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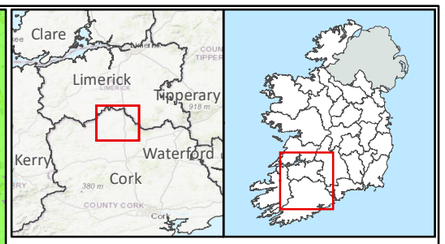

Legend

- Site Boundary
- Turbine Layout
- Met Mast
- Underground Cable Route
- Site Internal Roads
- Substation
- Construction Compound

Landslide Susceptibility

- Low
- Low (inferred)
- Moderately Low
- Moderately Low (inferred)
- Moderately High
- High
- Made
- Water

TITLE:	Landslide Susceptibilty		
PROJECT:	Annagh Wind Farm, Co. Cork		
FIGURE NO:	9.10		
CLIENT:	EMPower		
SCALE:	1:70000	**REVISION:**	0
DATE:	19/10/2021	**PAGE SIZE:**	A3

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Peat Stability Assessment

Following the site walkover, a review of the published checklist for peat landslide hazard and risk assessment was carried out. This was undertaken in accordance with the following best practice guidance: Scottish Executive – Peat Landslide Hazard and Risk Assessments (2017).

The potential for a landslide risk is defined in the Scottish Executive "Peat Landslide Hazard and Risk Assessments, Best Practice Guide for Proposed Electricity Generation Developments" (2017) as the following:

- *Peat is present at the development site in excess of 0.5 m depth, and;*
- *There is evidence of current or historical landslide activity at the site, or;*
- *Slopes > 2° are present on-site, or;*
- *The works will impinge on the peat covered areas and cannot be relocated to avoid peat covered areas.*

A walkover was carried out by an FTC Engineering Geologist during July 2020. No peat deposits were recorded.

As such and in accordance with the Scottish Executive Best Practice Guide for Proposed Electricity Generation Developments (2017) a peat stability assessment has not been undertaken.

9.3.8 Soil Contamination

There are no known areas of soil contamination on the proposed development site or the grid connection route. No evidence of soil contamination was noted during site walkovers. As agricultural equipment is used across much of the proposed development site it is possible that minor fuel spills and leaks have occurred locally in the past.

Further, due to the presence of local roads within the study area and along the proposed grid connection route there is a risk of fuel leakages and other highway related contamination in the upper soils.

According to the EPA online mapping (http://gis.epa.ie/Envision) with regards to licenced waste facilities and IPPC licenced facilities, the nearest active EPA Licenced Waste Facility is Ballyguyroe Landfill Site. (EPA Licence W0002-02), located approximately 16km to the east of the study area. However, this site no longer appears to be active.

9.3.9 Replant Lands

Replacement replanting of forestry in Ireland is subject to licence in compliance with the Forestry Act 2014 as amended. The consent for such replanting is covered by statutory instrument S.I. No. 191/2017 Forestry Regulations 2017 as amended. This legislation provides for development of afforestation and forest road construction project's compliance with the Environmental Impact Assessment Directive insofar as it applies to forestry development. Please see Chapter 3 for further details.

As it is proposed to fell approximately 12.6 ha of broadleaf forestry for the proposed project, replant lands of the same area are required. The replacement replanting of forestry can occur anywhere in the State subject to licence.

A replanting site has been identified at Emlagh, Co. Clare. These lands have been assessed in in this Chapter in terms of potential cumulative impacts. If these replant lands become unavailable, other similarly approved lands will be acquired for replanting should the proposed wind farm receive planning permission.

Emlagh, Co. Clare

The proposed replant lands are made up of an area of c.14.5 Ha of Wet Grassland in the townland of Emlagh approximately 2km northwest of Moynasta, accessed via un-named local roads, and farm/forestry access tracks. The site is located approximately 70km northwest of the proposed development.

The surrounding landscape is rural in character, with agricultural and commercial forestry being the dominant land uses; the replant lands site is surrounded to the north by conifer plantations, and to the east, south and west by agricultural land.

The underlying bedrock geology comprises the purple mudstone and sandstone of the Ballytrasna Formation; with the Quaternary deposits comprising of Glacial Till derived from Namurian Sandstones and Shales and Blanket Peat.

The groundwater vulnerability is classed by the GSI as being 'Moderate' across the site. The underlying groundwater aquifer is classed by the GSI as a 'Locally Important Aquifer' – bedrock that is moderately productive in local zones. The site is located in the Kilrush GWB, which has a poorly productive bedrock flow regime. The GWB is classified as having *'Good*' status in terms of quality and quantity. The overall risk result is in '*Review*'.

9.4 Do Nothing Scenario

If the proposed development were not constructed, it is likely that the current land uses will continue for the foreseeable future. The impact on the Land, Soils and Geology would likely remain unaltered as a result.

9.5 Construction Phase Impacts

The following on-site activities have been identified as the sources of potential impacts on the existing geological and hydrogeological conditions during the construction phase of the proposed development:

9.5.1 Tree Felling

An area of the proposed development site comprises of commercial broadleaf forestry.

Felling of approximately 12.6 ha of broadleaf forestry is required within and around the wind farm infrastructure to accommodate the construction of some turbines, hardstands, crane pads, access tracks, onsite substation, grid connection, temporary compounds and permanent met masts.

These works will be the subject of a Felling Licence Application to the Forest Service prior to construction as per the Forest Service's policy on granting felling licenses for wind farm developments. The proposed areas to be felled are illustrated on Figure 3.6 in Chapter 3, Description of the Proposed Development.

Proposed tree felling will involve the use of heavy felling machinery and exposure of underlying soils to surface water runoff, which could result in soil erosion. This also could lead to an increase in sediment and nutrient concentrations in the surface water run-off which may in turn impact groundwater in the Regionally and Locally Important Aquifers beneath the proposed development site.

The use of plant and machinery during tree felling works will require the storage and use of fuels and oils. Their storage and use present potential for spills and leaks which could contaminate underlying exposed soils and groundwater.

Further assessment of potential impacts to surface water discharges from felling activities are discussed in Chapter 10 of the EIAR.

The significance of these potential impacts on geological receptors, prior to mitigation, is considered to be **Slight.**

The significance of these potential impacts on hydrogeological receptors, prior to mitigation, is considered to be **Significant** as underlying groundwater is identified as intersecting with the Blackwater River (Cork/Waterford) SAC**.**

9.5.2 Earthworks

The proposed development will require construction phase earthworks associated with the excavation of turbine bases, removal of overburden deposits for the construction of turbine foundations, temporary site compound, sub-station, grid connection trenches, turbine hard standings, internal access roads and permanent met mast. Temporary accommodation works will also be required along the proposed turbine delivery route such as hedge or tree cutting, relocation of powerlines/poles, lampposts, signage and local road widening.

As such there is the potential for impact to Land, Soils and Geology from the excavation and movement of existing Alluvium and Glacial Till deposits during the construction phase of the proposed development.

The following earthworks excavations will be required:

- Excavation of Topsoil and Alluvium deposits;
- Excavation of Glacial Till to bedrock/founding stratum (as required).

The following filling and material deposition operations will be required:

- Deposition of surplus topsoil and Glacial Till deposits in berms for reinstatement proposes around turbine bases and hardstands.
- Importation and Filling of site won and imported General Fill and Engineering Aggregates.

Turbines of the size proposed for Annagh Wind Farm have foundation depths of 4m and diameters of 22m. Ideally, a suitable bearing stratum is encountered within 3m from ground surface so that the turbine foundation can be finished at / near existing ground level. Where deeper excavations (3-5m) are required to reach a suitable bearing stratum, soil replacement (engineered fill) is used to bring up the excavation so that the turbine foundation is finished at / near existing ground level.

Some temporary stockpiles of material may be necessary prior to reinstatement; however, no permanent stockpiles of material will remain after construction.

It is proposed that all onsite materials excavated shall be retained on site and re-used where suitable as part of the construction phase to minimise the import materials requirements.

Surplus Topsoil, Alluvium and Glacial Till recovered from excavations will be used for reinstatement proposed around turbine bases and hardstands.

Direct impacts to the existing geological regime associated with the construction phase of the proposed development are:

- Soil compaction may occur due to movement of construction traffic. This will occur particularly within areas of highly compressible soft deposits which are left in-situ during the construction phase. This could lead to an increase in surface water runoff due to reduced infiltration of rainfall and subsequently to an increase in erosion of overburden deposits left in-situ.
- The use of plant and machinery during construction will require the storage and use of fuels and oils. Their storage and use present potential for spills and leaks which could contaminate underlying exposed soils.
- During construction, imported engineering fill and excavated soils will be exposed in excavations and in temporary stockpiles. These soils will be subject to erosion by wind and rain which could deposit silt in streams with an indirect impact on surface water quality.

The significance of these potential impacts, prior to mitigation, is considered to be **Slight.**

The Impact classification is negative, slight significance, permanent, direct and high probability.

Direct impacts to the existing hydrogeological regime associated with earthworks associated with the construction phase of the proposed development are:

- Potential for groundwater pollution from the removal of overburden deposits particularly at proposed turbine locations. The aquifer underlying the proposed wind farm site and the majority of the proposed grid connection route is classified by the GSI as ranging from 'Low' to 'Medium' groundwater vulnerability with areas of 'High' and 'Extreme' vulnerability and exposed bedrock present in these areas. It is proposed to remove the overlying topsoil, alluvium and Glacial Till deposits as outlined in the proposed design.
- The vulnerability of the aquifer to groundwater pollution particularly during construction stage will be increased as overburden is removed thus reducing the level of protection from groundwater pollution.
- Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Soil erosion as a result of exposure of soils in open excavations and temporary storage of excavated materials represents a potential impact to the underlying groundwater aquifer.

Groundwater underlying the site is identified as intersecting with the Blackwater River (Cork/Waterford) SAC**.**

- Reduction in groundwater levels from dewatering of excavations as required during the construction stage if high groundwater is encountered. This impact is most likely during the excavation of turbine foundations. There are no groundwater supply wells recorded in the immediate vicinity of proposed turbine locations. It is considered that other excavations associated with substation, temporary compound and grid connection trenches will not extend into the underlying bedrock aquifers. It is possible however that perched groundwater may exist locally within overburden deposits or weathered bedrock. Upon completion of the construction phase, it is considered that groundwater levels will revert to the pre-construction situation when there is no longer a requirement to control groundwater levels.

The significance of these potential impacts, prior to mitigation, is considered to be **Significant.**

The Impact classification is negative, significant significance, permanent, direct and high probability.

9.5.3 Slope Stability

The proposed development and proposed infrastructure locations are located within areas of 'Low' susceptibility.

Direct impacts to the existing environment associated with potential slope instability and failure include:

- Slope failures have the potential to impact the existing geological conditions from the removal and deposition of landslide/slope failure material and the exposure of underlying overburden deposits and bedrock to an increase in surface water runoff and subsequent increase in erosion. Slope failure also has the potential to have an impact on the safety of construction workers and forestry workers that could be in the vicinity of a landslide/slope failure event, existing infrastructure (roads, access tracks) and nearby urban areas.
- The impact of a slope failure could potentially result in the influx of acidic and/or peat laden waters into downgradient surface water features resulting in a decrease in the receiving water's pH values. This may impact groundwater quality in the underlying Regionally and Locally Important Aquifers and in any groundwater abstractions in the vicinity of a landslide event.

The significance of these potential impacts on geological receptors, prior to mitigation, is considered to be **Slight.**

The Impact classification is negative, slight significance, short term, direct and low probability.

The significance of these potential impacts on hydrogeological receptors, prior to mitigation, is considered to be **Significant** as underlying groundwater is identified as intersecting with the Blackwater River (Cork/Waterford) SAC**.**

The Impact classification is negative, significant significance, short term, direct and low probability.

9.5.4 Internal Access Roads and Hardstands

There will be approximately 4.98km of internal access tracks associated with the proposed wind farm development. This will be a combination of existing track upgrade and construction of new tracks; approximately 4.6km of new track construction and approximately 0.38km of existing track upgrade. Hardstand areas will be provided at each turbine location.

All access tracks will be 5m wide along straight sections and 5.6m wider at bends. The access track for the met mast located at the south of the site will be 3.5m wide. The tracks will be finished with a well graded aggregate. The drainage system will be installed adjacent to the internal access tracks. Existing drainage infrastructure will be maintained and upgraded where necessary.

The need for floating roads is not expected at this site.

It is anticipated that the stone required for the construction of the internal access roads will be sourced from quarries in the vicinity.

As outlined in Chapter 13 of the EIAR, a source quarry for the supply of imported aggregate during the construction phase of the development is located at:

- Lackanamona Quarry, Mallow, Co. Cork, 25km to the south of the site

Access track formation will consist of a minimum 500mm hardcore on a geotextile separator. The likely construction methodology for newly constructed tracks will be as follows:

- The formation will be prepared to receive the geotextile membrane.
- Stone will be placed and compacted in layers to minimum 500mm depth.
- A drainage ditch will be formed, within the excavated width and along the sides of the track.
- Surplus excavated material will be placed along the side of sections of the tracks and dressed to blend in with surrounding landscaping and partially obscure sight of the track.

Direct impacts to the existing geological regime associated with the construction of proposed access tracks and hardstands are:

- Soil compaction may occur due to movement of construction traffic. This will occur particularly within areas of highly compressible soft deposits which are left in-situ during the construction phase. This could lead to an increase in surface water runoff due to reduced infiltration of rainfall and subsequently to an increase in erosion of overburden deposits left in-situ.
- The use of plant and machinery during construction will require the storage and use of fuels and oils. Their storage and use present potential for spills and leaks which could contaminate underlying exposed soils.
- During construction, imported engineering fill and excavated soils will be exposed in excavations and in temporary stockpiles. These soils will be subject to erosion by wind and rain which could deposit silt in streams with an indirect impact on surface water quality.

The significance of these potential impacts, prior to mitigation, is considered to be **Slight.**

The Impact classification is negative, slight significance, permanent, direct and high probability.

Direct impacts to the existing hydrogeological regime associated with the construction of proposed access tracks and hardstands are:

- Potential for groundwater pollution from the removal of overburden deposits. The aquifer underlying the proposed wind farm site is classified by the GSI as ranging from 'Low' to 'Medium' groundwater vulnerability with areas of 'High' and 'Extreme' vulnerability and exposed bedrock present in these areas. It is proposed to remove the overlying topsoil, alluvium and Glacial Till deposits as outlined in the proposed design.
- The vulnerability of the aquifer to groundwater pollution particularly during construction stage will be increased as overburden is removed thus reducing the level of protection from groundwater pollution.
- Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Soil erosion as a result of exposure of soils in open excavations and temporary storage of excavated materials represents a potential impact to the underlying groundwater aquifer.
- Potential for groundwater pollution from the use of cement-based compounds during the construction phase.

The significance of these potential impacts, prior to mitigation, is considered to be **Significant** as underlying groundwater is identified as intersecting with the Blackwater River (Cork/Waterford) SAC**.**

The Impact classification is negative, significant significance, permanent, direct and high probability.

9.5.5 Internal Cabling and Grid Connection

As outlined in Chapter 3 of this EIAR, electricity generated from wind turbines shall be collected at medium voltage (20/33kV) by an internal circuit of buried cables which will follow on-site access tracks. This circuit shall terminate at the proposed onsite substation before being exported to the grid via a buried cable to the existing Charleville 110kV substation.

Connection works will involve the installation of ducting, joint bays, drainage and ancillary infrastructure and the subsequent running of cables along the existing road network. For cable trenches located in public roads, the contractor will excavate cable trenches and then lay high density polyethylene (HDPE) ducting in the trench in a surround of cement bound material (CBM). Back-filling and reinstatement in public roads will be to a specification to be agreed with the road authority.

A similar construction methodology will apply for cable trenches laid within site access tracks. In this case the cable-ducts will generally be laid when the track is being constructed and will follow the edge of the site access tracks. The trenches within these locations will generally be backfilled using the excavated material.

Direct impacts to the existing environment associated with the proposed internal cabling and grid connection works include:

- The proposed grid connection, associated excavations and ducting may present a preferential pathway for the movement of groundwater and/or contamination in the subsurface. However, the subsoil at the proposed development is predominantly Glacial Till which has a low permeability throughout the majority of the proposed grid connection route.

- The excavations for the grid connection trenches and joint bays can have a direct impact on the exposed soils and rock in the form of increased erosion from surface water ingress.
- Where the material excavated from the proposed grid connection excavations are not suitable for reuse as backfill or deposition on site this material will be disposed of at a facility licenced (subject to environmental testing and classification) to accept this waste type.

Given that the open sections of the trench will be backfilled following the installation of each section of ducting the significance of these potential impacts on geological receptors, prior to mitigation, is **Slight**.

The Impact classification is negative, slight significance, permanent, direct and high probability.

The significance of these potential impacts on hydrogeological receptors, prior to mitigation, is considered to be **Significant** as underlying groundwater is identified as intersecting with the Blackwater River (Cork/Waterford) SAC**.**

The Impact classification is negative, significant significance, permanent, direct and high probability.

9.5.6 Turbine Delivery Route

The proposed turbine delivery route (TDR) will be from Foynes as described in more detail in Chapter 13 of this EIAR.

The following accommodation works are required along the TDR at the following locations. These works do not form part of the proposed development but have been assessed in this EIAR:

- Cut-through at the Clarina Roundabout
- Cut-through at the Mungret Interchange - West Roundabout
- Widening at the Mungret Interchange - East Roundabout
- Local widening at the junction of the N20 and the L1322;
- Local widening along the L1322 from the N20 to the site entrance.

The accommodation works associated with the TDR route will include the excavation of existing overburden deposits. The potential impact would be from the temporary exposure of the overburden to erosion via surface water ingress during the works.

Given the limited extent of excavations associated with these works the magnitude of these potential impacts on geological receptors, prior to mitigation, is considered to be **Not Significant.**

The rating of these potential impacts on hydrogeological receptors, prior to mitigation, is considered to be **Significant** as underlying groundwater is identified as intersecting with the Blackwater River (Cork/Waterford) SAC**.**

In summary, the overall magnitude of these potential direct impacts on geological receptors associated with the construction phase of the proposed development, prior to mitigation, is considered to be a Short Term, Direct, Negative, **Not Significant** Impact**.**

The overall magnitude of these potential direct impacts on hydrogeological receptors associated with the construction phase of the proposed development, prior to mitigation, is considered to be a Short Term, Direct, Negative, Significant Impact**.**

Following the identification of the potential direct impacts during the construction phase, as outlined above, mitigation measures to reduce the risk to an acceptable level are discussed in Section 9.5.2 of this Chapter.

9.5.7 Potential Indirect Impacts

As outlined in Section 9.3.9 a potential replanting site have been identified at Emlagh, Co. Clare. These lands are assessed for potential cumulative impacts throughout the EIAR.

Quantities of granular material will be required for the proposed development. This will place a demand on local aggregate extraction facilities.

Where the material excavated from the proposed grid connection excavations is not suitable for reuse as backfill or deposition on site this material will be disposed of at a facility licenced (subject to environmental testing and classification) to accept this waste type. This will take up available void space at licensed facilities if not recycled.

The significance of these potential impacts, prior to mitigation, is considered to be **Slight.**

The Impact classification is negative, slight significance, permanent, direct and high probability.

9.6 Operational Phase Impacts

The potential impacts on land, soils and geology from the operation of the proposed development are outlined below.

9.6.1 Potential Direct Impacts

Very few potential direct impacts are envisaged during the operational phase of the wind farm. These include:

- Some construction traffic may be necessary for maintenance of turbines, hardstands and access tracks which could result in minor accidental leaks or spills of fuel/oil.
- The grid transformer in the substation and transformers in each turbine are oil cooled. There is potential for spills / leaks of oils from this equipment resulting in contamination of soils and groundwater.

The magnitude of these potential impacts on geological receptors, prior to mitigation, is considered to be **Slight.**

The Impact classification is negative, slight significance, short term, direct and low probability.

The magnitude of these potential impacts on hydrogeological receptors, prior to mitigation, is considered to be **Imperceptible.**

The Impact classification is negative, imperceptible significance, short term, direct and low probability.

9.6.2 Potential Indirect Impacts

A small amount of granular material may be required to maintain access tracks during operation which will place intermittent minor demand on local quarries.

The magnitude of these potential impacts, prior to mitigation, is considered to be **Imperceptible.**

The Impact classification is negative, imperceptible significance, short term, direct and low probability.

