should any archaeological remains be located within these AAPs impacts may range from moderate to profound direct negative, depending on the nature and significance of the archaeological features.

Previously unknown archaeological sites and features may survive below ground across the proposed project and replacement lands. Should any such remains be encountered during construction, impacts may range from moderate to profound direct negative, depending on the nature and significance of the archaeological features.

Indirect impacts to the setting of monuments to the north and northwest of the proposed project is considered to be slight negative due to the nature of the monuments, being largely below ground features with no upstanding remains together with the distance of the recorded monuments from the proposed turbines and the level of existing screening provided by the intervening topography and existing forestry.

There is little to no visibility between the recorded monuments to the south and southwest of the proposed wind farm boundary, therefore operational impacts to the setting of these monuments is considered to be imperceptible. There are no predicted impacts to the setting of the National Monuments or monuments subject to Preservation Orders within the study area due to the distance from the proposed wind farm and the intervening topography and vegetation which screen these monuments from the turbines.

It is recommended that all ground disturbances across the proposed turbine locations, associated infrastructure and turbine delivery areas for the Proposed Project, as well as all ground disturbances at the proposed replacement lands be monitored by a suitably qualified archaeologist. Excavations associated with the grid connection will be located within the existing local and regional roads. These excavations should be subject to intermittent monitoring by a suitably qualified archaeologist. If any features of archaeological potential are discovered during the course of the works the Forestry Service archaeologist will be informed immediately and a buffer zone of at least 20m will be established around the archaeological site. Any further mitigation will require approval from the Forestry Service archaeologist of the Department of Agriculture.

As per the Code of Practice between Coillte and the Department of Culture, Heritage and the Gaeltacht, an exclusion zone should be established around the recorded monuments at Ballard and Trillickacurry (AH 57 and 60). These exclusion zones will be fenced off from the rest of the site and no construction works or ground

disturbance will be undertaken within the exclusion zones. This will ensure the preservation in situ of the monuments.

During the decommissioning phase of the project, the exclusion zones surrounding AH 57 and 60 will be maintained and no site operations will be permitted within these zones to ensure the preservation in situ of the monuments. The perimeter trees surrounding the exclusion zone will be marked with bright paint and all operational staff will be made aware of the monument's location and sensitivity.

Following the implementation of the above mitigation measures, there will be no residual impacts on the archaeological, architectural or cultural heritage resource.

3.10 SHADOW FLICKER

Shadow flicker is defined as the alternating light intensity produced by a wind turbine as the rotating blade casts shadows across the window of a residence.

In line with best practice, the scope of this assessment extends to a distance of 10 times the maximum rotor diameter (or 1.36 km). There are 4 No. properties within the 10 x rotor diameter study area. The model shows that the shadow flicker threshold may be exceeded at two of the properties, one of which is unoccupied and uninhabitable. The developer is committed to ensuring that shadow flicker does not occur at any dwelling that could potentially experience shadow flicker within the 10 rotor diameter study area, equivalent to 1.36 km.

The shadow flicker assessment described Chapter 11 of the main EIAR will inform the Shadow Flicker Control Measures (SFCM) that will be designed for relevant turbine to ensure that shadow flicker does not occur.

Shadow Flicker Control Measures (SFCM) are a standard element of commercial wind turbine packages which require the identified dates and times of day of potential occurrence at dwellings within the shadow flicker study area to be inserted into the SFCM computer program.

The installation of a programmable shadow flicker module will allow the control of turbines in order to eliminate shadow flicker. The correct operation of the installed shadow flicker control measures will ensure that there will be no impact from shadow flicker. The operation and performance of the shadow flicker control measures will be monitored on an ongoing basis.

3.11 MATERIAL ASSETS

The material assets assessed include transport infrastructure, electricity supply and infrastructure, aviation, television and telecommunications, water and wastewater infrastructure and waste management.

Transport Infrastructure

The proposed wind farm is located on the south side of the L8821-0 Local Road, south of Bodyke. The L8821-0 extends from Drummod in the west to the townland of Caherhurly in the east. Access to the proposed wind farm is provided from the L8821-0. The grid connection route runs between the Carrownagowan wind farm and an existing substation in Ardnacrushna.

Potential impacts on the surrounding road network will arise principally during the construction phase. Peak daily construction traffic is predicted to be 180 HGVs with the predicted highest peak hourly HGV traffic

volumes to be approximately 24 per hour. Peak construction traffic would principally occur during turbine base pours and therefore arise on twelve occasions.

Traffic studies carried out for the proposed development indicate that while the increased traffic volume on the local road network during the construction phase would be substantial, this increase will be well within the carrying capacity of the local road network.

The wind turbine loads would be delivered in consultation with Clare County Council, Galway County Council or Limerick City and County Council and An Garda Síochana, during off-peak traffic periods. A total of 190 delivery vehicles will be required for the 19 turbines. This could result in temporary delays for other location traffic during the off peak traffic delivery periods.

Diversions will be implemented to provide an alternative route for road closures required during construction. A traffic management plan will be implemented to ensure significant effects do not result.

Aviation

Shannon Airport, one of Ireland's main international Airports and important state economic asset, is located circa 28km south west of the proposed wind farm development site. There are also numerous aerodromes and airfields in the surrounding region.

Following consultation, the Irish Aviation Authority expressed concern that there was potential that the wind farm could adversely affect the radiated signal and Instrument Landing System (ILS) for Runway 24 at Shannon Airport.