9.7 Decommissioning Phase Impacts

The potential impacts associated with decommissioning will be similar to those associated with construction but of reduced magnitude.

During decommissioning, it may be possible to reverse or at least reduce some of the impacts caused during construction by rehabilitating construction areas such as turbine bases, hardstanding areas and site compound. This will be done by covering with topsoil to encourage vegetation growth and reduce run-off and sedimentation.

Other impacts such as possible soil compaction and contamination by fuel leaks will remain but will be of reduced magnitude.

Grid connection cables will be left in the ground, therefore no potential impacts during decommissioning stage are likely to occur.

9.8 Cumulative Impacts

Relevant projects in proximity to the proposed development are listed in Table 9.11.

Table 9-11: Potential Cumulative Impacts from other Developments

Development	Distance to Proposed Development (km)	Status	Interface	Potential Cumulative Impact
M20 Limerick to Cork	4km	Pre-Planning	Potential for requirement of imported aggregate for construction	Imperceptible
100 hectare Solar Farm, Lands at Ballyroe and Dromin, Ballyhea	2km	Planning Granted	Potential for requirement of imported aggregate for construction of access tracks	Imperceptible

Development	Distance to Proposed Development (km)	Status	Interface	Potential Cumulative Impact
68 hectare solar farm.	0.1km	Planning Granted	Potential for requirement of imported aggregate for construction of access tracks	Imperceptible
Rathnacally Wind Farm	2km	Constructed	Potential for requirement of imported aggregate for maintenance of access tracks	Imperceptible
Boolard Wind Farm	2km	Constructed	Potential for requirement of imported aggregate for maintenance of access tracks	Imperceptible
Replant lands, Emlagh, Co. Clare	72km	Proposed	Regionally and Locally Important Bedrock Aquifers Groundwater wells and springs	Imperceptible

The surrounding area predominantly comprises agricultural farmland and forestry with no other significant industries identified. Furthermore, given the resultant **Slight** impact of the proposed development, it is considered there will be no significant cumulative impacts from other industrial developments on the geology of the site.

Where plant and machinery is required for drainage works the potential exists for minor accidental leaks or spills of fuel/oil.

The proposed M20 Limerick to Cork and the consented Annagh and Ballyhea Solar Farms are located within the Mitchelstown GWB and potentially discharge to the Blackwater River (Cork/Waterford) SAC. The construction of the M20 and solar farms will lead to disturbance of soils and subsoils on site and there is potential for groundwater pollution. The Magnitude of the impact from these works is considered to be Small Adverse in nature. The importance of the hydrogeology receptor is 'Extremely High'. Should these works take place at the same time as the construction phase of the proposed project, they will result in a **Significant** cumulative impact.

The Rathnacally and Boolard Wind Farms are located within the Rathnacally GWB and are constructed. There is the potential for groundwater pollution from run-off impacting on the groundwater receptor. The Magnitude of the impact from these works is considered to be Negligible in nature. The importance of the groundwater receptors is considered to be 'Low'. The significance of this potential cumulative impact is considered to be **Imperceptible**.

A replanting site has been identified at Emlagh, Co. Clare. These lands have been assessed cumulatively in this EIAR. Given the distance to the proposed replant lands at Emlagh, Co. Clare (approximately 70km) to the proposed development it is considered there are no cumulative impacts from these works on the existing geological or hydrogeological environments. The EPA risk result for the Kilrush GWB is in '*Review'.* Irrespective of if the GWB was '*At Risk*' or '*Not At Risk*', the proposed development will not cause deterioration of the GWB and will not in any way prevent the GWB from continuing to meet its 'Good' status.

There may be indirect cumulative impacts in terms of demands placed on local quarries for aggregate and concrete required during the construction phase of the development.

9.9 Summary of Potential Impacts

A summary of unmitigated potential impacts on land, soils and geology attributes from the proposed development is provided in Table 9.12 with the potential impacts on hydrogeological attributes provided in Table 9.13.

Table 9-12: Summary of Potential Unmitigated Impact Significance on Land, Soils and Geology Attributes

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Construction Phase					
Earthworks	Removal of overburden material, open excavations and subsequent exposure underlying overburden and bedrock leading to increased erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils.	Local organic soils and Glacial Till deposits. Bedrock	Medium	Small Adverse	Slight
Felling Activities	Exposure of underlying overburden leading to increased erosion. Felling machinery resulting soil compaction of soft deposits and an increase in surface water runoff resulting in increased erosion of exposed soils.	Local organic soils and Glacial Till deposits.	Medium	Small Adverse	Slight
Construction of Internal Site Access Tracks, Hardstands and Temporary Compound	Open excavations, increased runoff causing erosion of underlying overburden. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill	Local organic soils and Glacial Till deposits. Local quarries	Medium	Small Adverse	Slight
Construction of Turbine and Substation Foundations	Open excavations, increased runoff causing erosion of underlying overburden and bedrock. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill and concrete products	Local organic soils and Glacial Till deposits. Bedrock Local quarries	Medium	Small Adverse	Slight
Construction of the Grid Connection and Internal Cabling	Removal of overburden material and exposure underlying Clay to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill and concrete products Disposal of surplus excavated material to licenced facility	Local organic soils and Glacial Till deposits. Local quarries Licenced Waste Facilities	Medium	Small Adverse	Slight

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Construction Phase					
Earthworks associated with the construction of the proposed development and associated infrastructure	Slope Failure	Local organic soils and Glacial Till deposits. Bedrock	Medium	Small Adverse	Slight
Accommodation works along TDR	Removal of overburden material and exposure of underlying Clay and Bedrock to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill Disposal of surplus excavated material to licenced facility	Local organic soils and Glacial Till deposits. Bedrock Local quarries Licenced Waste Facilities	Medium	Small Adverse	Not Significant
Operational Phase					
Maintenance Traffic, Substation	Release of hydrocarbons or fuel spill	Local organic soils and Glacial Till deposits. Bedrock	Medium	Small Adverse	Slight
Maintenance of access tracks	Importation of engineering fill	Local quarries	Medium	Small Adverse	Slight
Cumulative Impacts					
Construction of the proposed development and associated infrastructure	Cumulative impacts on local quarries from extraction of fill for proposed development	Local quarries	Medium	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Construction Phase					
Solar Farm, Ballyhea	Importation of engineering fill from local quarries	Local quarries	Medium	Negligible	Imperceptible
Solar Farm, Annagh	Importation of engineering fill from local quarries	Local quarries	Medium	Negligible	Imperceptible
Boolard Wind Farm	Importation of engineering fill from local quarries for maintenance purposes	Local quarries	Medium	Negligible	Imperceptible
Rathnacally Wind farm	Importation of engineering fill from local quarries for maintenance purposes	Local quarries	Medium	Negligible	Imperceptible
M20 Limerick – Cork Motorway	Importation of engineering fill from local quarries for maintenance purposes	Local quarries	Medium	Negligible	Imperceptible

Table 9-13: Summary of Potential Unmitigated Impact Significance on Hydrogeology

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Construction Phase					
Earthworks	Potential for groundwater pollution from the removal of overburden deposits Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer Potential for contamination to groundwater from spills/leakages during construction phase earthworks Reduction in groundwater levels from dewatering of excavation as required during the construction phase	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs	Extremely High	Small Adverse	Significant

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Construction Phase					
		Blackwater River (Cork/Waterford) SAC			
Felling Activities	Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer Potential for contamination to groundwater from spills/leakages from felling machinery	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs Blackwater River (Cork/Waterford) SAC	Extremely High	Small Adverse	Significant
Construction of Internal Site Access Tracks, Hardstands and Temporary Compound	Potential for groundwater pollution from the removal of overburden deposits Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer Potential for contamination to groundwater from spills/leakages during construction phase earthworks. Potential for ground water pollution from the use of cement-based compounds during the construction phase	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs Blackwater River (Cork/Waterford) SAC	Extremely High	Small Adverse	Significant
Construction of Turbine and Substation Foundations	Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer Potential for contamination to groundwater from spills/leakages during construction phase earthworks	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and	Extremely High	Small Adverse	Significant

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Construction Phase					
	Potential for ground water pollution from the use of cement-based compounds during the construction phase Reduction in groundwater levels from dewatering of excavation as required during the construction phase	Springs Blackwater River (Cork/Waterford) SAC			
Construction of the Grid Connection and Internal Cabling	Potential for groundwater pollution from the removal of overburden deposits. Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer Potential for contamination to groundwater from spills/leakages during construction phase earthworks.	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs Blackwater River (Cork/Waterford) SAC	Extremely High	Small Adverse	Significant
Earthworks associated with the construction of the proposed development and associated infrastructure	Slope Failure	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs Blackwater River (Cork/Waterford) SAC	Extremely High	Small Adverse	Significant
Accommodation works along TDR	Potential for groundwater pollution from the removal of overburden deposits. Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and	Extremely High	Small Adverse	Significant

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Construction Phase					
	Potential for contamination to groundwater from spills/leakages during construction phase earthworks.	Springs Blackwater River (Cork/Waterford) SAC			
Operational Phase					
Operational traffic, refuelling of vehicles, substation	Some operational traffic will be necessary for maintenance plus normal operational traffic which could result in minor accidental leaks or spills of fuel/oil.	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs Blackwater River (Cork/Waterford) SAC	Extremely High	Negligible	Imperceptible
Cumulative Impacts					
Solar Farm, Ballyhea	Potential for ground water pollution from the removal of overburden deposits.	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs Blackwater River (Cork/Waterford) SAC	Extremely High	Small Adverse	Significant

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Construction Phase					
Charleville Solar Farm, Fiddane	Potential for ground water pollution from the removal of overburden deposits.	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs Blackwater River (Cork/Waterford) SAC	Extremely High	Small Adverse	Significant
Boolard Wind Farm	Potential for groundwater pollution from runoff from wind farm.	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs	Low	Negligible	Imperceptible
Rathnacally Wind farm	Potential for groundwater pollution from runoff from wind farm.	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs	Low	Negligible	Imperceptible
M20 Limerick – Cork Motorway	Potential for ground water pollution from the removal of overburden deposits.	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and	Extremely High	Small Adverse	Significant

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Construction Phase					
		Springs Blackwater River (Cork/Waterford) SAC			
Replant Lands, Emlagh	Potential for silt infiltration to groundwater as a results of increased surface water runoff during drainage works. Potential for contamination to groundwater from spills/leakages during drainage works.	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs	Low	Negligible	Imperceptible

9.10 Mitigation Measures

The following section outlines appropriate mitigation measures by design and best practice to avoid or reduce the potential impact of the proposed development. Further details are provided in Section 4.3.5 of the CEMP which is contained in Appendix 3.1 of Volume 3 of this EIAR.

9.10.1 Mitigation by Design and Best Practice

With regard to the proposed development, detailed design and best practice will be implemented as follows:

- The proposed development has been designed in accordance with best practice and the relevant standards.
- The works have been designed and checked by geotechnical and civil engineers, suitably qualified and experienced in excavation and earthworks design and construction methodologies.
- Any excavation and construction related works will be subject to a design risk assessment at detailed design stage to evaluate risk levels for the construction, operation and maintenance of the works. Identified impacts will be minimised by the application of principles of avoidance, prevention and protection. Information on residual impacts will be recorded and relayed to appropriate parties
- A detailed method statement for each element of the works will be prepared by the Contractor prior to any element of the work being carried out.
- Given that the works comprises a significant proportion of excavation and earthworks, suitably qualified and experienced geotechnical personnel will be required on site to supervise the works.
- The Contract will require programming of the works such that earthworks are not scheduled during severe weather conditions. Where such weather is forecast, suitable measures will be taken to secure the works. The Project Manager is the person responsible for determining when works are to be stopped due to weather.

9.10.2 Construction Phase

The following sections outline appropriate mitigation measures to avoid or reduce the potential impact of the proposed development.

The primary mitigation measure employed has been the design of the wind farm in terms of locating the turbines, access roads, material storage areas and other site infrastructure within an area of commercial forestry where the soils are extensively worked and drained. . Extensive work has already been undertaken at the preliminary design stage to apply risk avoidance by design which included:

- Excavation of trial pits to establish overburden and bedrock characteristics.
- Shear vane testing to establish characteristic strengths where soft ground deposits were identified.
- Relocation and micro-siting of turbines, hardstandings and access roads based on the site assessments and geotechnical assessments in order to reduce ground risk associated with the proposed development.

9.10.2.1 Construction Environmental Management Plan

A Construction Environmental Management Plan (CEMP) has been prepared for the proposed development and is included in Volume 3, Appendix 3.1. The CEMP defines the work practices, environmental management procedures and management responsibilities relating to the construction phase of the proposed development.

The CEMP describes how the contractor for the main construction works will implement a site Environmental Management System (EMS) to meet the specified contractual, regulatory and statutory requirements including the requirements identified as part of the environmental impact assessment process.

The CEMP will be updated prior to construction to take account of any amendments arising during the consenting process and relevant conditions attached to the planning permission and will be implemented for the duration of the construction phase of the project. The CEMP will be a live document and will be reviewed and updated as required.

Reference to relevant sections of the CEMP with respect to the mitigation of potential impacts to Land, Soils and Geology from the proposed development are outlined below.

9.10.2.2 Earthworks

The development will be constructed in a phased manner to reduce the potential impacts of the development on the Land, Soils and Geology at the site. Phased construction reduces the amount of open, exposed excavations at any one time. Given that the works comprises a significant proportion of excavation and earthworks, suitably qualified and experienced geotechnical personnel will be required on site to supervise the works.

Details of the proposed methodology and mitigation measures is summarised below and are also outlined in Section 4.3.5 of the CEMP in Appendix 3.1 of Volume 3.

One of the primary mitigation measures employed at the preliminary design stage is the minimisation of volumes of excavated overburden deposits to be exported off site. Excavated overburden will be retained on-site and reused as far as possible.

This will include:

- Use of suitable site won material (glacial till/bedrock) as general fill in the construction of access tracks, hardstands and in reinstatement around turbine foundations.
- Surplus overburden will be re-used on site in the form of landscaping.

Surplus overburden deposits excavated during the course of the works will be temporarily stored in a level area adjacent to the construction phase excavations prior to reuse.

Some temporary stockpiles (not exceeding 2m in height) of material will be necessary adjacent to the excavation areas prior to reinstatement, however no long-term stockpiles of material will remain after construction and no surplus/waste soil or rock will be removed from the proposed development site. Temporary stockpiles will be sealed and shaped to prevent water ingress, and silt fences will be installed around these areas to filter any runoff.

To mitigate against the compaction of soil at the site, prior to the commencement of any earthworks, the work corridor will be pegged, and machinery will stay within this corridor so that peatland/soils outside the work area are not damaged. Excavations will then be carried out from access tracks, where possible, as they are constructed in order to reduce the compaction of soft ground.

To mitigate against erosion of the exposed soil or rock, all excavations will be constructed and backfilled as quickly as possible. Excavations will stop during or prior to heavy rainfall events. To mitigate against possible contamination of the exposed soils and bedrock, refuelling of machinery and plant will only occur at designated refuelling areas.

Soil excavated from trenches along the proposed grid connection route will be taken to a licenced facility for disposal or recycling where required. If feasible, the upper layers of tarmac and asphalt will be excavated separately to the lower engineered fill layers. The lower engineered fill layers will be reused, subject to suitability testing. The tarmac/asphalt layers will be taken to a licenced facility for disposal or recycling.

All temporary cuts/excavations will be carried out such that they are stable or adequately supported. Gravel fill will be used to provide additional support to temporary cuts/excavations where appropriate. Unstable temporary cuts/excavations will not be left unsupported. Where appropriate and necessary, temporary cuts and excavations will be protected against the ingress of water or erosion.

Interceptor drains will be installed prior to any construction works commencing. Temporary settlement ponds and silt management measures will be installed to mitigate against sediment run-off as required. Further assessment of potential impacts to surface water discharges during the construction phase are discussed in Chapter 10 of this EIAR.

9.10.2.3 Control of Sediment Laden Runoff

The potential impact from silt laden surface water runoff from increased erosion of exposed overburden deposits will be assessed at site-specific locations particularly at new and existing drainage locations and where earthworks and tree felling are proposed.

Details of the proposed Surface Water Management System and mitigation measures is summarised below and are also outlined in Section 4.3.5 of the CEMP in Appendix 3.1 of Volume 3.

Best practices will be employed in the prevention of silt laden run-off from entering watercourses as discussed below.

To minimise the impact to surface water quality, existing drainage will be maintained outside the immediate site area, and where appropriate additional site drainage and settlement ponds will be installed as required prior to construction activities. Silt fencing will be installed in new and existing drainage and monitoring of water quality undertaken during the construction phase.

Final drainage will be constructed following the completion of these activities with silt fencing maintained until such time as a vegetation cover has become established. Chapter 10 of this EIAR discusses surface water issues in more detail.

9.10.2.4 Measures for Spills

Details of oil spill protection measures adjacent to sensitive receptors and emergency spill response procedures are outlined in Section 4.3.5 of the CEMP which is contained in Appendix 3.1 of Volume 3.

Storage tanks, used to store fuel for the various items of machinery, will be self-contained and double-walled. Refuelling of construction vehicles will be carried out from these tanks or from delivery vehicles at designated refuelling areas. Specific mitigation measures relating to the management of hydrocarbons are as follows:

- Fuels, lubricants and hydraulic fluids for equipment used on the construction site will be carefully handled to avoid spillage.
- Any spillage of fuels, lubricants or hydraulic oils will be immediately contained, and the contaminated soil removed from the site and properly disposed of;
- Waste oils and hydraulic fluids will be collected in leak-proof containers and removed from the site for disposal or re-cycling; and
- Appropriate spill control equipment, such as oil soakage pads, will be kept within the construction area and in each item of plant to deal with any accidental spillage.

9.10.2.5 Slope Stability

With regard to slope stability issues, detailed design and construction phase best practice will be implemented as follows:

- The works will be designed and supervised by a suitably qualified and experienced geotechnical engineer or engineering geologist, and hydrologist or drainage engineer.
- Drainage infrastructure will be put in place in advance of turbine excavations. Drains will divert surface water and groundwater away from excavations into the proposed surface drainage network. Uncontrolled, direct and concentrated discharges of water onto the ground surface will be avoided.
- Loading or stockpiling on the surface of soft ground will be avoided. Loading or stockpiling on other deposits will not be undertaken without first establishing the adequacy of the ground to support loads by an appropriately qualified geotechnical engineer experienced in construction within upland conditions.
- A detailed assessment of the stability of conditions at proposed infrastructure locations will be undertaken by a suitably qualified and experienced geotechnical engineer prior to the commencement of all excavations to ensure these activities do not result in or contribute to slope failure.
- Excavations which could have the potential to undermine the up-slope component of an existing slope will be sufficiently supported to resist lateral slippage and careful attention will be given to the existing drainage.
- Where possible, earthworks will not be commenced when heavy or sustained rainfall is forecast. A rainfall gauge will be installed on site to provide a record of rainfall intensity. An inspection of site stability and drainage by the Geotechnical Engineer will be carried out on site when a daily rainfall of over 25mm is recorded on site, works will only recommence after heavy rain with the prior approval of the Geotechnical Engineer following their inspection.

Further details will be given in the CEMP included in Appendix 3.1 of Volume 3 of this EIAR.

Prior to the progression of the project to detailed design and to inform the detailed design of the proposed development, the developer will also ensure that:

- Additional and more extensive ground investigation works are undertaken, and these should be tailored to the engineering requirements of the project.
- The scheme will be developed to full detailed design prior to construction to minimise the risk of ground instability.
- Adequate time is afforded to any designers or contractors involved in the execution of the additional ground investigation works; detailed design and construction works.

9.10.2.6 Groundwater

To mitigate against the increased vulnerability of the underlying aquifer to groundwater pollution, all excavations will be constructed and backfilled as quickly as possible. Excavations will stop during or prior to heavy rainfall events. To mitigate against possible contamination of the underlying groundwater, refuelling of machinery and plant will only occur at designated refuelling areas. Details of mitigation measures related to spills and fuel storage are outlined above.

The dewatering of the foundation excavations is not expected to cause interference with domestic wells in the area, due to large offset distances to known wells, relatively shallow depths of excavation and temporary short-term nature of dewatering, if required. To monitor groundwater during the construction phase groundwater monitoring wells will be installed between areas of deeper excavations and sensitive groundwater receptors. The wells will be used to monitor groundwater levels and quality to assess any potential impacts during the construction works.

The GSI database is however not complete; it is probable that there are other wells in addition to those in the GSI databases, but are generally associated with houses, the offset to which from the turbines is a minimum of 690m at a financially involved landowner's dwelling. Given the limited depth of the excavations during the construction phase and the distance to sensitive groundwater receptors the potential risk posed to groundwater supply wells is considered to be **Imperceptible** following the implementation of mitigation measures discussed above.

If, however, in the unlikely event of a previously unknown domestic well being impacted by the proposed development, an alternative supply will be provided – either a connection to mains water or a replacement well will be drilled.

The GSI holds records of groundwater wells in the vicinity of the proposed grid connection route. However, trenches are shallow (1.2 m deep) and will only be open for a short period.

Depending on the ground conditions, presence of services, traffic management required, weather conditions, etc., the rate of installation of cable ducting would vary between 50m and 100m per day. Dewatering is therefore unlikely to be required and no impacts on wells is envisaged.

Grid connection and internal cable trenches could provide preferential pathways for groundwater and contaminant movement.

Trenches will be excavated during dry periods where possible in short sections and left open for minimal periods, to avoid acting as a conduit for surface water flows. To further mitigate the risk of cable trenches becoming preferential pathways, clay plugs (or other low permeability material) will be installed at intervals along the trench to stop/inhibit water movement.

9.10.3 Mitigation Measures during Operation

It is not envisaged that the operation of the proposed development will result in significant impacts on the geological and hydrogeological regimes within the study area, as there will be no further disturbance of overburden post-construction.

The main potential residual impact during the operation phase would be the risk to groundwater from contamination from spills. Storage tanks, used to store fuel for the various items of machinery, will be self-contained and double-walled. Refuelling of maintenance vehicles will be carried out from these tanks or from delivery vehicles at designated refuelling areas. Specific mitigation measures relating to the management of hydrocarbons are as follows:

- Fuels, lubricants and hydraulic fluids for equipment used on the site will be carefully handled to avoid spillage.
- Any spillage of fuels, lubricants or hydraulic oils will be immediately contained, and the contaminated soil removed from the site and properly disposed of;
- Waste oils and hydraulic fluids will be collected in leak-proof containers and removed from the site for disposal or re-cycling; and
- Appropriate spill control equipment, such as oil soakage pads, will be kept within the refuelling areas and in each item of plant to deal with any accidental spillage.

Due to the reduced magnitude of the impacts, no additional mitigation measures are required for the maintenance and operation of the wind farm, over and above those incorporated into the design of the substation transformer, which will be bunded to protect soils against accidental leakages of oils and battery fluids.

9.10.4 Mitigation Measures during Decommissioning

Mitigation measures applied during decommissioning activities will be similar to those applied during construction where relevant.

Some of the impacts associated with reinstatement of the site (excavation of turbine bases, access tracks etc.) will be avoided by leaving these in place where possible. The Irish Wind Energy Association (IWEA) (11) states that when decommissioning a wind farm "*the concrete bases could be removed, but it may be better to leave them under the ground, as this causes less disturbance*". It is proposed to leave the access tracks in-situ at the decommissioning stage. IWEA also state that "*it may be best*" to leave site tracks in-situ depending on the size and geography of the development.

It is considered that leaving the turbine foundations, access tracks and hardstanding areas in-situ will cause less environmental damage than removing and recycling them. It is proposed to retain these elements of the construction and cover with overburden material to allow for re-vegetation of the development site.

Removal of this infrastructure would result in considerable disruption to the local environment in terms of increased sedimentation, erosion, dust, noise, traffic and an increased possibility of contamination of the local water table. However, if removal is deemed to be required by the respective local authority all infrastructure will be removed with mitigation measures similar to those during construction being employed.

Mitigation measures to avoid contamination by accidental fuel leakage and compaction of soil by on-site plant will be implemented as per the construction phase mitigation measures outlined above.

9.10.5 Cumulative

During the construction of the proposed development there will be the requirement for the importation of engineered fill from source quarries and potential for disposal of materials unsuitable for reuse at licensed facilities. Should these coincide with demand for imported aggregate for maintenance works at the existing wind farms at Boolard and Rathnacally there would be a cumulative impact in terms of demands placed on local quarries for aggregate.

Given the wind farms at Boolard and Rathnacally are already constructed and operational it is considered unlikely significant quantities of aggregate would be required. As such, it is considered there will be an **Imperceptible** cumulative impact during the construction phase of the development.

Prior to mitigation, there was potential for cumulative hydrogeological impacts between the proposed development and the proposed M20 Limerick to Cork and the consented Charleville (Fiddane) and Ballyhea Solar Farms. The mitigation measures described above will ensure the proposed development will have an **Imperceptible** cumulative impact during the construction phase of the development.

No significant, direct negative cumulative effects are envisaged during the operation or decommissioning phase of the proposed development. As such no mitigation measures are required with respect to potential cumulative impacts of the proposed development.

9.11 Residual Effects

It can be observed from Table 9.14 and Table 9.15, that, following the implementation of mitigation measures, the residual impact significance to the receiving environment would be imperceptible during the construction period and imperceptible during the operation of the proposed development. Mitigation measures will be monitored throughout the construction and operational phases.

The proposed development is not expected to contribute to any significant, negative cumulative effects of other existing or known developments in the vicinity. Slight residual cumulative effects from the excavation of fill material from local quarries and disposal of material deemed unsuitable for reuse are considered to result from the proposed development by placing demand on existing quarries and available void space at licensed facilities during the construction phase of the development.

Table 9-14: Residual Impact Significance for Sensitive Geological Attributes

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction Phase							
Earthworks	Removal of overburden material, open excavations and subsequent exposure underlying overburden and bedrock leading to increased erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils.	Local peat deposits, organic soils and Glacial Till deposits. Bedrock	Medium	Moderate	Moderate	Negligible	Imperceptible
Felling Activities	Exposure of underlying overburden leading to increased erosion. Felling machinery resulting soil compaction of soft deposits and an increase in surface water runoff resulting in increased erosion of exposed soils.	Local peat deposits, organic soils and Glacial Till deposits.	Medium	Moderate	Slight	Negligible	Imperceptible
Construction of Internal Site Access Tracks, Hardstands and Temporary Compound	Open excavations, increased runoff causing erosion of underlying overburden and bedrock. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill	Local peat deposits, organic soils and Glacial Till deposits. Bedrock Local quarries	Medium	Moderate	Slight	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction Phase							
Construction of Turbine and Substation Foundations	Open excavations, increased runoff causing erosion of underlying overburden and bedrock. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill and concrete products	Local peat deposits, organic soils and Glacial Till deposits. Bedrock Local quarries	Medium	Moderate	Slight	Negligible	Imperceptible
Construction of the Grid Connection and Internal Cabling	Removal of overburden material and exposure underlying Clay and Bedrock to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill and concrete products Disposal of surplus excavated material to licenced facility	Local peat deposits, organic soils and Glacial Till deposits. Bedrock Local quarries Licenced Waste Facilities	Medium	Small Adverse	Slight	Small Adverse	Imperceptible
Earthworks associated with the construction of the proposed development and associated infrastructure	Slope Failure	Local peat deposits, organic soils and Glacial Till deposits.	Medium	Small Adverse	Slight	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction Phase							
Accommodation works along TDR	Removal of overburden material and exposure underlying Clay and Bedrock to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill Disposal of surplus excavated material to licenced facility	Local peat deposits, organic soils and Glacial Till deposits. Bedrock Local quarries Licenced Waste Facilities	Medium	Small Adverse	Not Significant	Negligible	Imperceptible
Operational Phase							
Maintenance Traffic	Release of hydrocarbons or fuel spill	Local peat deposits, organic soils and Glacial Till deposits. Bedrock.	Medium	Small Adverse	Slight	Negligible	Imperceptible
Maintenance of access tracks	Importation of engineering fill	Local quarries	Medium	Small Adverse	Slight	Small Adverse	Imperceptible
Cumulative Impacts							
Construction of the proposed development and associated infrastructure	Cumulative impacts on local quarries from extraction of fill for proposed development	Local quarries	Medium	Negligible	Imperceptible	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction Phase							
Consented Solar Farm, Ballyhea	Importation of engineering fill from local quarries	Local quarries	Medium	Negligible	Imperceptible	Negligible	Imperceptible
Consented Charleville Solar Farm, Fiddane	Importation of engineering fill from local quarries	Local quarries	Medium	Negligible	Imperceptible	Negligible	Imperceptible
Boolard Wind Farm	Importation of engineering fill from local quarries	Local quarries	Medium	Negligible	Imperceptible	Negligible	Imperceptible
Rathnacally Wind Farm	Importation of engineering fill from local quarries	Local quarries	Medium	Negligible	Imperceptible	Negligible	Imperceptible
M20 Limerick – Cork Motorway	Importation of engineering fill from local quarries	Local quarries	Medium	Negligible	Imperceptible	Negligible	Imperceptible

Table 9-15: Residual Impact Significance for Sensitive Hydrogeological Attributes

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction Phase							
Earthworks	Potential for groundwater pollution from the removal of overburden deposits. Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during construction phase earthworks. Reduction in groundwater levels from dewatering of excavation as required during the construction phase.	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs Blackwater River (Cork/Waterford) SAC	Extremely High	Small Adverse	Significant	Negligible	Imperceptible
Felling Activities	Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer Potential for contamination to groundwater from spills/leakages from felling machinery.	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs Blackwater River (Cork/Waterford) SAC	Extremely High	Small Adverse	Significant	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction Phase							
Construction of Internal Site Access Tracks, Hardstands and Temporary Compound	Potential for groundwater pollution from the removal of overburden deposits. Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during construction phase earthworks. Potential for groundwater pollution from the use of cement-based compounds during the construction phase.	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs Blackwater River (Cork/Waterford) SAC	Extremely High	Small Adverse	Significant	Negligible	Imperceptible
Construction of Turbine and Substation Foundations	Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during construction phase earthworks.	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs Blackwater River (Cork/Waterford) SAC	Extremely High	Small Adverse	Significant	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction Phase							
	Potential for groundwater pollution from the use of cement-based compounds during the construction phase.						
Construction of the Grid Connection and Internal Cabling	Potential for groundwater pollution from the removal of overburden deposits. Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during construction phase earthworks.	Locally and Regionally Important Bedrock Aquifers Groundwater Wells and Springs Blackwater River (Cork/Waterford) SAC	Extremely High	Small Adverse	Significant	Negligible	Imperceptible
Earthworks associated with the construction of the proposed development and associated infrastructure	Slope Failure	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs Blackwater River (Cork/Waterford) SAC	Extremely High	Small Adverse	Significant	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction Phase							
Accommodation works along TDR	Potential for groundwater pollution from the removal of overburden deposits. Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during construction phase earthworks.	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs Blackwater River (Cork/Waterford) SAC	Extremely High	Small Adverse	Significant	Negligible	Imperceptible
Operational Phase							
Operational traffic, refuelling of vehicles, substation	Some operational traffic will be necessary for maintenance plus normal operational traffic which could result in minor accidental leaks or spills of fuel/oil.	Locally and Regionally Important Bedrock Aquifers Groundwater Wells and Springs Blackwater River (Cork/Waterford) SAC	Extremely High	Negligible	Imperceptible	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction Phase							
Cumulative Impacts							
Solar Farm, Ballyhea	Potential for ground water pollution from the removal of overburden deposits.	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs Blackwater River (Cork/Waterford) SAC	Extremely High	Small Adverse	Significant	Negligible	Imperceptible
Charleville Solar Farm, Fiddane	Potential for ground water pollution from the removal of overburden deposits.	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs Blackwater River (Cork/Waterford) SAC	Extremely High	Small Adverse	Significant	Negligible	Imperceptible
Boolard Wind Farm	Potential for groundwater pollution from runoff from wind farm.	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs	Low	Negligible	Imperceptible	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction Phase							
Rathnacally Wind farm	Potential for groundwater pollution from runoff from wind farm.	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs	Low	Negligible	Imperceptible	Negligible	Imperceptible
M20 Limerick – Cork Motorway	Potential for ground water pollution from the removal of overburden deposits.	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs Blackwater River (Cork/Waterford) SAC	Extremely High	Small Adverse	Significant	Negligible	Imperceptible
Replant Lands, Emlagh	Potential for silt infiltration to groundwater as a results of increased surface water runoff during drainage works. Potential for contamination to groundwater from spills/leakages during drainage works.	Regionally and Locally Important Bedrock Aquifers Groundwater Wells and Springs	Low	Negligible	Imperceptible	Negligible	Imperceptible

9.12 Conclusions

A study has been undertaken which has identified the principal impacts of the construction of the proposed project in relation to the Land, Soils and Geology.

The assessment of Land, Soils & Geology has established a baseline for the receiving environment for the impact assessment. Potential impacts were considered for the construction, operational and decommissioning phases of the proposed development as well as potential residual and cumulative impacts. Mitigation measures have been proposed where relevant.

The proposed development site is not a sensitive site in terms of land, soils & geology.

A desk study was undertaken prior to site assessment works which included a site walkover and intrusive ground investigation at the proposed turbine, infrastructure, and access road locations.

The subsoils across the proposed project comprise predominantly glacial till derived from sandstone bedrock and alluvium. This was confirmed during the site assessment works. Bedrock is indicated from the GSI mapping to comprise of a mixture of muddy and crinoidal limestones.

No slope stability issues were identified for the proposed project. Slopes are generally gentle; however, no peat was recorded on the site. As such, no peat stability issues are likely.

A number of potential impacts have been identified associated with the excavation of soil and rock on the main wind farm site as listed in Table 9.12 and Table 9.13. The significance of these potential impacts on geological receptors is assessed as being of moderate/slight significance prior to mitigation. The significance of these potential impacts on hydrological receptors is assessed as being of significant significance prior to mitigation.

With mitigation measures, outlined in Section 9.10, put in place during the construction, operational and decommissioning stages the proposed project will have imperceptible significance on the Land, Soils & Geology.

The proposed project is not expected to contribute to any significant, negative cumulative effects with other existing or proposed developments in the vicinity once mitigation measures are implemented.

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ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR) FOR THE PROPOSED ANNAGH WIND FARM, CO. CORK

VOLUME 2 – MAIN EIAR

CHAPTER 10 – HYDROOGY AND WATER QUALITY

Prepared for: EMPower

EMPower

Date: November 2021

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10. HYDROLOGY AND WATER QUALITY

10.1 Introduction and Chapter Structure

This chapter has been prepared to describe the existing hydrology and water quality of the local environment in the study area and to examine the aspects of the hydrology and water quality of the local environment that could be affected by the activities associated with the proposed development.

Section 10.3 of this chapter provides details on the existing hydrology and water quality in the receiving environment including receiving waterbodies and catchments. It includes information on any historical flooding within the site, internal site drainage, turbine delivery route and cable route watercourse crossings.

Following an analysis of the receiving environment potential impacts during construction, operation and decommission phases are identified and discussed in Sections 10.4. Flood risk assessment is set out in Section 10.5.

Section 10.6 describes the proposed drainage layout and Section 10.7 identifies the proposed mitigation measures for impacts identified in Section 10.4 and 10.5.

10.1.1 Study Area

The Study area regarding hydrology and water quality comprises of catchments, sub-catchments, sub-basins and associated hydrological features therein relevant to the proposed project.

The elements of the project include the wind farm site, grid connection route (GCR) and turbine delivery route (TDR). Detailed descriptions of the project and its subject components is presented in Chapter 3 of this EIAR.

10.1.2 Objectives

The objectives of the assessment are as follows:

- Produce a baseline study of the existing hydrological environment within the project study area.
- Identify the potential impact of the project on flood risk as a result of the project.
- Identify likely impacts of the proposed development on surface water during construction, operational and decommissioning stages of the project.
- Consider potential cumulative impacts arising from other developments within the study area.
- Identify mitigation measures to avoid, reduce significant negative impacts and assess residual impacts on the existing environment, post-mitigation.

10.2 Methodology

The following sources of information were considered in this assessment:

- The design layout of the wind farm site, grid connection, replant lands and TDR.
- Legislation and guidance, as described in Section 10.2.1 below.
- A desk-based assessment of the surface water hydrology and water quality in the catchments relevant to the proposed project, including an assessment of the watercourses which will be intercepted by the layout of the wind farm site, grid connection and TDR, and those which will receive surface water runoff from same.
- A field assessment of the existing hydrological environment, to both verify desk-based assessment and record all significant hydrological features.
- Cork County Development Plan 2014.
- Draft Cork County Development Plan 2022.

10.2.1 Legislation and Guidance

10.2.1.1 Relevant EU Directives and Legislation

Water Framework Directive (WFD)

The WFD established a new system for the protection and improvement of water quality and water dependent ecosystems. It has influenced the management of water resources and has affected conservation, fisheries, flood defence, planning and development. It has endeavoured to ensure that all impacts on water resources – physical modification, diffuse and point source pollution, abstraction or otherwise – are controlled.

The overriding purpose of the WFD is to achieve at least 'good status' in all European waters and to ensure that no further deterioration occurs in these waters. European waters are classified as ground waters, rivers, lakes, transitional and coastal waters. The WFD has been implemented in Ireland by dividing the island of Ireland into eight river basin districts. These districts are natural geographical areas that occur in the landscape. River Basin Management Plan 2018-2021 has been prepared by Department of Housing, Planning and Local Government. The plan sets out the actions that Ireland will take to improve water quality and achieve 'good' ecological status in water bodies (rivers, lakes, estuaries and coastal waters) by 2027.

The WFD has been transposed into Irish law following:

- European Communities (Water Policy) Regulations, 2003 (S.I. No. 722 of 2003)[1]
- European Union (Water Policy) Regulations 2014 (S.I. No. 350 of 2014)
- European Communities Environmental Objectives (Surface Waters) Regulations, 2009 (S.I. No. 272 of 2009)[2]
- European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010)[3]

[1] Amended in 2005 (S.I. No 413/2005), 2008 (S.I. No. 219/2008) and 2010 (S.I. No. 93/2010)

[2] Amended in 2012 (S.I. No. 327/2012) and 2015 (S.I. No. 386/2015)

[3] Amended in 2011 (S.I. No 389/2011), 2012 (S.I. No 149/2012) and 2016 (S.I. No 366/2016)

- European Communities (Good Agricultural Practice for Protection of Waters) Regulations 2010 (S.I. No. 610 of 2010)[4]
- European Communities (Technical Specifications for the Chemical Analysis and Monitoring of Water Status) Regulations, 2011 (S.I. No. 489 of 2011).

Water Framework Directive Waterbody Status

The European Communities Environmental Objectives (Surface Water) Regulations 2009 (S.I. No. 272 of 2009)[5] (the Surface Water Regulations), give effect to the criteria and standards used for classifying surface waters in accordance with the WFD. There are five categories of surface water status: 'High', 'Good', 'Moderate', 'Poor' and 'Bad'.

A surface waterbody must achieve both good ecological status and good chemical status before it can be considered to be of good status. The chemical status of a waterbody is assessed based on certain chemical pollutants. The ecological status is assessed based on Biotic Indices or Quality (Q) Values. The EPA Biological Quality Rating System for Rivers (Q Rating System) and its relationship with the WFD Status is shown in Table 10-1:

Table 10-1: EPA Q Rating System and WFD Status

Q-Value	Water Quality	WFD Status
Q5	Pristine	High
Q4-5	Very good	
Q4	Good	Good
Q3-4	Slightly Polluted	Moderate
Q3	Moderately Polluted	Poor
Q2-3	Moderate to Poor	
Q2	Poor	Bad
Q1-2	Poor to bad	
Q1	Bad	

In accordance with the Surface Water Regulations, water classified as 'High' or 'Good' must not be allowed to deteriorate. Water classified as less than good must be restored. The Surface Water Regulations also state that, for the purpose of classification, a status of less than good is assigned in the case of a waterbody where the environmental objectives are not met.

[4] Amended in 2014 (S.I. 31/2014)

[5] Amended in 2012 (S.I. No. 327 of 2012) and 2015 (S.I. No. 386 of 2015)

10.2.1.2 Relevant Guidance

The following guidelines were considered in the development of this chapter to identify relevant objectives relating to hydrology and surface water quality:

- Guidelines on the information to be contained in Environmental Impact Assessment Reports - Draft, Environmental Protection Agency (EPA), August 2017;
- Advice Notes for Preparing Environmental Impact Statements, EPA, Draft September 2015;
- Wind Energy Development Planning Guidelines - Department of the Environment, Heritage and Local Government, 2006;
- Best Practice Guidelines for the Irish Wind Energy Industry - Irish Wind Energy Association, 2012;
- Good Practice Note on Strategic Environmental Assessment for the Energy Sector, Environmental Protection Agency (EPA), March 2021.