A navigational aids assessment was subsequently undertaken by PagerPower to determine whether the proposed wind farm development would adversely affect aircraft using the ILS. (Refer to Volume III, Appendix 15-1.)

The results of the assessment determine that the horizontal clearance between aircraft flying the test trajectories and the turbines is more than six times the minimum horizontal clearance distance of 150 metres applicable for VFR flights in Ireland. The proposed turbines will therefore not affect aircraft flying ILS test trajectories and will therefore not have a significant impact on ILS test flights.

Television and Telecommunications

The wind farm is not located between TV transmitters and receptors and it is unlikely that receptors in the vicinity of the wind farm could experience interference with television reception. Notwithstanding this, as is standard practice, a signed Protocol between the developer and RTE will be in place, in which the developer will be responsible to resolve any issue of interference with television reception as a result of the proposed development.

Following consultation with telecommunications providers, Vodafone, Eir, BT, Imagine, Ivertec, Three and Virgin confirmed there would be no impact in the area. Any confirmed effects on TV and Telecommunication reception in areas can be suitably addressed under agreement between the applicant and any affected Telecommunication provider.

Water, Wastewater and Waste Management Infrastructure

No public water or wastewater utility infrastructure is required at the wind farm site. Water needs for construction activities will be low and limited to truck washing, wheel wash, dust suppression and sanitary facilities. It is proposed that this water requirement will be sourced from on-site rainwater collection systems

and settlement ponds. It is estimated that up to approximately 3,000 litres per day of potable water will be required during peak construction for construction employees. It is proposed that this water requirement will be imported in bulk water tanks. Potable water for during the operational and maintenance phase is estimated to be approximately 60 litres. This water will be supplied as bottled water. The volumes of water required are minimal and would have a negligible impact on the water supply utilities. Wastewater from welfare facilities on site, will drain to integrated wastewater holding tanks associated with the toilet units. The stored effluent will then be collected on a regular basis from site by a permitted waste contractor and removed to a licenced waste facility for treatment and disposal.

The types of wastes to be generated would be similar to established construction waste streams and would not require unusual or new treatment options. Waste volumes are not likely to be significant as to require new permitted treatment, storage and disposal facilities.

On decommissioning about 85 per cent of turbine components, including steel, copper wire, electronics and gearing, can be recycled or reused.

3.12 INTERACTION OF THE FOREGOING

There is potential for interactions between one aspect of the environment and another which can result in direct or indirect impacts, and which may be positive or negative.

A matrix has been generated to summarise the relevant interactions and interdependencies between specific environmental aspects (Refer to **Table 2**). It contains each of the environmental topics, which were considered as part of this environmental impact assessment, on both axes.

The most dynamic interaction and interdependencies relate to the connection between biodiversity, soils, and water. Changes in site run-off from changes and removal of soil cover can result in effects or changes on hydrology, both in terms of water quality and hydraulic regime, which may result in secondary ecological effects on vegetation patterns and habitats and species. The relationship and effects of these aspects have been fully considered in **EIAR Volume 2 Chapter 6** Biodiversity, **Chapter 8** Water and **Chapter 9** Land and Soils. Where any potential interactive effects have been identified, appropriate mitigation is included in the relevant chapters of the EIAR.

Table 2Matrix of Environmental Factor Interactions

	POPULATION AND HUMAN HEALTH	BIODIVERSITY (+ ORNITHOLOGY)	LAND AND SOIL	WATER	AIR AND CLIMATE CHANGE	NOISE AND VIBRATION	LANDSCAPE AND VISUAL	CULTURAL HERITAGE	SHADOW FLICKER	MATERIAL ASSETS
POPULATION AND HUMAN HEALTH										
					+ +					
BIODIVERSITY (+ ORNITHOLOGY)										
					+ +					
LAND AND SOIL										
WATER										
AIR AND CLIMATE CHANGE										
	+ +	+ +								+ +
NOISE AND VIBRATION										
LANDSCAPE AND VISUAL										
CULTURAL HERITAGE										
SHADOW FLICKER										
MATERIAL ASSETS										
					+ +					

Construction

Operation

+ + Positive effect

4 MANAGEMENT OF ENVIRONMENTAL IMPACTS

Environmental impacts during construction will be managed through the design and implementation of a Construction and Environmental Management Plan (CEMP). This will address working hours, traffic management, control of pollution, waste management, noise, dust and vibration.

Potential environmental impacts during operation can be managed and the necessary plans and controls are incorporated in the mitigation measures in this EIAR.

With the implementation of the proposed mitigation measures there will be no significant residual effects as a result of the proposed project.

5 CONCLUSION

All power generation has environmental effects; those created by wind farms are minimal. The long term impacts of the project will be the provision of a renewable energy source which will help Ireland meet targets for reductions in greenhouse gas emissions. The effect of the project will be clearly positive as wind energy does not defer the environmental costs of non-renewable electricity production to future generations.

With the implementation of the recommended mitigation measures in the construction and operation of the Carrownagowan wind farm, no significant residual impacts are expected to Population and Human Health, Biodiversity, Ornithology, Water, Land and Soils, Air and Climate, Noise, Cultural Heritage and Material Assets. Overall, the design and layout of the proposed Carrownagowan Wind Farm is considered appropriate for the landscape and the proposal is not considered to significantly affect the overall landscape sensitivity and values of the area.