In addition to considering the documents above, the methodology for the baseline assessment has been devised with due consideration of the following guidelines and research:

- The Planning System and Flood Risk Management - Guidelines for Planning Authorities - Department of Environment, Heritage and Local Government (DoEHLG) and the Office of Public Works (OPW), November 2009
- Environmental good practice on site guide (fourth edition) (C741) - Construction Industry Research and Information Association (CIRIA), January 2015)
- River Basin Management Plan 2018-2021 (Department of Housing, Planning and Local Government)
- Best Practice Guide BPGCS005 Oil Storage Guidelines (Enterprise Ireland)
- Guidelines for the Crossing of Watercourses During the Construction of National Road Schemes (National Roads Authority, 2005)
- Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters (Inland Fisheries Ireland, 2016)
- Good Practice During Wind Farm Construction (Scottish Natural Heritage 2010)
- The SuDS Manual (C753) - Construction Industry Research and Information Association (CIRIA), 2015
- Control of water pollution from linear construction projects (C648) - Construction Industry Research and Information Association (CIRIA), December 2001
- Control of water pollution from construction sites. Guidance for Consultants and Contractors (C532) - Construction Industry Research and Information Association (CIRIA), December 2001
- PUB C571 Sustainable construction procurement - a guide to delivering environmentally responsible projects - Construction Industry Research and Information Association (CIRIA), January 2001
- UK Guidance for Pollution Prevention (GPP):
    - GPP2: Above ground oil storage tanks (Natural Resources Wales (NRW), Northern Ireland Environment Agency (NIEA), the Scottish Environment Protection Agency (SEPA), Energy Institute, Oil Care Campaign, January 2018)
    - GPP4: Treatment and disposal of wastewater where there is no connection to the public foul sewer (NRW, NIEA, SEPA, November 2017)
    - GPP5: Works and maintenance in or near water (NRW, NIEA, SEPA, January 2017)

- GPP8: Safe storage and disposal of used oil (NRW, NIEA, SEPA, July 2017)
- GPP21: Pollution Incident Response Plans (NRW, NIEA, SEPA, July 2017)
- GPP22: Dealing with Spills (NRW, NIEA, SEPA, October 2018)
- GPP26: Safe storage of Drums and intermediate Bulk Containers (IBCs), (NRW, NIEA, SEPA, February 2019)

- Coillte (2009): Forrest Operations & Water Protection Guidelines.

10.2.2 Desk Study

The desk top study involved an examination of the hydrological aspects and water quality aspects of the following sources of information:

- Current and historic Ordnance Survey Ireland mapping, and ortho-photography.
- Science and Stories about Integrated Catchment Management (https://www.catchments.ie/)
- OPW Indicative Flood Maps (https://www.floodinfo.ie/map/floodplans/).
- Geological Survey of Ireland (www.gsi.ie).
- Review of the WFD online mapping and data (available at http://www.wfdireland.ie/maps.html).
- Review of the EPA online mapping (https://gis.epa.ie/EPAMaps/).
- History of flooding and status of drainage in the vicinity of the proposed development (available at http://www.floodinfo.ie/map/floodmaps/).
- Environmental Protection Agency (http://www.epa.ie/hydronet).
- Met Eireann Meteorological Database (available at https://www.met.ie).

10.2.3 Field Assessment

Site walkover surveys were carried out in August and November 2020 and April 2021 to establish the pattern of existing drainage and to record existing hydrology features of the wind farm site. During the site visits, the GPS coordinates, descriptions, and photographs of hydrological features were recorded. The site walkover involved an initial review of available information gathered in the desk study followed by a site visit.

During a site visit carried out in April 2021 the crossing structures associated with the GCR were inspected. Findings from this assessment were used to propose the most suitable methodology for cable route crossings with respect to watercourses.

10.2.4 Evaluation Criteria

The sensitivity of receptors, the quality of impacts the magnitude of impacts, the probability and duration of the impacts are assessed for the proposed development to determine significance of the impacts.

Thresholds for assessing the sensitivity of the environment and magnitude of impacts are outlined in Figure 10-1.

Quality of effect of an impact is either ‘Positive, ‘Neutral’ or ‘Negative’ and may have influence in the ‘Momentary’, ‘Short’, ‘Medium’ or ‘Long-term’. The probability of impact can be either ‘Likely’ or ‘Unlikely’.

10.2.4.1 Sensitivity of Receptors

The sensitivity of a hydrological receptor or attribute is based on its ability to absorb development without perceptible change. The hydrological environment of the site is considered to be of high sensitivity for receptors draining to the Ardglass Stream and Oakfront Stream which form part of the Blackwater River (Cork/Waterford) SAC just downstream of the site.

The receptors which are part of Special Areas of Conservation (SAC) are rated as 'high' sensitivity.[6]

10.2.4.2 Assessment of Magnitude and Significance of Hydrological Impact

The assessment of the magnitude of an impact incorporates the timing, scale, size, duration and probability of the impact in accordance with the EPA Guidelines. The significance criteria for hydrological impacts are defined as set out in Table 10-2:

Table 10-2: Assessment of Magnitude of Hydrological Impact[7]

Impact Significance	Criteria
Imperceptible	An impact capable of measurement but without noticeable consequences
Not significant	An impact which causes noticeable changes in the character of environment but without significant consequences
Slight impacts	An impact which causes noticeable changes in the character of the environment without affecting its sensitivities
Moderate impacts	An impact that alters the character of the environment in a manner that is consistent with existing and emerging trends
Significant impacts	An impact which, by its character, magnitude, duration or intensity significantly alters a sensitive aspect of the environment
Very Significant	An impact which, by its character, magnitude, duration or intensity significantly alters most of a sensitive aspect of the environment
Profound impacts	An impact which obliterates sensitive characteristics

The diagram below, Figure 10-1, shows how comparison of the character of the predicted impact to the sensitivity of the receiving environment can determine the significance of the impact. Sensitivity of the receiving environment can be 'high', 'medium', 'low' or 'negligible'. Description of impact is defined by its character, magnitude, duration, probability and consequences. The magnitude of impact can be 'high', 'medium', 'low' or 'negligible'.

[6] A handbook on environmental impact assessment Guidance for Competent Authorities, Consultees and others involved in the Environmental Impact Assessment Process in Scotland, Scottish Natural Heritage.

[7] Guidelines on the information to be contained in environmental impact assessment report Draft August 2017.

The conventional source-pathway-target model will be applied to assess potential impacts on downstream environmental receptors resulting from the development:

- Description of Potential Impact Source: The activity that brings about the potential impact or the potential source of pollution.
- Pathway / Mechanism: The route by which a potential source of impact can transfer or migrate to.
- Receptor: A receptor is a part of the natural environment that could potentially be impacted.
- Pre-mitigation Impact: Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impact before mitigation is put in place.

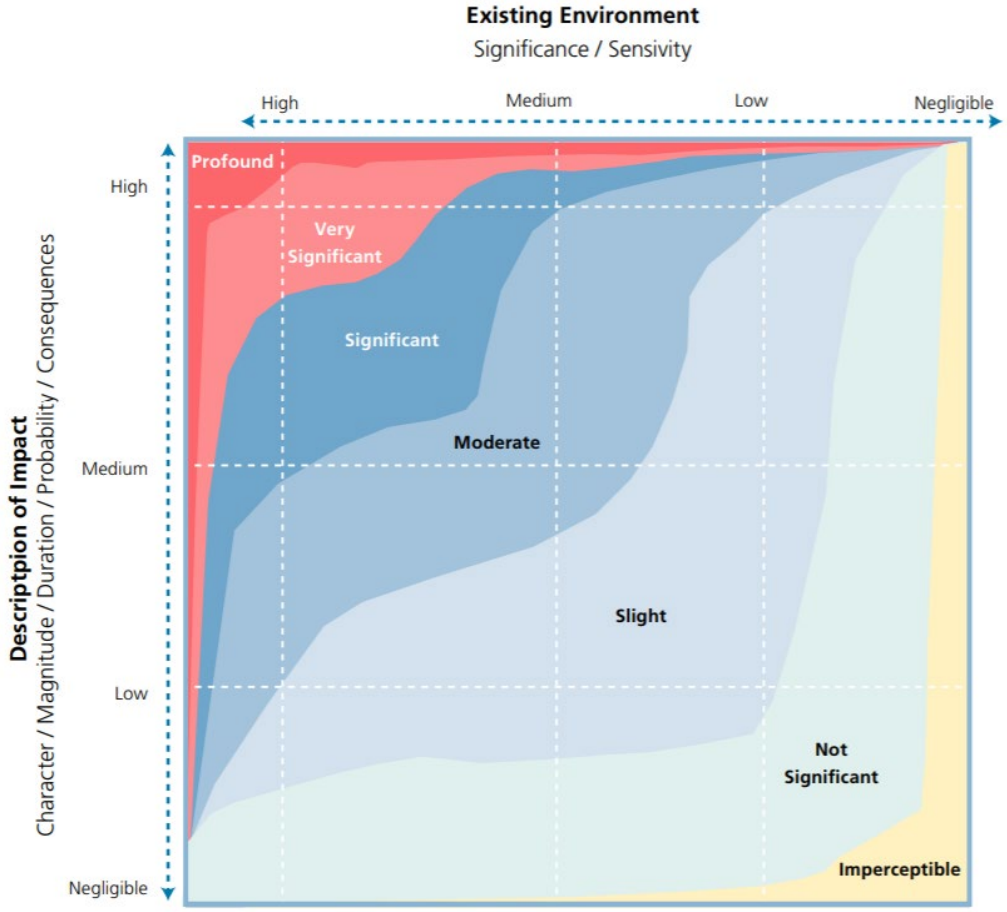

Figure 10-1: Classifications of the Significance of Impacts[8]

[8] Environmental Protection Agency: Guidelines on the information to be contained in environmental impact assessment report Draft August 2017

10.2.5 Consultation

This chapter considers the consultation responses as referred to in Chapter 5, with particular regard to concerns relating to hydrology and water quality. The scope of this appraisal has been informed by consultation with the Inland Fisheries Ireland (IFI). Full details of the responses received are set out in Appendix 5.1.

IFI were contacted on the 22/06/2021 to request feedback on the stream crossing methodology for the proposed Annagh Wind Farm Project. No response has been received to date.

10.3 Existing Environment

10.3.1 Description of Catchments

The wind farm site is situated within Awbeg (Buttevant)_SC_010 sub-catchment as defined by the WFD and shown on Figure 10-2. This sub-catchment is part of the Blackwater Munster (ID 18) catchment.

The wind farm site is situated within two sub-basins. These waterbodies are:

- Awbeg (Buttevant)-West_020 (IE_SW_18A090400) and
- Oakfront_010 (IE_SW_18O120820).

Turbines T1, T3 and T6 are within Oakfront_010 sub-basin.
Turbines T2, T4 and T5 are within Awbeg (Buttevant) West_020 sub-basin.

The cable route between the proposed on-site substation and existing 110kV substation at Charleville is within 2 sub-basins. These are:

- Oakfront_010 (IE_SW_18O120820),
- Awbeg (Buttevant)_010 (IE_SW_18A050550).

The main hydrology features within the wind farm site are the Ardglass Stream and Oakfront Stream which drain into the River Awbeg (Buttevant) West approximately 1.3km downstream of the site as shown on Figure 10-2. This river is part of the Blackwater River (Cork/Waterford) SAC.

The wind farm site is drained by forestry and field drains which ultimately join the Oakfront Stream. The existing site drainage is detailed in Section 10.3.4.

The average annual rainfall in period 1981-2010 in the area of the wind farm site is 1,002 mm. M5-60 at development location is 16.9 mm according to the Met Éireann rainfall data. This is the predicted rainfall depth in a sixty minute storm with an annual exceedance probability of 20%.

There are no lakes or reservoirs within the wind farm site study area.

According to the PFRA maps the wind farm site is prone to fluvial flooding as shown on Figure 10-3. This is detailed in Section 10.5.

Path: R:\Map Production\2020\P2359\Workspace\EIAR\P2359_GIS_Fig10-2_WaterbodyCatchmentMap_A3.mxd

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
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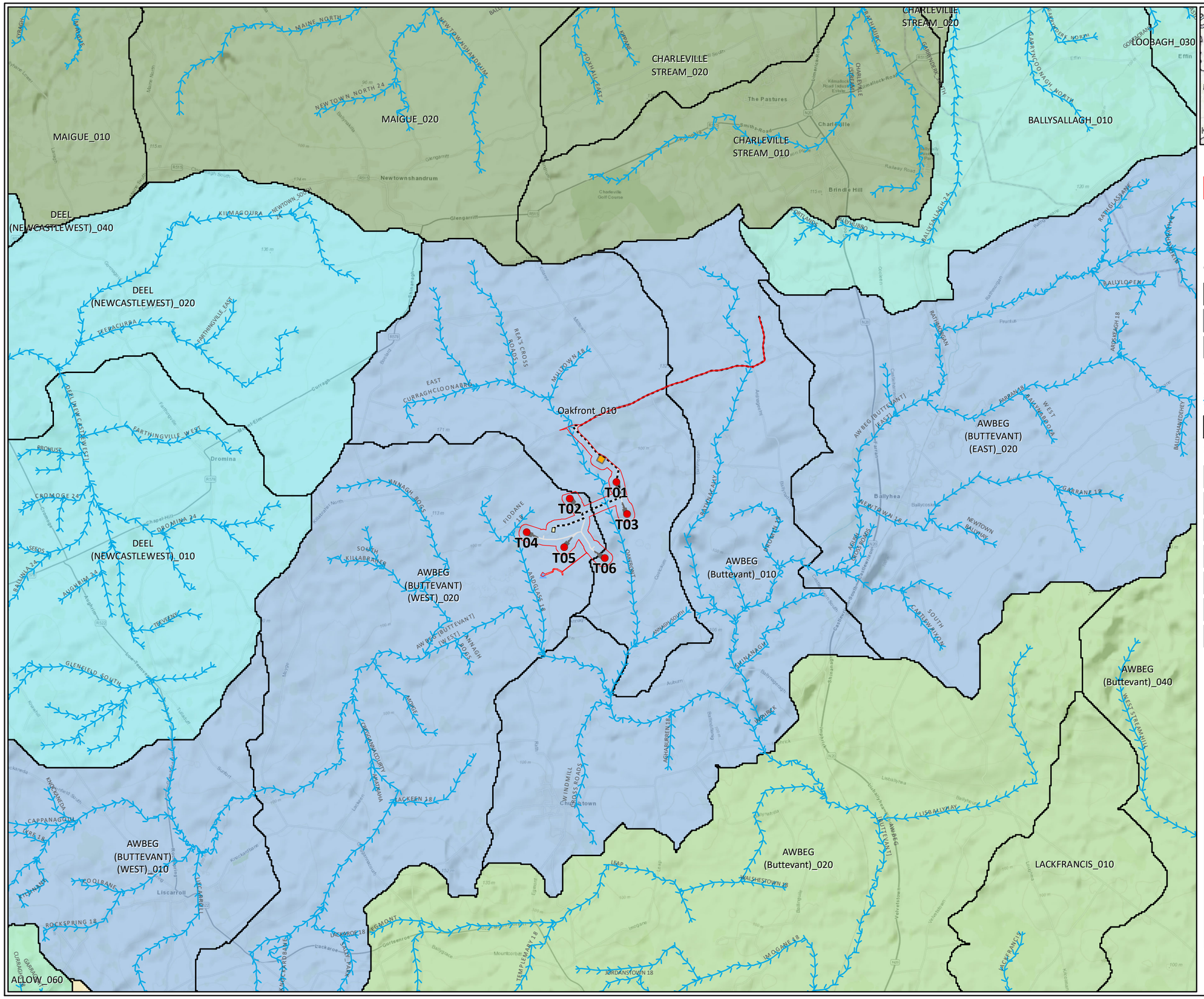

Legend

- Site Boundary
- Turbine Layout
- Met Mast
- Underground Cable Route
- Substation
- Construction Compound
- Turbine Hardstanding
- Site Internal Roads
- Rivers
- WFD River Sub Basins

WFD Sub Catchments

- Awbeg[Buttevant]_SC_010
- Awbeg[Buttevant]_SC_020
- Blackwater[Munster]_SC_060
- Dalua_SC_020
- Deel[Newcastlewest]_SC_010
- Maigue_SC_010
- Maigue_SC_020

TITLE:	Waterbody Catchments		
PROJECT:	Annagh Wind Farm, Co. Cork		
FIGURE NO:	10.2		
CLIENT:	EMPower		
SCALE:	1:50000	**REVISION:**	0
DATE:	15/10/2021	**PAGE SIZE:**	A3

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Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
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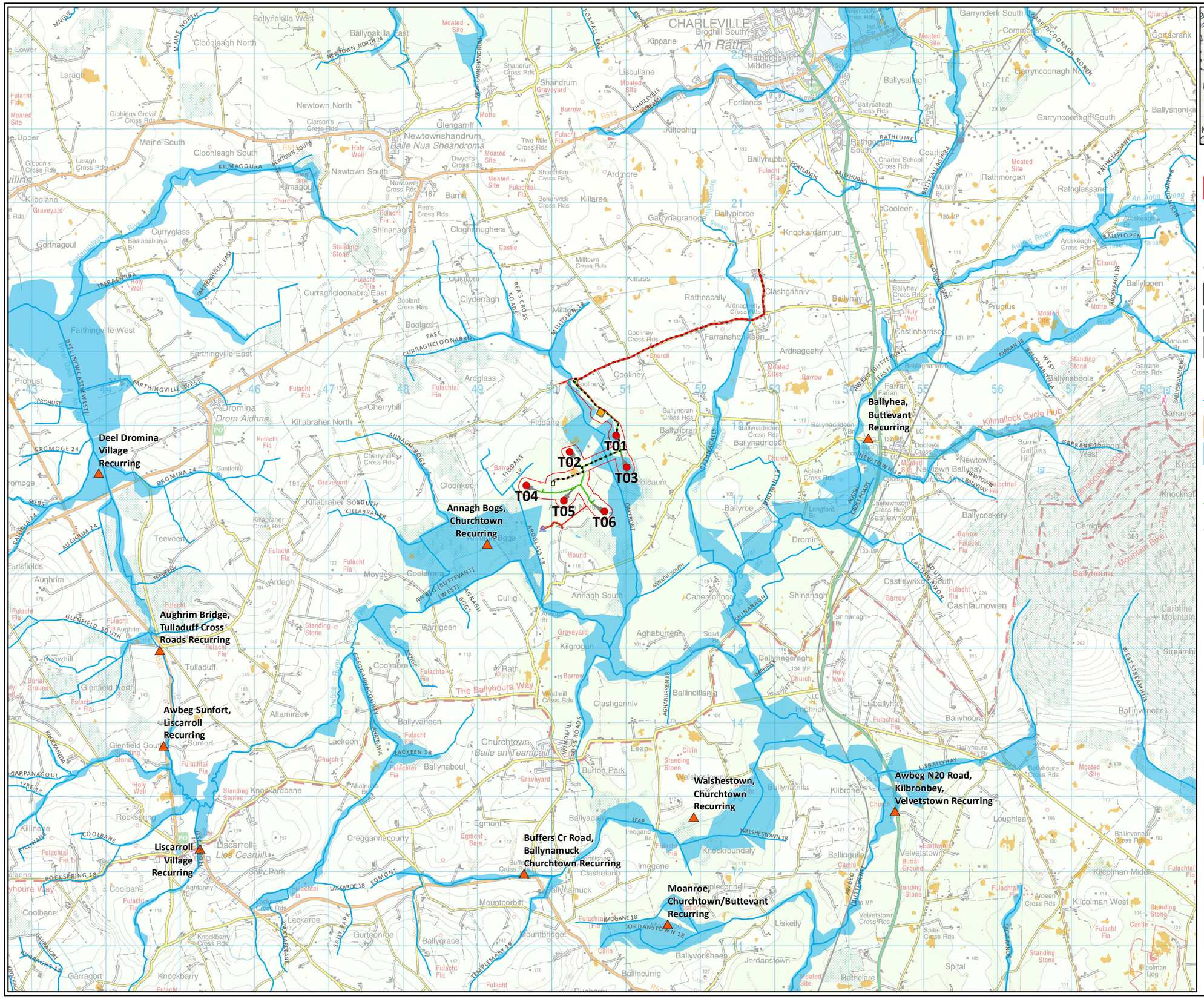

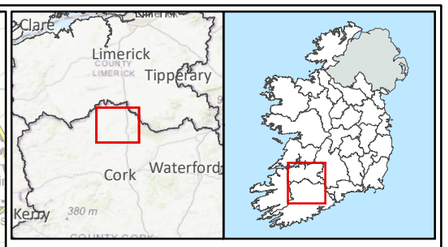

Legend

- Site Boundary
- Turbine Layout
- Met Mast
- Underground Cable Route
- Substation
- Construction Compound
- Turbine Hardstanding
- OPW Historic Flood Points
- Rivers
- PFRA 1% AEP Pluvial Flood Extent
- PFRA 1% AEP Fluvial Flood Extent

Roads

- New
- Upgrade

TITLE:	OPW Flood Data		
PROJECT:	Annagh Wind Farm, Co. Cork		
FIGURE NO:	10.3		
CLIENT:	EMPower		
SCALE:	1:50000	**REVISION:**	0
DATE:	15/10/2021	**PAGE SIZE:**	A3

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10.3.2 Surface Water Quality

WFD water quality status and river waterbody risk associated with the wind farm site and grid connection are provided in Table 10-3. It can be observed that the river status and waterbody risk of the Awbeg (Buttevant)-West_020 are classified as 'Poor and 'At Risk' for period 2012-2018.

River status and waterbody risk for Oakfront_010 is 'Unassigned' and 'Review'. In water bodies where data confidence was very low status was set as 'unassigned', even where the conservation status was considered to be favourable.

For waterbodies associated with grid connection, river status is 'Unassigned' and 'Good' as shown on table below. Waterbody risk of the sub-basins associated with GCR is under 'Review'. Waterbodies classified as 'Review" are reviewed by the EPA.

Table 10-3: WFD River Status and River Waterbody Risk[9]

Waterbody	Waterbody	River Status	Waterbody Risk
Wind Farm			
Awbeg (Buttevant)-West_020	IE_SW_18A090400	Poor	At Risk
Oakfront_010	IE_SW_18O120820	Unassigned	Review
Grid Connection			
Oakfront_010	IE_SW_18O120820	Unassigned	Review
Awbeg (Buttevant)_010	IE_SW_18A050550	Good	Review

Regardless of their current quality, surface waters should be treated the same in terms of the level of protection and mitigation measures employed (there should be no negative change in status). Strict mitigation measures in relation to maintaining a high quality of surface water runoff from the development will ensure that the status of surface waterbodies in the vicinity of the site will be maintained regardless of their existing status.

The EPA scheme of Biotic Indices or Quality (Q) Values was developed to determine the status of organic pollution in Irish rivers by assessing the occurrence of macro-invertebrate taxa of varying sensitivity to pollution. Biological Water Quality data was examined as part of this assessment.

Biological water quality ratings Q5, Q5-4 and Q4 relate to 'Unpolluted' status, Q3-4 relates to 'Slightly polluted', Q3 and Q2-3 relate to 'Moderately polluted' and Q2, Q1-2, Q1 relate to 'Seriously polluted' watercourse.[10]

The location of the EPA's Q-value stations for the receiving waters are shown on Figure 10-4.

[9] https://gis.epa.ie/EPAMaps/.

[10] http://www.epa.ie/QValue/webusers/

The most recent Biological Water Quality Ratings at stations downstream of the wind farm site and grid connection are outlined in Table 10-4. There are no water quality stations along Ardglass and Oakfront Streams. The closest stations are located at the River Awbeg (Buttevant) West and at the Rathnacally Stream as shown on Figure 10-4.

Q ratings range between Q2-3 to Q4.

Table 10-4: EPA Biological Water Quality Ratings

Station ID	Station Name	2018
RS18A090400	Annagh Bridge	2-3
RS18A090500	Garrigagulla Bridge	3-4
RS18A080280	Bridge upstream of confluence with Awbeg (Buttevant) East	4

Water sampling has been carried out as part of Aquatic assessment. Results of the laboratory analysis are provided in Appendix C of the Aquatic Report.

Site surveys of the watercourses within the vicinity of the proposed wind farm project were conducted in September 2020. Survey effort focused on both instream and riparian habitats approx. 150m upstream and 150m downstream of each sampling point (see Figure 2.1 of the Aquatic report).

Given the unsuitability of some sites (lack of flow, lack of water or too deep), biological water quality was assessed at a total of n=7 aquatic survey sites through Q-sampling during September 2020 (Figure 2.3 of the Aquatic report). Macro-invertebrate samples were converted to Q-ratings as per Toner et al. (2005).

All samples failed to meet the good status (≥Q4) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC).

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Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
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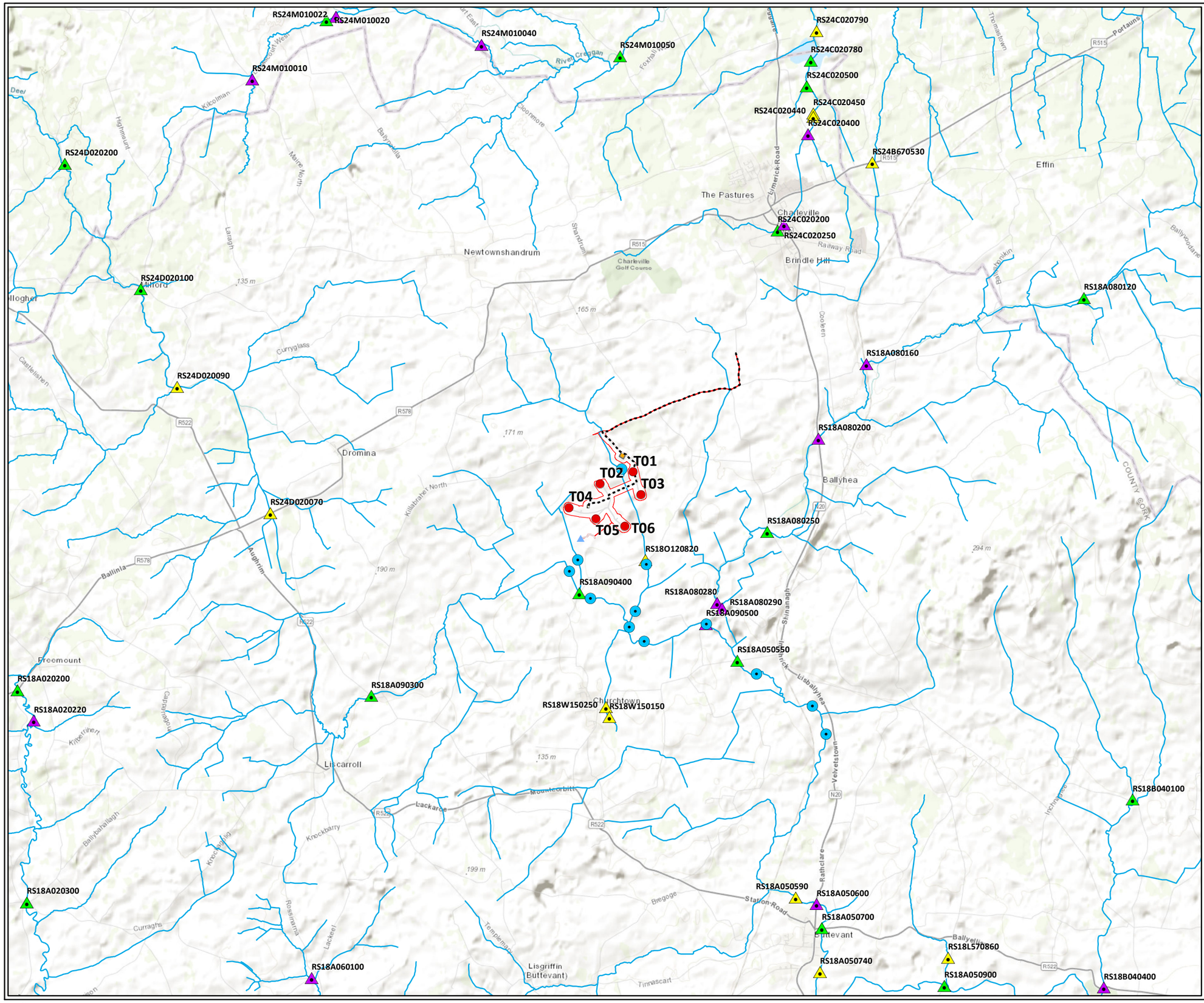

Legend

- Turbine Layout
- Met Mast
- Underground Cable Route
- Site Internal Roads
- Substation
- Construction Compound
- Site Boundary
- Rivers
- Sampling Locations

EPA Biological Q Stations

- Investigative
- Operational
- Pre WFD

TITLE:	Water Quality Monitoring Locations		
PROJECT:	Annagh Wind Farm, Co. Cork		
FIGURE NO:	10.4		
CLIENT:	EMPower		
SCALE:	1:70000	**REVISION:**	0
DATE:	15/10/2021	**PAGE SIZE:**	A3

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N W E S
0 0.5 1 2 Kilometers

10.3.3 Existing Drainage

A site walkover survey took place in August and November 2020, and April 2021 to examine the existing drainage and hydrological features at the site. The visit involved a walkover of the site by Fehily Timoney & Company (FT) by Author (please refer to Table 1.1), recording existing drainage features and noting their locations. The locations of the hydrological features observed during the site visit are shown in Figure 10-5.

Photographs of existing hydrological features are included in Appendix 10.1.

Drains and Existing Road Drainage

Turbines are situated within 2 sub-basins. Greenfield runoff from the eastern and central part of the site is drained into the Oakfront Stream by forestry drains and field drains. The western part of the site drains into the Ardglass Stream.

A sketch showing existing drains within the wind farm site is provided in Appendix 10.1.

During the site visits 3 no. crossing points over existing open drains were identified. The location and general description of these crossings are provided in Table 10-5:

Table 10-5: Existing Hydrology Features

Feature ID	ITM_X	ITM_Y	General description
WF-HF1	618568.3	550289.6	Stone culvert
WF-HF14	616806.9	550468.6	N/A
WF-HF16	550184.4	618653.7	Arch bridge

Hydrology features WF-HF1 is a stone culvert. During multiple site visits it was noted to be completely dry. This culvert is located at the proposed site entrance at the northern part of the site. Photos of the culvert are provided in Appendix 10.1.

Hydrology feature WF-HF14 is located at the southern part of the site. This structure couldn't be properly inspected due to heavy vegetation. The proposed wind farm layout will not utilize this crossing point. The closest turbine is T6, located 222m northeast of this crossing points.

Hydrology feature WF-HF14 is over a drain which is a part of Awbeg Drainage District.

Hydrology features WF-HF16 is a single arch bridge over the Oakfront Stream located at the north western part of the site. The bridge details and photos are provided in Appendix 10.1

The proposed wind farm site is part of benefiting lands of the Awbeg Arterial Drainage District which is maintained on a 6-year rolling basis by Cork County Council.

Path: R:\Map Production\2020\P2359\Workspace\EIAR\P2359_GIS_Fig10-5_HydrologicalFeaturesOverview_A3.mxd

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
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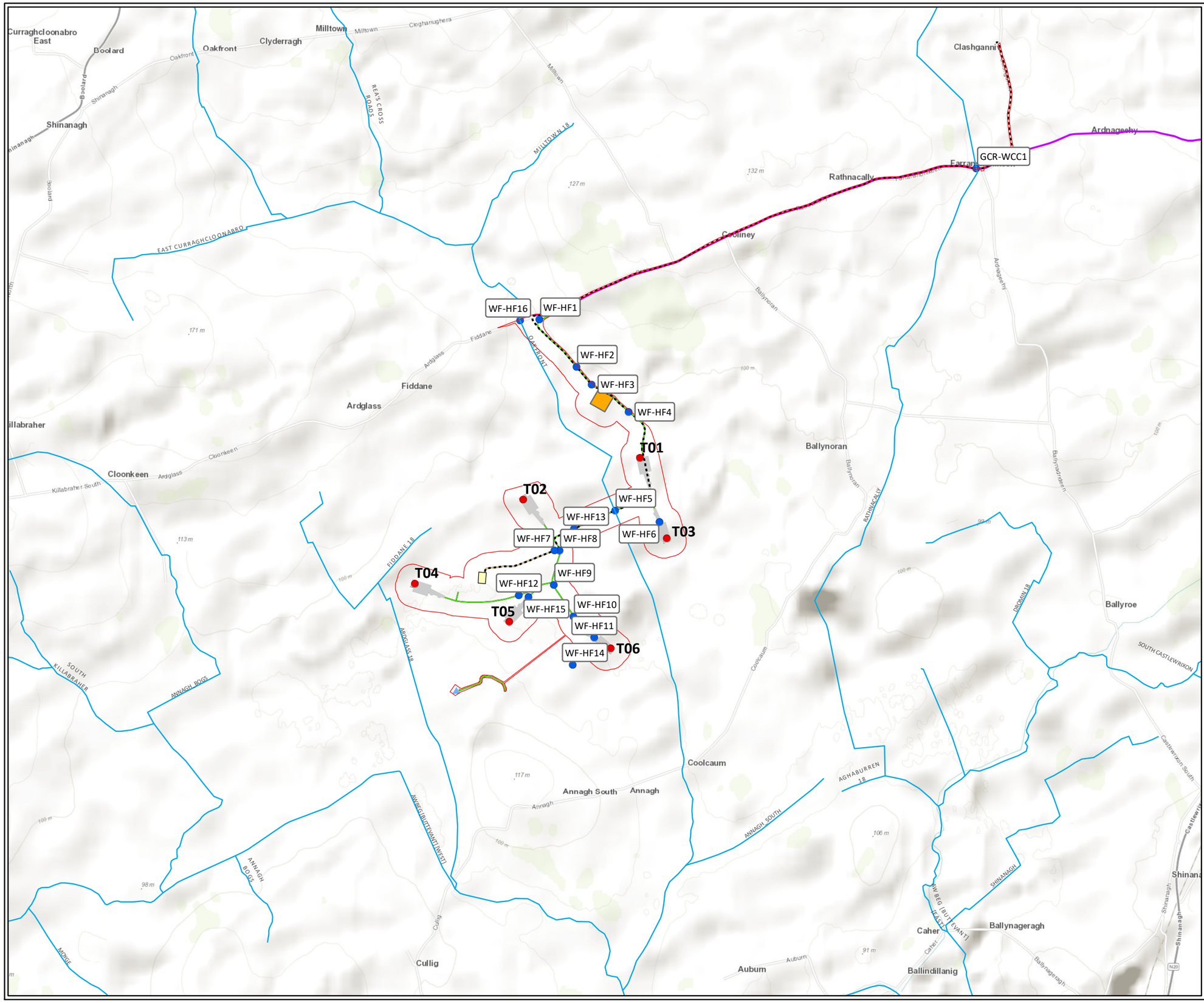

Legend

- Site Boundary
- Turbine Layout
- Met Mast
- Hydrological Features
- Rivers
- Turbine Delivery Route
- Underground Cable Route
- Substation
- Construction Compound
- Turbine Hardstanding

Roads

- New
- Upgrade

N W E S

0 0.5 1 2 Kilometers

TITLE: Hydrological Features Overview			
PROJECT: Annagh Wind Farm, Co. Cork			
FIGURE NO:	10.5		
CLIENT:	EMPower		
SCALE:	1:20000	**REVISION:**	0
DATE:	15/10/2021	**PAGE SIZE:**	A3

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10.3.4 Grid Connection Route

The grid connection route from the proposed 110kV substation at Charleville to the proposed on-site substation crosses only Rathacally Stream at one location as show on Figure 10-5. The proposed method of crossing over the stream is Horizontal directional drilling (HDD) as provided in Table 10-6.

The cable ducting will be installed so as not to impact the existing culvert. Installation of grid cable will not have an effect on flow conveyance area of the crossing structures.

The proposed grid connection trench will be up to 930 mm wide and up to 1200 mm deep. Where the proposed grid connection cable route encounters minor culverts, the ducts will be installed above or below the culvert depending on its depth in accordance with construction methodologies outlined in the CEMP (Appendix 3.1).

Table 10-6: Grid Connection Crossing Methods

Feature ID	ITM_X	ITM_Y	Crossing Method
GCR - WCC1	552633.8	619465.4	HDD

Crossings for the cables in the internal access roads serving the proposed development, have been assessed as part of the proposed drainage for the wind farm development. These crossing locations are discussed in Section 10.6.

The potential impacts on hydrology and water quality of the GCR are discussed in Section 10.4.3.

10.3.5 Turbine Delivery Route

Turbine components will be delivered along the route as described in Section 3 of this report.

TDR route is situated within 2 catchments, Shannon Estuary South and Blackwater (Munster).

Minor works (furniture removal, vegetation trimming, tree removing, placement of temporary load bearing surface) will be required along the TDR to accommodate the delivery. No works are proposed to existing watercourse crossings.

Vegetation on the northern side of the Rathnacally Stream will be cut and the wall of the nearby pump enclosure will be lowered by 0.5m. Pump enclosure is approximately 25m from the watercourse.

The potential impacts on hydrology and water quality of the TDR are discussed in Section 10.4.4.

10.4 Potential Impacts

The potential impacts on the hydrological regime are assessed in the following sections for the activities associated with each phase (construction, operation, maintenance, and decommissioning) of the proposed project. The conventional source-pathway-target model was applied to assess potential impacts on downstream environment receptors as a result of the proposed project. Where potential impacts are identified, the classification of the impact is evaluated as per criteria outlined in Section 10.2.4.

The potential significance of the impacts in relation to the various phases of the project and cumulative impact with neighbouring developments are outlined below.

10.4.1 Do Nothing Impact

If the proposed project does not proceed, the main wind farm site will remain as predominantly forestry for the foreseeable future.

10.4.2 Potential Impacts During Construction

10.4.2.1 Unmitigated Increase in Surface Runoff

During the construction period, the project has the potential to lead to impacts on hydrology and water quality unless appropriate mitigations are applied. Inappropriate construction practices could also have the potential to impact the water quality and WFD status of existing waterbodies listed in Table 10-3 which includes the Blackwater River (Cork/Waterford) SAC.

Tree felling, new access tracks and upgrade of existing agricultural tracks, turbine hardstanding areas, the on-site substation, have the potential to contribute to the increase in runoff, as indicated in Table 10-7.

The estimated peak runoff from the wind farm site was calculated using Rational Equation (RE) for pre and post-construction scenario for 1 in 100 year storm event. The difference between these two values is equal to an increase in the peak runoff resulted from changes in the surface at hardstanding area around turbines, access roads and substation.

The peak runoff for RE equation occurs for a storm event with duration equal to the time of concentration. Time of concentration at the location of the main wind farm site is estimated to be 60min. Therefore, the estimated increase in runoff was calculated for a 1-in-100 year storm event with a duration of 60 minutes. This equates to rainfall with an intensity of 36.3 mm/h. The intensity is increased by 20% for Mid-range future climate change scenario (MRFS).

The estimated increase in the peak runoff due to the construction of the wind farm is provided in Table 10-7.

The overall estimated increase in the unmitigated peak runoff due to the wind farm is 0.174 m^3/s (or 0.20 %) for a 1 in 100 years storm event.

Pathway / Mechanism: Site drainage network.

Receptor: Waterbodies down gradient from the wind farm site.

Pre-mitigation Impact: Direct, Negative, Reversible, Likely.

The significance of the effect of the increase in runoff is "**Not Significant**" on receiving waters because estimated increases in the peak runoff is low compared to the flows of receiving waters and not being concentrated at one point.

This is without taking account of mitigation measures that will be put in place to slow runoff down within the proposed wind farm drainage system.

Table 10-7: Increase in Surface Water Runoff

Croaghaun Wind Farm			Sub-basin Area	Construction Area	Overland	New tracks (5m wide)	Widening of existing tracks	Hardstanding, Compound and Substation Area	Turbine Foundation	Total Runoff (Area x runoff coeff.)	Rainfall Intensity	Run-off	Increase in Runoff	Increase in Runoff
	Catchment	**Scenario**	ha	ha	ha	ha	ha	ha	ha	ha	mm/hr	m^3/s	m^3/s	%
	Awbeg (Buttevant)-West_020	Existing	2469	4.80	4.80					**1.44**	43.6	0.17		
		Post Development			0.00	1.765	0.250	2.705	0.075	**2.20**	43.6	0.27		
		Increase in Run-off											**0.092**	**0.16**
	Oakfront_010	Existing	1384	4.23	4.23					**1.27**	43.6	0.15		
		Post Development			0.00	1.351	0.000	2.805	0.075	**1.95**	43.6	0.24		
		Increase in Run-off											**0.082**	**0.24**
												TOTAL INCREASE:	**0.174**	**0.20**

Notes: *Impervious factor for overland flow is 0.3. For tracks and hardstanding areas impervious factor of 0.45 is applied; for turbine foundation the runoff coefficient of 1.00 is applied. Rainfall Intensity for 1-in-100 year return period storm of 60 minutes duration supplied by Met Eireann.*

Factor of 1.2 is applied to rainfall intensity for MRFS.

Q100 flow derived using the Modified Rational method Q=2.78 x (Rainfall Intensity) x (Contributing Impervious Area(factored).)

10.4.2.2 Suspended Solids

The activities associated with construction of the wind farm site will require earthworks. Potential sources of sediment laden water include:

- Standing water in excavations could contain an increased concentration of suspended solids as a result of the disturbance of the underlying soils.
- Haul roads passing close to watercourses could allow the migration of silt laden runoff into watercourses.
- Silt carried on the wheels of vehicles leaving the main wind farm site could be carried onto the public road.
- A blockage in the proposed roadside drains could allow a break out of silt laden runoff to reach adjacent watercourses or streams.
- Overland flow entering excavations could increase the quantity of surface water to be treated for sediment removal.
- Inappropriate management of excavations could lead to loss of suspended solids to surface waters.
- Inappropriate storage and management of the excavated material could lead to loss of suspended solids to surface waters.
- Surface water inflows and minor groundwater seepages may occur in turbine base excavations. Surface water inflows can occur following a rainfall event. Pumped water from the pits will most likely contain suspended solids.
- To accommodate the access to the locations of the proposed turbines, a total of 14 crossings over the watercourses will be constructed or reconstructed. During the construction there is a potential to release suspended solids into the watercourse. Works leading to erosion of the river banks/bed could result in the release of suspended solids.
- Tree felling could lead to an increase in sediment in the surface water runoff, if the brash is left in place in the riparian buffer zones.

Pathway / Mechanism: Drainage and surface water discharge routes.

Receptor: Waterbodies down gradient from the wind farm site.

Pre-mitigation Impact: Direct, Negative, Short Term, Likely.

These activities can result in the release of suspended solids to surface watercourses and could result in an increase in the suspended sediment load, resulting in increased turbidity which in turn could affect the water quality and fish stocks of downstream water bodies if the appropriate mitigation measures are not put in place.

The significance of the effect of the release of suspended solids into the receiving waters is "**Significant**".

10.4.2.3 Release of Hydrocarbons

- Refueling activities could result in fuel spillages which could pollute underground and surface water, especially during the construction of new culverts/bridges.

- There is the potential for fuel spill/leaks from storage tanks which will be stored on main wind farm site for plant machinery. Fuel spill/leaks could infiltrate underground and pollute underground water. Fuel spills/ leaks could be drained to watercourses and pollute them.
- Tree felling process require trafficking of heavy machinery which can lead to pollution of watercourses due to spillage of fuels and hydrocarbons.

Pathway / Mechanism: Site drainage network and groundwater flow paths.

Receptor: Surface water and groundwater.

Pre-mitigation Impact: Direct, Negative, Temporary, Unlikely.

Hydrocarbon has a high toxicity to humans and all flora and fauna, including fish, and is persistent in the environment. It is also a nutrient supply for adapted micro-organisms, which can rapidly deplete dissolved oxygen in waters, resulting in death of aquatic organisms.

The significance of the effect of the release of the hydrocarbons into the receiving waters is "**Slight**" due to the low likelihood and low quantities involved.

10.4.2.4 Contamination from Wastewater and Pollutants

- Sanitary waste could lead to contamination of receiving waters.
- Crayfish plague is a pathogenic water mould which can kill crayfish. It can be spread on contaminated equipment.

Pathway / Mechanism: Site drainage network and groundwater flow paths.

Receptor: Surface water and groundwater.

Pre-mitigation Impact: Indirect, Negative, Temporary, Unlikely.

Release of effluent from domestic wastewater treatment systems has the potential to impact receiving water.

The significance of the effect of the release of sanitary waste into the receiving waters is "**Slight**" because it is unlikely that the huge amount of sanitary waste could be released into the environment.

10.4.2.5 Release of Cement-Based Products

Cement based product will be used in turbines foundation and substation, and will also be used for constructing new watercourse crossing structure (WF-HF5). However, precast structures will be used for watercourse crossings with the exception only of construction of bridge abutments.

- Cement-based products could lead to contamination of receiving waters and groundwaters.

Pathway / Mechanism: Site drainage network.

Receptor: Surface water.

Pre-mitigation Impact: Indirect, Negative, Brief, Unlikely.

Concrete and other cement-based products are highly alkaline and corrosive and can have significant negative impacts on water quality. They generate very fine, highly alkaline silt (pH 11.5) that can physically damage fish by burning their skin and blocking their gills.

Entry of cement based products into the site drainage system, into surface water runoff, and hence to surface watercourses or directly into watercourses represents a risk to the aquatic environment. Wet concrete and wash out of transport and placement machinery are the activities most likely to generate a risk of cement based pollution.

The significance of the effect of the release of the cement based products into the receiving waters is "**Moderate**" because it is unlikely that a huge amount of cement based products could be released into the environment.

10.4.2.6 Potential Impacts from Tree Felling

It is estimated that 12.6 ha in total of existing forestry will be felled to allowed for development of the proposed wind farm infrastructure. The main potential impacts during tree felling process are release of sediments and nutrients in watercourses due to exposure of soil and subsoil following vehicle tracking, skidding and extraction methods. The release of nutrients in watercourses can come from pine brushes if not managed correctly during felling process. Tree felling for this proposed development will be in small compartments or coupes within the forest areas. Felling has the potential to impact adversely upon the environment if done in an uncontrolled manner; however, by the adoption of sound planning procedures, operating techniques and control measures as outlined in Section 10.7.1.6, this will considerably reduce any potential adverse environmental effects.

- Potential impacts related to suspended solids is addressed in Section 10.4.2.2
- Excessive haulage distances to roads, leading to site soil damage
- Rutting and compaction through the overuse of tracks
- Tree felling could lead to an increase in sediment and nutrients in the surface water runoff, if the brash is left in place in the riparian buffer zones.
- During clear-felling there is a higher potential for nutrient loss as there are no living tree roots left to take up the nutrients. Any organic matter (particularly recently dead material such as brash or roots) that is left on site to rot will release phosphorus and nitrogen. Decaying brash resulting from the clear-fell can generate nutrients which could potentially lead to nutrient enrichment of any small first order streams. The breakdown of brash, roots and other organic matter takes a number of years.

In Ireland, forestry is an activity that operates under strict environmental controls such as tree felling licences and also principles of sustainable forest management with great emphasis on the protection of the aquatic environment.

The significance of the nutrients is appraised below:

Pathway / Mechanism: Site drainage network and surface water discharge routes.

Receptor: Surface water.

Pre-mitigation Impact: Indirect, Negative, Temporary, Likely.

The significance of the effect of the release of the nutrients into the receiving waters is "**Moderate**".

10.4.3 Potential Impacts Associated with Construction of Grid Connection

The following potential impacts could result from the construction activities related to grid route installation and watercourse crossings:

- Suspended solids drained to watercourse could potentially lead to siltation and physical effect on flora and fauna.
- Excavated soil could be mobilised in the surface water runoff during an extreme rainfall event.
- The excavation of trenches for cable laying, and the launch and reception areas for directional drilling, could lead to silt laden surface water run-off.
- Inadequate storage of fuels and oils could lead to contamination of surface water.
- Refuelling activities could result in fuel spillage.
- Works leading to erosion of the riverbanks/bed could negatively impact on the fisheries habitat.
- Drilling fluids associated with HDD works could pollute watercourse.
- Sediment laden runoff during the launch pit and reception pit excavation works.

The potential impacts can be broken down into two groups and are detailed below:

Suspended Solids

Pathway / Mechanism: Surface water discharge routes.

Receptor: Waterbodies down gradient from the grid connection and HDD.

Pre-mitigation Impact: Direct, Negative, Temporary, Likely.

These activities can result in the release of suspended solids to surface watercourses and could result in an increase in the suspended sediment load, resulting in increased turbidity which in turn could affect the water quality and fish stocks of downstream water bodies.

The significance of the effect of the release of suspended solids into the receiving waters is "**Slight**".

Hydrocarbons

Pathway / Mechanism: Site drainage network and groundwater flow paths.

Receptor: Waterbodies down gradient from the grid connection and HDD.

Pre-mitigation Impact: Direct, Negative, Temporary, Unlikely.

Hydrocarbon has a high toxicity to humans and all flora and fauna, including fish, and is persistent in the environment. It is also a nutrient supply for adapted micro-organisms, which can rapidly deplete dissolved oxygen in waters, resulting in death of aquatic organisms.

The significance of the effect of the release of the hydrocarbons into the receiving waters is "**Slight**" because it is unlikely that the huge amount of hydrocarbons could be released into the environment.

10.4.4 Potential Impacts Associated with Turbine Delivery Route Works

Modifications along the TDR involves the temporary removal of street furniture and removal of some vegetation in addition to the temporary local widening at bends using hardcore material. These are small local areas, therefore it is not anticipated that this will have any significant hydrological impact.

Vegetation on the northern side of the Rathnacally Stream will be cut and the wall of the nearby pump enclosure will be lowered by 0.5m at Node 10.5. Pump enclosure is approximately 25m from the watercourse. There is a potential for release of sediments and debris into the stream. There is also a potential for oil leakage from machinery and equipment that will be used.

Due to the small extent of the wall which will be removed and vegetation that will be cut, it is concluded that the potential for effect from the works associated with TDR on the receiving waters is "**Not Significant**".

10.4.5 Potential Impacts During Operation and Maintenance

Due to the grassing over the drainage swales and revegetation of other exposed surfaces, and the non-intrusive nature of operations, there is a negligible risk of sediment release to the watercourses during the operational stage.

During the operation stage, small quantities of oil will be used in cooling the transformers associated with the facility. There is therefore a potential for small oil spills.

The significance of the effect of the potential for small oil spills into the receiving waters is "**Not Significant**".

10.4.6 Potential Impact During Decommissioning

The decommissioning phase is described in Chapter 3 of this EIAR and these works will be subject to a decommissioning plan, to be agreed with County Council. A decommissioning plan can be found in the CEMP in Appendix 3.1.

In the event of decommissioning, activities would take place in a similar fashion to the construction phase. Potential impacts would be similar to the construction phase but to a lesser degree.

There would be increased trafficking and an increased risk of disturbance to underlying soils at the wind farm, during the decommissioning phase.

Any such potential impacts would be likely to be less than during the construction stage as the drainage swales would be fully mature and would provide additional filtration of runoff. Any diesel or fuel oils stored on main wind farm site will be bunded.

For access tracks and turbine hard standings it is proposed that they are left in place. The foundations will be covered over and allowed to re-vegetate naturally. Removal of this infrastructure would result in considerable disruption to the local environment in terms of an increased possibility of sedimentation. It is considered that leaving the turbine foundations hardstanding areas in-situ will cause less environmental damage than removing them.

Grid connection infrastructure including substations and ancillary electrical equipment shall form part of the national grid and will be left in situ.

Therefore, it is concluded that the potential impact on hydrology and water quality during decommissioning stage is '**Not Significant'**.

10.5 Flood Risk Assessment

Flood risk assessment (FRA) is provided in Appendix 10.2. Findings are summarised herein.

As part of the flood risk assessment the following elements of the project were assessed:

- Wind farm site
- Grid connection
- Turbine delivery route

Wind Farm Site

The proposed development is within flood zone A. However, the majority of the site is within flood zone C.

Turbines and substation are located within Flood zone C.

The proposed crossing point over the Oakfront stream is sized to cater 1% AEP MRFS event flows. This will allow for the site to be accessed during extreme storm events.

The proposed substation will have a drainage system in place to mitigate the potential risk of flooding at the sub-station and downstream of it. The proposed on-site substation is within flood zone C.

Grid connection

There are no recorded flood incidents or recurring flooding along the grid connection route or in 2km buffer zone. According to the PFRA flood mapping, the grid connection crosses Flood Zone A at the location GCR – WCC1.

An increase in runoff due to grid connection cable installation is not expected because the finished surfaces are not changed. The installation of grid cables will not reduce the flood plain area. The cable ducting will be installed so as not to impact the existing crossing structure. Installation of grid cable will not have an effect on flow conveyance area of the crossing structures.

Therefore, there is no increase in the flood risk due to grid connection.

Turbine Delivery Route

The general locations of accommodation work along TDR are shown in Figure 3.5 Minor works such as vegetation trimming, tree removal, placement of temporary load bearing surface are not expected to increase the risk of flooding.

10.6 Proposed Drainage

The proposed drainage for the site has been addressed by the potential impacts, discussed in Section 10.4 and it has also been addressed by the flood risk assessment undertaken in Section 10.5. In addition to draining the development, the drainage design has the capacity to introduce hydrological links from the proposed development to the receiving environment.

An appropriate drainage design is the primary mitigation measure for the protection of waterbodies, incorporating silt protection infrastructure and control measures to reduce the rate of surface water runoff from the wind farm site.

The mitigation measures that follow in Section 10.7 refer to the drainage design and also include other best practice measures to mitigate any potential impacts from the development.

The proposed layout of the drainage for the development is shown in the Surface Water Management Plan (SWMP) contained in Appendix 10.3. Where possible, existing access roads and tracks have been utilised in the layout design for the proposed development to minimise the disturbance to soils.

The following types of surfaces are considered on this site in addressing the drainage for the proposed development:

1) proposed new site access tracks and hard standings associated with the construction of turbines.
2) proposed on-site substation.
3) temporary site compound.

10.6.1 Interceptor Drains

It is not expected that overland flows will be obstructed to any great extent by the drainage layout, however, where required, interceptor drains will collect overland flows on the upslope side of the access tracks and hardstanding areas. Collected water will be carried under wind farm infrastructures by cross drains. The overland flow will then discharge diffusely on the downslope side over vegetated areas within the site boundary.

SuDS design approach shall ensure that existing drainage patterns shall be maintained throughout the site.

10.6.2 Existing Tracks and Surfaced Access Roads

It is proposed to upgrade approximately 0.4km of existing agricultural roads. All track widening will be undertaken using clean uncrushable stone with a minimum of fines.

Road drainage will be over the edge, where the surface runoff will be collected in swales. Swales will be connected to settlement ponds at the end of the swale. Settlement ponds will discharge treated water overland via a diffuse outfall which will minimise any risk of soil erosion and allow further filtration of any remaining sediment particles. This treated water will ultimately percolate to ground or travel overground and be assimilated into the existing drainage network within the boundary of the proposed development at appropriate greenfield run-off rates. There will be no direct discharges from the wind farm to any existing natural watercourse.

The settlement ponds will be designed to provide sufficient retention time and a low velocity environment to allow suspended solids of a very small particle size to fall out of suspension prior to allowing the water to outfall to the receiving environment.

10.6.3 New Site Access Tracks and Hard Surfaces

It is proposed to construct approximately 4.5 km of completely new access track. Proposed new tracks and turbine hard standing areas will be drained via roadside swales and interceptors drains. Roadside drains will be connected to settlement ponds at the end of the swale. Settlement ponds will discharge treated water overland via a diffuse outfall.

These grassed swales will serve to detain flow and reduce the velocities of surface water flows. The swales will be 0.3 m deep with a bottom width of 0.5 m and side slope of 1 in 3. The swales will be constructed in accordance with CIRIA C698 Site Handbook for the Construction of SuDS which will be used in conjunction with CIRIA C753 The SuDS Manual.

Where roadside drains are laid at slopes greater than 2%, check dams will be required in the swales to slow down the velocities of flows and prevent erosion occurring, as shown in Appendix 10.2.. This will reduce effective slope and runoff velocities and any consequent potential for erosion.

Site drainage, including silt traps and settlement ponds, will be put in place in parallel with construction, such that excavation for new infrastructure will have functional drainage system in place. The settlement ponds will remain in place during construction phase. The settlement ponds will drain diffusely overland, over existing vegetated areas, within the site boundary. The settlement ponds will be backfilled and the swales that were connected to them will be re-connected to the outfall once construction is completed.

The proposed locations of the settlement ponds are provided in the SWMP contained in Appendix 10.3 and in the Planning Drawings. Silt fencing will be provided at strategic locations to further protect watercourses during the construction phase.

10.6.4 Proposed and Existing Watercourse Crossings

The proposed wind farm site layout will have 14 crossings over the watercourses. These crossings are listed in Table 10-8 and shown on Figure 10-5.

There will be one new crossing over the Oakfront Stream and 13 over the field and forestry drains. The proposed crossing structure over the Oakfront Stream is a single span bridge. For small crossings over the field and forestry drains a pre-cast box culvert is proposed.

A Section 50 application will be required to obtain the consent of the OPW for the construction of the crossing over the Oakfront Stream.

Table 10-8: Existing and Proposed Hydrology Features

Feature ID	Existing / Proposed	Feature /activity	Proposed Method of Crossing
WF-HF1	Existing	Pre-cast box culvert	New access track. Cable ducts installed above proposed pre-cast concrete box culvert. Existing culvert will be extended.
WF-HF2	Proposed	450mm diameter pipe	New access track. Cable ducts installed above proposed pipe.
WF-HF3	Proposed	450mm diameter pipe	New access track. Cable ducts installed above proposed pipe.
WF-HF4	Proposed	450mm diameter pipe	New access track. Cable ducts installed above proposed pipe.
WF-HF5	Proposed	Single span bridge	New access track. Cable ducts to be incorporated into proposed pre-cast concrete structure.
WF-HF6	Proposed	450mm diameter pipe	New access track. Cable ducts installed above proposed pipe.
WF-HF7	Proposed	450mm diameter pipe	New access track. Cable ducts installed above proposed pipe.
WF-HF8	Proposed	450mm diameter pipe	New access track. Cable ducts installed above proposed pipe.
WF-HF9	Proposed	450mm diameter pipe	New access track. Cable ducts installed above proposed pipe.

Feature ID	Existing / Proposed	Feature /activity	Proposed Method of Crossing
WF-HF10	Proposed	450mm diameter pipe	New access track. Cable ducts installed above proposed pipe.
WF-HF11	Proposed	450mm diameter pipe	New access track. Cable ducts installed above proposed pipe.
WF-HF12	Proposed	450mm diameter pipe	New access track. Cable ducts installed above proposed pipe.
WF-HF13	Proposed	450mm diameter pipe	New access track. Cable ducts installed above proposed pipe.
WF-HF15	Proposed	450mm diameter pipe	New access track. Cable ducts installed above proposed pipe.

The existing stone culvert, marked as WF-HF1, will be extended to accommodate for the site machinery requirements. The existing stone culvert will be extended with a pre-cast box culvert.

Manmade agricultural and forest drains will be crossed using 450mm diameter pipes. Where cross drains are to be provided to convey the drainage across the track, the minimum sizes of these cross drains are 300 mm diameter pipes.

Silt Protection Controls (SPCs) are proposed at the location of the drain crossings. SPCs will consist of a minimum of silt traps containing filter stone and filter material staked across the width of the swales and upstream of the outfall to any watercourse.

10.6.5 Drainage of On-site Substation

During the construction phase it is proposed to drain the substation using shallow swales, with a settlement pond at the end of the swale run. The settlement pond will be removed after the construction period.

At the upslope side of the substation, interceptor drains will be installed.

The runoff from roofs will be collected to rainwater harvesting tank. This rainwater harvesting tank will be connected to a manhole, this manhole will form a part of the road drainage. The access road at the substation will be drained by a closed pipe system connected to a soakaway.

A foul system is proposed within the station to cater for the wastewater generated in the welfare facilities. The foul system will consist of an underground pipe network, foul manholes and a 9 m^3 full retention foul effluent storage tank. The tank will have an associated high level alarm which will be connected to the control building. A foul holding tank to be maintained and emptied quarterly is the most preferable means of treating and disposing of foul waste from the site. . The licensed contractor charged to empty and dispose of the waste will be the holder of a valid waste collection permit.

10.6.6 Drainage of Temporary Site Compound

The site layout includes one temporary site compound. The compound is set back from the drains. Drains around the hardstanding areas of the site compound will be in the form of shallow grassed swales to minimise the disturbance to sub-soils.

Surface water runoff from the compound will be directed through a Class 1 by-pass oil interceptor before discharge to water drainage system for the site. This drain flows to a settlement pond before final discharge over land. More details are provided in SWMP contained in Appendix 10.3.

During the construction phase, it will be necessary to provide bottled water for potable supply for the construction personnel. A water tanker will supply water used for other purposes.

Portaloo and/or containerised toilets and welfare units with storage tanks will be used to provide toilet facilities for site personnel during construction.

All portaloo units located on site during the construction phase will be operated and maintained in accordance with the manufacturer's instructions and will be serviced under contract with the supplier. All such units will be removed off-site following completion of the construction phase.

10.6.7 Drain Diversion

It is proposed to divert an existing field drain which runs in west -east direction. This field drain feeds into the Ardglass Stream. Please refer to Appendix 10.1 showing the location of this drain. It is proposed to divert this drain around the footprint of the proposed turbine T4. Due to the very low area draining towards this drain, it is unlikely this will have significant negative impact on the local drainage and the flood risk.

The proposed mitigation measures are provided in Section 10.7.1.

10.7 Mitigation Measures and Residual Impacts

Proposed drainage measures to reduce, and protect the receiving waters from, potential impacts during the construction of the proposed development are as outlined in Section 10.6. These include measures to prevent runoff erosion from vulnerable areas and consequent sediment release into the nearby watercourses to which the proposed development site drains. This section provides proposed mitigation measures and evaluates the significance of residual impacts.

10.7.1 Proposed Mitigation Measures During Construction

10.7.1.1 Increase in Surface Runoff

Permanent roadside drainage will be installed as part of the construction stage. This will include the use of interceptor drains, swales and check dams. The proposed drainage system will increase time of concentration. Time of concentration (Tc) is time required for an entire catchment to contribute to runoff at the point of interest.

These measures will buffer site runoff during periods of high rainfall by retaining the water until the hyetograph has receded. A hyetograph is a graphical representation of the distribution of rainfall intensity over time.

Post-mitigation Impact (residual impact): Neutral, Direct, Negligible, Reversible, Unlikely.

Not significant residual impacts on local or downstream hydrology are anticipated.

Given the increase in runoff due to the construction of the wind farm is 0.174 m^3/s (or 0.20%), **not significant** residual effects are anticipated.

10.7.1.2 Suspended Solids

The key mitigation measure during the construction phase is locating the proposed turbines 50m from the watercourse. No construction activities or drainage will be within 50m of the watercourses, with an exception for watercourse crossings, access road leading to the proposed substation and turbine T4. The proposed buffer zones will:

- Avoid physical damage to watercourses, and associated release of sediment.
- Avoid excavations within close proximity to surface water courses.
- Minimise the potential for the entry of suspended sediment from earthworks into watercourses.
- Minimise the potential for the entry of suspended sediment from the construction phase drainage system into watercourses, achieved in part by ending drain discharge outside the buffer zone and allowing percolation across the vegetation of the buffer zone.

The following measures shall be implemented during the construction phase:

- settlement ponds with a diffuse outflow detail will be put in place in advance as construction progresses across the site. Erosion control and retention facilities, including settlement ponds will be regularly maintained during the construction phase. The three-stage treatment train (swale – settlement pond – diffuse outflow) proposed to retain and treat the discharges from hard surface areas as a result of the development will reduce any risk of flooding downstream.
- A water quality monitoring programme will be established to ensure that water quality is maintained throughout the construction phase. The details of this programme are outlined below. This programme will ensure that designed measures including settlement ponds are working, and existing water quality is maintained.
- It is proposed to divert an existing field drain as stated in Section 10.6.7. The diversion of the field drain will take place during a dry period. It is proposed to put double silt fences in the drain just upstream and downstream of the diversion area. Prior to construction is it proposed to build a small stone dam within a ditch to prevent water ingress. Clean water accumulated upstream of a dam will be pumped downstream of the construction area.
- Where haul roads pass close to watercourses, silt fencing will be used to protect the streams.
- Silt traps will also be provided at outfalls from roadside swales to settlement ponds.
- Interceptor cut-off drains will be provided on the upslope side of the access roads to prevent the mixing of overland flows with the drainage for the proposed development. These interceptor drains will discharge diffusely over land to avoid concentration of runoff.

The roadside drains will therefore only carry the site access road runoff and so avoid carrying large volumes of water and concentrating flows.

- Where new cross-drains are proposed on this site to convey surface water from roadside swales to settlement ponds, these will be sized at a minimum of 300 mm diameter to avoid blockages.
- Cross drains of 450 mm will be provided to prevent a risk of clogging for drainage crossings and conveying flow from agricultural drains and forestry drains under access track roads.
- Standing water, which could arise in excavations, has the potential to contain an increased concentration of suspended solids as a result of the disturbance to soils. The excavations for turbines will be pumped into the site drainage system (including settlement ponds), which will be constructed at site clearance stage, in advance of excavations for the turbine bases.
- All open water bodies adjacent to proposed construction areas will be protected by fencing including the proposed settlement ponds.
- Excavated subsoil material not required for in-site reinstatement will be removed to the designated material storage areas.
- Silt fencing will be erected at the locations of the drain crossings for the duration of the construction period.
- Site access tracks have been laid out to reduce longitudinal slope of roadside drains where possible. Where roadside drains are laid at slopes greater than 2%, check damns will be provided. This will reduce effective slope and runoff velocities and any consequent potential for erosion.
- Silt fencing will be erected at the location of stream crossings along the cable route.
- The temporary storage of excavated material on site will be put at least 50 m from watercourses.
- An Environmental Clerk of Works (ECOW) will be appointed by the developer to ensure the effective operation and maintenance of drainage and other mitigation measures during the construction process. The operations management of the Site will include regular monitoring of the drainage system and maintenance as required.
- Additional protection will be provided in the form of silt fencing downslope during construction of new watercourse crossings, to further ensure that there is no impact from the development to streams and rivers downslope of the site. All open water bodies adjacent to proposed construction areas will be protected by fencing.
- Daily visual inspections of drains and streams will be performed during the construction period of the new crossing structures to ensure suspended solids are not entering the streams and rivers alongside the work area, to identify any obstructions to channels, and to allow for appropriate maintenance of the existing roadside drainage regime.
- Weather warnings will be monitored, and no construction will take place during extreme events. Large excavations and movements of subsoil or vegetation stripping will be suspended or scaled back if heavy rain is forecast. The extent to which works will be scaled back or suspended will relate directly to the amount of rainfall forecast. Works will be suspended by an ECOW if forecasting suggests either of the following is likely to occur:
    - >10 mm/hr (high intensity local rainfall events).
    - >25 mm in a 24 hour period (heavy frontal rainfall lasting most of the day).
    - >half monthly average rainfall in any 7 days.
- Prior to works being suspended the following control measures will be completed:
    - Secure all open excavations.
    - Provide temporary or emergency drainage to prevent back-up of surface runoff.

- Avoid working during heavy rainfall and for up to 24 hours after heavy rainfall events to ensure drainage systems are not overloaded.

- Drains and silt traps will be maintained throughout all felling works, ensuring that they are clear of sediment build-up and are not severely eroded.
- Brash mats will be used to support vehicles on soft ground, reducing peat and mineral soils erosion and avoiding the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal will take place when they become heavily used and worn. Provision will be made for brash mats along all off-road routes, to protect the soil from compaction and rutting. Where there is risk of severe erosion occurring, extraction will be suspended during periods of high rainfall.

Water Quality Monitoring Programme

A monitoring programme will be established to ensure that water quality is maintained. The details of this programme are outlined below. This programme will ensure that designed measures are working, and water quality is not affected.

An Environmental Clerk of Works (ECOW) will be on-site during construction to monitor water quality. Turbidity meters will be installed prior to construction downstream of the site.

Levels of turbidity will be monitored pre-construction to confirm existing levels in the waterbodies. Should the turbidity levels measured during construction be higher than the existing levels, construction will be stopped, and remediation measures will be put in place immediately, to include silt fencing.

Water samples will be taken weekly during ground disturbance works and will include measurement of the parameters provided in Table 10-9 below:

Table 10-9: Surface Water Quality Monitoring Parameters

Parameter	Maximum Value	Regulation
Turbidity	-	-
pH	6.0 < pH < 9.0	Surface Water Regulations 2009
BOD	High Status < 1.3 (mean) or <2.2 (95%ile) Good Status <1.5 (mean) or < 2.6 (95%ile)	Surface Water Regulations 2009
Total Suspended Solids (mg/l)	<25	Salmonid Water Regulations 1988
Total Ammonia (mg/l N)	High Status < 0.04 (mean) or <0.09 (95%ile) Good Status <0.14 (mean) or < 0.065 (95%ile)	Surface Water Regulations 2009
Nitrite (NO_2) (mg/l)	<0.05	Salmonid Water Regulations 1988
Molybdate Reactive Phosphorus (mg/l P)	High Status < 0.025 (mean) or <0.045 (95%ile) Good Status <0.035 (mean) or < 0.075 (95%ile)	Surface Water Regulations 2009

Post-mitigation Impact (residual impact): Direct, Negative, Low, Short Term, Unlikely.

Given the level of protection provided by the hydrological buffer zones and the proposed measures, **not significant** residual effects are anticipated.

10.7.1.3 Release of Hydrocarbons

- Refueling of plant during construction will only be carried out at designated refueling station locations on site.
- Storage of fuels, lubricants and hydraulic fluids will occur at the contractor's compound, which will be fenced and have a lockable gate, thereby ensuring that the area in which fuels, lubricants and hydraulic fluids are stored will be properly secured against unauthorized access or vandalism.
- Emergency drip trays and spill kits will be kept available on site, to ensure that any spills from vehicles are contained and removed off site. The emergency response procedure is provided in the SWMP provided in Appendix 10.3.
- Designated contractors' personnel will be trained and certified in oil spill control and clean up procedures, and in the proper and safe disposal of any waste generated through such an event.
- Any diesel, fuel or hydraulic oils stored on site will be stored in bunded storage tanks – the bund area will have a volume of at least 110 % of the volume of such materials stored.

Post-mitigation Impact (residual impact): Direct, Negative, Negligible, Temporary, Unlikely.

Given the level of protection provided and emergency response procedure, **not significant** residual effects are anticipated.

10.7.1.4 Contamination from Wastewater and Pollutants

- Portaloos and/or containerised toilets and welfare units will be used to provide toilet facilities for site personnel. Sanitary waste will be removed from site via a licenced waste disposal contractor.
- To reduce the risk of invasive species and pathogen introduction (e.g. Crayfish plague), all equipment will be thoroughly checked, cleaned and dried in accordance with best practice as specified in the CIRIA guidelines below. Furthermore, plant machinery which has worked within riparian corridors or come in to contact with water will be steam-cleaned and dried in advance of works commencement in the Blackwater catchment. Crayfish plague is known from the Suir, Deel and Maigue Catchments to the north since 2017 but has not been detected to date in the Blackwater catchment. The potential introduction of Crayfish plague is of particular concern at watercourse crossings given the potential for White-clawed Crayfish populations downstream.
    - CIRIA (2001). Control of water pollution from construction sites - Guidance for consultants and contractors (C532). Construction Industry Research and Information Association, London.
    - CIRIA (2006). Control of Pollution from Linear Construction Project; Technical Guidance (C648). Construction Industry Research and Information Association, London.
    - CIRIA (2015a). Manual on scour at bridges and other hydraulic structures, second edition (C742). Construction Industry Research and Information Association, London.

- CIRIA (2015b). Environmental Good Practice on Site (4th edition) (C741). Construction Industry Research and Information Association, London.
- CIRIA (2019). Culvert, screen and outfall manual (C786). Construction Industry Research and Information Association, London.

Post-mitigation Impact (residual impact): Direct, Negative, Negligible, Temporary, Low Probability.

Given the above, **not significant** residual effects on hydrology and water quality are anticipated.

10.7.1.5 Release of Cement-Based Products

- Prior to leaving the site, every truck delivering concrete to the site must wash the chute only to a lined pit provided at each turbine location and substation compound.
- There will be no on-site batching of concrete and no storage of cement will be permitted within 50 m of the crossing construction areas, except at turbine T4.
- During all concrete works pH will be measured daily upstream and downstream of works areas. A change in 0.5 pH units will trigger cessation of works and investigation of possible concrete source.
- Where possible, pre-cast elements will be used to minimise the need for wet concrete works within the site.
- Weather forecasting will be used to plan dry days for pouring concrete.
- It will be ensured that the concrete pour site is free of standing water prior to concreting and plastic covers will be available in case of a sudden rainfall event.

Post-mitigation Impact (residual impact): Negative, Direct, Negligible, Brief, Unlikely.

Not significant residual impacts on hydrology and water quality are anticipated.

10.7.1.6 Proposed Mitigation Measures for Tree Felling

Tree felling will be permitted under limited felling license(s) from the Forest Service and to the conditions of such a license. A Limited Felling License will be in place prior to works commencing on site. To ensure a tree clearance method that reduces the potential for sediment and nutrient runoff, the construction methodology will follow the specifications set out in:

- Felling and Reforestation Policy, Forest Service, Department of Agriculture, Food and the Marine, Dublin. May 2017
- Standards for Felling and Reforestation, Forest Service, Department of Agriculture, Food and the Marine, Dublin. October 2019
- Forestry Standards Manual (Agricultural, Food and the Marine, 2015)
- Forestry Act 2014 and the Forestry Regulations 2017 (SI No 191 of 2017) and SI 31 of 2020 - Forestry (Amdmt) Regs 2020 re reg 19AA procedures (pdf 99Kb)

- Forest Service. 2000a. Forestry and Water Quality Guidelines. Forest Service, Department of the Marine and Natural Resources, Dublin.
- Forest Service. 2000b. Code of Best Forest Practice – Ireland. Irish National Forest Standard. Forest Service, Department of the Marine and Natural Resources, Dublin.
- Forest Service. 2000c. Forest Harvesting and the Environment Guidelines. Forest Service, Department of the Marine and Natural Resources, Dublin.

The following mitigation measures are proposed:

- Before operation commence, identify a 10m wide exclusion zone along the edge of all aquatic zones
- Ensure all operators are aware of exclusion zone
- Machine traffic and timber stacking are not permitted within these zones
- Trees within the reach of the harvester arm will be felled by harvester, and snedded and bunched outside the exclusion zone.
- Trees outside machine reach to be felled manually by chainsaw operators. Felled trees to be winched out of the exclusion zone where appropriate and safe to do so, or removed by extended harvester arm, for subsequent snedding and processing outside the exclusion zone.
- In all cases, fell trees away from the water feature.
- Regarding aquatic zones, ensure banks remain undisturbed. No branches or debris are to enter the aquatic zone during operations. Immediately and with care, remove any branches that do fall in.
- Minimise the crossing of drains during felling and extraction, and restrict machine activity to brashed extraction racks and haulage routes.
- Where necessary, deploy a heavy-duty plastic culvert lengthways into the channel and cover with brash material. The culvert must be of a diameter approximating the depth of the drain, to avoid any unnecessary undulation along the extraction route.
- Where required, a solution for smaller drains is to temporarily lay log sections lengthways into the channel and overlay with brash. Again, select logs that approximate the depth of the channel to be crossed.
- When installing and removing the temporary crossing, ensure that no work is carried out within the aquatic zone, and that the stream bed and bankside remain undisturbed.
- Carefully remove temporary crossings as they become no longer needed. Any brash padding used must be peeled back carefully away from the water feature, to avoid dislodging collected sediment.
- Direct crossing over the stream bed is not permitted.
- Ensure the feature is crossed at a right angle to the flow of water.
- Where needed, any necessary crossing shall be via an appropriate structure that spans proud of the flow of water and prevents the breakdown and erosion of the banks.
- Solutions include the laying down of a bridge comprising logs overlaid with geotextile and brash to intercept soil falling off wheels.
- Branches, logs or debris will not be allowed to build up in aquatic zones. All such material will be removed when harvesting operations have been completed.

- Timber will be stacked in dry areas, and outside a local 50m watercourse buffer. Straw bales and check dams will be emplaced on the down gradient side of timber storage sites.
- Brash mats will be used to support vehicles on soft ground (e.g. during trenching and drainage construction), reducing peat and mineral soils erosion and avoiding the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal will take place when they become heavily used and worn. Provision will be made for brash mats along all off-road routes, to protect the soil from compaction and rutting. Where there is risk of severe erosion occurring, extraction will be suspended during periods of high rainfall.
- Prior to the commencement of operations, silt traps will be installed within existing forest drains that connect with aquatic zones, either directly or indirectly through other relevant watercourses.
- Silt traps will be staggered along the length of the drain, and not only at the lower reaches towards its outflow.
- Silt trap design can vary, from depressions added to the drain bed, to log sections laid lengthways into the drain, to the use of geotextile barriers
- Silt fences will be utilized where necessary, to block pathway for silt in areas where overland flow is possible.
- Once silt traps and silt fences become functional, they will be regularly checked and maintained as necessary, in order to ensure continued effectiveness throughout operations.
- Felling and extraction and other machine operations onsite (or redirect to more stable areas of the site) will cease during and after periods of rainfall which result in the possibility of the surface mobilisation of silt.
- At least weekly check Silt traps and silt fences will be checked weekly, and maintained as required, to ensure their continued effectiveness throughout works. All excess silts will be removed and disposed of appropriately.
- Daily visual checks will be undertaken of relevant watercourses (primarily at their outflow from the site) and adjoining aquatic zones, to confirm (or otherwise) that no sediment or silt discharge will be arising from site works.
- A record will be kept of the above monitoring, and retain for possible inspection.

Post-mitigation Impact (residual): Direct, Negative, Low, Temporary, Likely.

Not significant residual impacts on the hydrology and water quality are anticipated.

10.7.2 Proposed Mitigation Measures During Grid Connection and HDD

In Section 10.4.3 it is noted that the release of suspended solids and hydrocarbons could have an effect on receiving waters. The following mitigation measures are proposed:

10.7.2.1 Suspended Solids

- Cables will be installed in trenches adjacent to the site access roads or laid within the access road carriageway corridor, where required. Trenches will be excavated during dry periods in short sections and left open for minimal periods, to avoid acting as a conduit for surface water flows.

- The temporary storage of excavated material on site will be put at least 50 m from watercourses as detailed in soil management plan provided in CEMP. Please refer to Appendix 3.1.
- Weather warnings will be monitored by an ECOW, and no construction will take place during extreme events to mitigate against potential flooding.
- Any excavated material will be used in the reinstatement of the cable trenches subject to approval. Unsuitable surplus material will be removed from the site to an appropriate licenced facility as detailed in Section 3.6.12. For trenching within the domain of public roads, approved fill material will be imported in accordance with the method statement described in Section 3.
- All excavated soil material will be managed on site in accordance with the CEMP provided in Appendix 3.1.
- Silt fencing will be provided around any exposed areas to prevent the ingress of suspended solids into adjacent watercourses. These mitigation measures will prevent surface water contamination and will prevent subsequent flows of contaminated water into watercourses.

Post-mitigation Impact (residual impact): Negative, Direct, Negligible, Brief, Unlikely.

Not significant residual impacts on hydrology and water quality are anticipated.

10.7.2.2 Hydrocarbons

- Refueling of plant during construction will only be carried out at least 50m from any open water body.
- Storage of fuels, lubricants and hydraulic fluids will occur at the contractor's compound, which will be fenced and have a lockable gate, thereby ensuring that the area in which fuels, lubricants and hydraulic fluids are stored will be properly secured against unauthorized access or vandalism.
- Emergency drip trays and spill kits will be kept available on site, to ensure that any spills from vehicles are contained and removed off site. The emergency response procedure is provided in SWMP provided in Appendix 10.3.
- Designated contractors' personnel will be trained and certified in oil spill control and clean up procedures, and in the proper and safe disposal of any waste generated through such an event.
- Any diesel, fuel or hydraulic oils stored on site will be stored in bunded storage tanks – the bund area will have a volume of at least 110 % of the volume of such materials stored.

Post-mitigation Impact (residual): Negative, Direct, Negligible, Brief, Unlikely.

Not significant residual impacts on hydrology and water quality are anticipated.

10.7.3 Proposed Mitigation Measures During Turbine Delivery

There are not specific mitigation measures required for works associated with TDR, except for Node 10.5.
The following mitigation measures are proposed:

- Weather forecasting will be used to plan dry days. This is to avoid sediments and debris being flushed into the stream.

- Trimmed vegetation and segments of the removed wall will be removed from this area and disposed of as licensed facility as described in Section 3.6.12. .
- There will be no refuelling or fuel storage at least 50m from any waterbody.

The significance of the effect of the works associated with TDR on the receiving waters is "**Not Significant**".

10.7.4 Proposed Mitigation Measures during Operation and Maintenance

The main hydrological impact of the project is an increase in runoff. This is mitigated by the drainage system. It is anticipated that the drainage system will increase time of concentration and consequently the peak runoff will be decreased. The drainage system will be left in-situ during operational stage.

When operational, the project will have a negligible effect on surface water quality as there will be no further disturbance of soils post-construction.

The following mitigation measures are proposed for replacing or removal of the wind turbine blades:

- Emergency drip trays and spill kits will be available on main wind farm site, to ensure that any spills from vehicles are contained and removed off site.
- Refuelling or maintenance of machinery will not occur within 50m of a watercourse. Mobile bowser, drip kits, qualified personnel will be used where refuelling is required.

Mitigation measures listed in Section 10.7.2.1 are proposed for replacing the grid connection cable.

During the operation stage, small quantities of oil will be used in cooling the transformers associated with the facility. There is therefore a potential for small oil spills. Risks of potential oil leakage and pollutions draining to the watercourse from the installed transformer is mitigated with transformer interceptor bund wall.

It is not envisaged that the maintenance period will involve any significant impacts on the hydrological regime of the area. The maintenance will incorporate effective maintenance of the drainage system. The maintenance regime will include inspecting the following post extreme storm event:

- Drains, cross-drains and culverts for any blockages
- Outfalls to existing field drains and watercourses
- Roadside swales for any obstructions
- Swales
- Progress of the re-establishment of vegetation.

The maintenance regime will also include implementing appropriate remedial measures as required after the above inspections and testing the water quality at the outfalls at appropriate intervals. Visual inspections will be undertaken during the maintenance period in accordance with maintenance schedule in CIRIA C753.

With mitigation measures being applied, it is anticipated that there will be a '**not significant'** impact on hydrology and water quality during Operation and Maintenance stage of the project.

10.7.5 Proposed Mitigation Measures during Decommissioning

In the event of decommissioning of the wind farm site, the access tracks will be used in the decommissioning process. Drainage system will be fully functional. Mitigation measures applied during decommissioning activities will be similar to those applied during construction but will be of reduced magnitude.

For the access tracks and turbine foundations it is proposed that they are left in place and covered with local soil/topsoil at decommissioning stage. It is considered that leaving the turbine foundations, access tracks and hardstanding areas in-situ will cause less environmental damage than removing them.

The grid connection ducting and substation will be left in situ as part of the national grid, therefore no potential impacts during decommissioning stage are likely to occur. Hence no mitigation measures are required.

With mitigation measures being applied, it is anticipated that there will be a '**not significant'** impact on hydrology and water quality during Decommissioning stage of the project.

10.8 Summary of Residual Impacts

The residual impacts are summarised below for each stage of the proposed development.

10.8.1 Residual Impacts during Construction Stage

The potential impacts associated with the construction of the wind farm site, GCR, TDR include:

- Increased runoff,
- Release of sediments,
- Release of hydrocarbons,
- Release of cement based-products,
- Release of wastewater disposal,
- And release of nutrients to receiving waters.

The effect of the impacts on hydrology and water quality will be mitigated with measures outlined in Section 10.7. This will ensure that the residual impacts of the construction stage are **Not significant**.

10.8.2 Residual Impacts during Operational and Maintenance Stage

There are no significant residual impacts relating to hydrology and water quality as the increased surface runoff measures are implemented and sedimentation release to watercourses is unlikely to occur as there is no disruption in soils.

With mitigation measures being in place, the residual impacts during Operational and Maintenance stage are **Not significant**.

10.8.3 Residual Impacts during Decommissioning Stage

Decommissioning stage impacts will be much less than construction stage as drainage system is already in place and much less ground disturbance works as new tracks and hardstanding areas will be left in place and/or covered over and revegetated.

Infrastructure associated with the grid connection will form part of the national transmission network and will be left in-situ. Therefore, no impacts are envisaged.

With mitigation measures being in place, the residual impacts during Decommissioning stage are **Not significant**.

10.9 Cumulative Impact

As part of the assessment of cumulative impacts, planning searches were undertaken using Cork County Council online planning enquiry portals, An Bord Pleanála website and the EIAR portal to search for large scale developments within 20km of the proposed Annagh wind farm project area. The CCC planning portal was also searched for small scale developments. The majority of the applications were of a scale and/or distance that they would not cause a cumulative effect in relation to Hydrology and Water quality.

Cumulative impact from a hydrological point of view can only occur if assessed developments are hydrologically linked. The major developments which are in the same sub-basin and within 10km from the proposed wind farm are listed below:

- Replant Lands (Forestry Replanting)
- Tree Felling
- Solar farm at Fiddane, Charleville, Co. Cork
- Solar farm at Ballyroe, Charleveille, Co. Cork
- Boolard wind farm
- Rathnacally wind farm
- N/M20 Motorway
- Knockatalig wind farm
- Castlepook wind farm
- Kilberrihert wind farm
- Kilmeedy wind farm
- Dromdeeveen I & II wind farm
- Private Turbine

Replant Lands (Forestry Replanting)

Replant sites have been identified at Emlagh, Co. Clare.

The total area approved for replanting is 14.5 ha. The site is located in the townland of Emlagh, 2.8 km from the village of Moyasta in Co. Clare. The site lies at an elevation of < 40m sloping gently from west to east.

There is one natural watercourse present on site flowing along the north-eastern boundary (length along boundary 240 m). This is approximately 0.5m deep (down a 1m bank), slow flowing in a southerly direction and with a silt and gravel substrate. It is little vegetated except along its banks. It flows south eastward, discharging into Poulnasherry Bay (Lower River Shannon SAC), near Moyasta up to 3 km downstream. Drainage channels present are approximately 1m deep, 1m wide but with little water flow, being clogged with vegetation and silt. They discharge/filter into the on-site natural watercourse.

The proposed forestry replanting site is remote from the site of the Proposed Development (in County Clare), and they are not within the same surface water catchment. There is no hydrological connectivity between the replanting site and the site of the Proposed Development, and therefore there can be no cumulative effects or interactions at any phase of the development.

Tree felling

Tree felling process and construction of the proposed wind farm will have a negative impact of water quality if no mitigation measures are being applied. With mitigation measure listed in Section 10.7.1 being applied, residual impact of tree felling and construction of the proposed wind farm is not significant. Therefore, there is no cumulative impact.

Charleville Solar farm at Fiddane, Charleville

The Charleville solar farm at Fiddane, Charleville is located approximately 0.1km North of the proposed wind farm site and is hydrologically linked to it. Environmental impact assessment screening report of the solar farm concluded that there will be no significant environmental impact as a result of the development. As stated in Section 10.4.2 the increase in runoff due to the construction and operational stage of the project is 'not significant'. This will be further reduced with the drainage system within the wind farm site. The release of suspended solids and pollutants during the construction of the proposed wind farm will be mitigated by proposed mitigation measures described in Section 10.7. The impact of works associated with GCR and TDR are not significant on hydrology and water quality. Following above, it is concluded that the cumulative impact on hydrology and water quality is not significant.

Solar farm at Ballyroe, Charleville

Solar farm at Ballyroe, Charleville is located approximately 1km south-east of the proposed wind farm site and is hydrologically linked to the wind farm site. The Solar Farm (2) is located in Awbeg (Buttevant)_010 sub-basin. The GCR and TDR run through this sub-basin. The impact of works associated with GCR and TDR are not significant on hydrology and water quality. Therefore, the cumulative impact is not significant.

Boolard Wind Farm

The Boolard Wind Farm is located approximately 2.4km North West of the proposed wind farm site and is hydrologically linked to it. It is situated within Oakfront_010 sub-basin. The Boolard wind farm is operational, therefore, no soil disruption and release of suspended solids is anticipated. As stated in Section 10.4.2 the increase in runoff due to the construction and operational stage of the project is 'not significant'. This will be further reduced with the drainage system within the wind farm site. The release of suspended solids and pollutants during the construction of the proposed wind farm will be mitigated by proposed mitigation measures described in Section 10.7. The impact of works associated with GCR and TDR are not significant on hydrology and water quality. Therefore, the cumulative impact on hydrology and water quality is not significant.

Rathnacally Wind Farm

The Rathnacally Wind Farm is located approximately 2.3km east of the proposed wind farm site and is not directly hydrologically linked to the wind farm site. The Rathnacally Wind Farm is located in Awbeg (Buttevant)_010 sub-basin. The GCR and TDR run through this sub-basin. The impact of works associated with GCR and TDR are not significant on hydrology and water quality. The Rathnacally wind farm is operational, therefore, no soil disruption and release of suspended solids is anticipated. Therefore, the cumulative impact is not significant.

N/M20 Motorway

The proposed Cork-Limerick improvement scheme is not in the same sub-basin as the proposed wind farm. Therefore, it is concluded there is no potential for cumulative impact.

Knockatalig Wind Farm

The Knockatalig Wind Farm is located approximately 8.6km east of the proposed wind farm site and is not hydrologically linked to it. Therefore, there is no potential for cumulative impact.

Castlepook wind farm

The Knockatalig Wind Farm is located approximately 9.7km east of the proposed wind farm site and is not hydrologically linked to it. Therefore, there is no potential for cumulative impact.

Kilberrihert wind farm

The Kilberrihert Wind Farm is located approximately 9km south of the proposed wind farm site and is not hydrologically linked to it. Therefore, there is no potential for cumulative impact.

Kilmeedy wind farm

The Kilmeedy Wind Farm is located approximately 16km north of the proposed wind farm site and is not hydrologically linked to it. Therefore, there is no potential for cumulative impact.

Dromdeeveen I & II wind farm

The Dromdeeveen I & II wind farm is located approximately 20km west of the proposed wind farm site and is not hydrologically linked to it. Therefore, there is no potential for cumulative impact.

Private Turbine

The Private turbine is located approximately 12km west of the proposed wind farm site and is not hydrologically linked to it. Therefore, there is no potential for cumulative impact.

Replant Land

The replant land is located approximately 70.2km north-west of the proposed wind farm site and is not hydrologically linked to it. Therefore, there is no potential for cumulative impact.

10.10 Conclusion

As a result of the construction of the wind farm site, surface water runoff is likely to increase by 0.174 m^3/s (or 0.20 %) for 1%AEP event due to changes to hard surfaces if unmitigated. Increase in runoff due to construction of the development is not significant and the peak runoff will be mitigated by the drainage system. Surface water drainage measures, pollution control and other preventative measures have been incorporated into the project design to minimise significant adverse impacts on water quality and downstream designated sites.

In total, 14 new crossings will be constructed. One single span bridge over the Oakfront Stream and 13 new crossings over the small field and forestry drains.

During the construction of the wind farm site there will be disturbance of the soils. Earthwork activities can result in the release of suspended solids into the receiving bodies. This can have significant negative impact on water quality. Releasing surface runoff without implementing sediment control measures is not acceptable for receptors. With the proposed mitigation measures detailed in Section 10.7 the impact of the release of suspended solids is **Not significant**.

During the construction period there is also a potential release of the hydrocarbons, wastewater disposal and cement based products. With the proposed mitigation measures the significance of the impacts are **Not Significant**.

When operational, the wind farm will have a negligible effect on surface water quality as there will be no further disturbance of soils post-construction. In the event of decommissioning of the wind farm site, the access tracks will be used in the decommissioning process. Mitigation measures applied during decommissioning activities will be similar to those applied during construction phase.. Thus, the significance of the impacts is **Not Significant**.

The river status of the receiving waters of the wind farm site are classified as 'Poor' and 'Unassigned'. Waterbody risk is classified as 'At Risk' and 'Review'. Regardless of their current quality, surface waters should be treated the same in terms of the level of protection and mitigation measures employed (there should be no negative change in status). Strict mitigation measures in relation to maintaining a high quality of surface water runoff from the development will ensure that the status of surface waterbodies in the vicinity of the site will be maintained regardless of their existing status.

By implementing the mitigation measures outlined in Section 10.7, it is not anticipated that deterioration in WFD classifications will occur for the waterbodies described in 10.3, which includes the Blackwater River (Cork/Waterford) SAC.

Grid connection route will cross the Rathacally stream at one location. The proposed method of crossing is HDD. With the implementation of the proposed mitigation measures, the significance of the impacts associated with the grid connection route is **Not significant**.

Turbine components will be delivered along the route as described in Section 3 of this report. Minor works (furniture removal, vegetation trimming, tree removing, placement of temporary load bearing surface) will be required along the TDR to accommodate the delivery. The significance of the effect of the works associated with TDR onto the receiving waters is **Not Significant**.

The residual and cumulative impacts of the proposed development are **Not significant**. This will be achieved with the proposed mitigation measures detailed in Section 10.7.

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ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR) FOR THE PROPOSED ANNAGH WIND FARM, CO. CORK

VOLUME 2 – MAIN EIAR

CHAPTER 11 – POPULATION, HUMAN HEALTH & MATERIAL ASSETS

Prepared for: EMPower

EMPower

Date: November 2021

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11. POPULATION, HUMAN HEALTH & MATERIAL ASSETS

11.1 Introduction

This chapter of the Environmental Impact Assessment Report (EIAR) examines the potential effects of the proposed Annagh Wind Farm on Population, Human Health and Material Assets. The chapter includes a description of the existing environment in respect of population, human health and material assets and considers the likely effects arising from the proposed project during construction, operation and decommissioning under the following elements:

- Population;
- Employment and Economic Activity;
- Land Use;
- Recreation, Amenity and Tourism;
- Human Health and Safety; and
- Renewable Resources, Non-renewable Resources and Utility Infrastructure.

The proposed Annagh Wind Farm project potentially poses a wide range of sources of effects from which subsequent potential impacts may arise for the elements listed above. These aforementioned elements focus on human interaction with the proposed project. The assessment presented in this chapter draws upon the findings of other chapters throughout the EIAR, including air quality, noise, shadow flicker, traffic & transport, landscape and visual impacts and telecommunications & aviation. These EIAR chapters are addressed separately in Chapters 6, 7, 12, 13, 15 and 16 of Volume 2 of this EIAR respectively. Potential effects associated with lands, soils and geology are discussed in Chapter 9 and potential effects associated with hydrology and water quality are discussed in Chapter 10 of this EIAR. In addition, other assessments are set out including those relating to potential effects on population statistics, socio-economics, changes to land use, facilities, human perception, human safety and potential effects on resources.

Material assets relating to transport infrastructure are dealt with in Chapter 13: Traffic and Transportation. Material assets with respect to natural resources are considered in Chapter 9: Lands, Soil and Geology, Chapter 10 Hydrology and Water Quality, Chapter: 6 Air Quality and Climate, and Chapter 8: Biodiversity. Assets of Archaeological, Architectural, and Cultural Heritage are considered in Chapter 14 of Volume 2 of this EIAR. The findings of these chapters in terms of the potential and residual effects on population and human health are drawn upon in this chapter.

Throughout this chapter the ‘proposed development’ refers to the elements of the project for which consent is being sought as set out in Chapter 3. This comprises the wind farm site including turbines, hardstandings, met mast, substation, access tracks, associated infrastructure and grid connection and associated works. The ‘project’ refers to all elements including the proposed development, works involving the Turbine Delivery Route (TDR) and replant lands. An Appropriate Assessment Screening Report and Natura Impact Statement for the replant lands element of the project is presented in Appendix 3.3 of Volume 3 of this EIAR. The replant lands are assessed Cumulative in each technical chapter throughout the EIAR.

For assessment purposes within this chapter, the proposed project is separated into three distinct elements. The wind farm site will be referred to as the ‘Wind Farm Site’.

The area of the proposed grid connection route cable infrastructure will be referred to as the 'GCR' and the area of the Turbine Delivery Route will be referred to as the 'TDR'.

11.2 Methodology

This chapter of the EIAR which assesses potential effects on population, human health and material assets has been prepared following a review of the National Planning Framework, The Regional Spatial and Economic Strategy for the Southern Region, and the Cork County Development Plan 2014.

This chapter of the EIAR has been completed in accordance with the guidance set out by the Environmental Protection Agency (EPA), in particular, the Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports' (EPA, August 2017), The Government of Ireland's Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (August, 2018) and the European Union's guidance document: Environmental Impact Assessment of Projects: Guidance on the preparation of the Environmental Impact Assessment Report as per Directive 2011/92/EU as amended by 2014/52/EU. The determination of significance of effects is in line with the EPA's Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports' (EPA, August 2017).

Population

Demographic data has been sourced from the Central Statistics Office (CSO)'s Census of Ireland (2006 to 2016) records. Demographic information relating to the State, County Cork, and the 'Study Area' has been assessed to establish the existing demographic trends. The demographic analysis of the study area as set out in this Chapter is defined in terms of Electoral Divisions (EDs), within which the wind farm site boundary is contained and within which the GCR works and TDR are contained. The area of the TDR considered for the purposes of assessment of potential effects on population trends covers only the section of the TDR along the L1322 local road between the proposed site entrance and the N20, where significant accommodation works are required. Areas of the TDR located along national primary routes between the Port of Foynes and the junction of the N20 and L1322 at Ballyhea have been screened out as effects on population trends are likely to be imperceptible due to the transient nature of the delivery of turbine components and the limited works associated with the accommodation works at each point of interest along the national road corridor.

Therefore, for the purpose of this aspect of the assessment, there are four separate Electoral Divisions contained within the 'Study Area' as follows:

- Ardskeagh (includes a section of the TDR);
- Churchtown (includes the wind farm site and GCR);
- Milltown (includes the wind farm site and GCR);
- Springfort (includes the wind farm site and GCR).

The Study Area including the Wind Farm Site, GCR and TDR are identified in Figure 11-1.

Eircode data (2020), Geodirectory data, and planning application lists sourced from Cork County Council, An Bord Pleanála and the Department of Housing and Local Government's EIA Portal have been assessed to identify any commercial or residential receptors in proximity to the proposed development.

These sources were assessed in April 2021. Eircode and Geodirectory data provides locations (geographic coordinates) for registered addresses. This information was ground-proofed with a house survey where a surveyor travelled the Wind Farm Site and identified locations of all residential receptors in proximity to the proposed wind farm. A desktop house survey was carried out for the GCR and TDR where temporary works are proposed. A planning search was conducted to identify permitted unbuilt dwellings and planned dwellings which do not appear on Eircode or Geodirectory Databases and are not visible from ground proofing exercises.

The data gathered has informed the consideration of effects on the existing population within the immediate environs of the proposed development and allows for a comprehensive assessment of the potential effects on population trends which may occur during the construction, operational, and decommissioning phases of the proposed development.

Socio-Economics

A socio-economic profile of the existing environment was established using live register data (2018 to 2021) and Census (2016) data to outline an employment profile of the study area. Peer reviewed research from the Institute for Sustainable Futures and the European Wind Energy Association was referred to in order to estimate the employment which the proposed development has the potential to create through the construction, operation and decommissioning phases of the proposed development, and the effect this employment will have on the study area.

Land Use

Land use in the area was examined to determine potential effects on existing land use patterns which may arise as a result of the proposed development. Corine Land Cover data (2018) was studied and observation was carried out throughout the site surveys to determine land uses in the study area. The effect of the proposed development was then considered with regard to these land uses. As detailed in Chapter 5, the Felling Section of the Department of Agriculture, Food and the Marine have requested that potential effects to land use, i.e. the conversion of forestry to another type of land use, should be considered in the EIAR.

Recreation, Amenity & Tourism

With regard to Recreation, Amenity and Tourism, Fáilte Ireland published 'Guidance on how to assess impact on tourism as part of an Environmental Impact Assessment.' This document has been considered and is referred to in Section 11.6 of this Chapter. The document informed the methodology used in assessing potential effects on Recreation, Amenity and Tourism. A profile of tourism in the region was established through examination of Fáilte Ireland Statistics in order to indicate the strength of Recreation and Tourism in the surrounding region. Recreation and amenity facilities and attractions in the area were identified through a desktop study and distances from the proposed development were established. Potential effects as a result of the proposed development were then considered in relation to the tourism profile, amenity and recreation facilities and attractions of the area.

Human, Health & Safety

The assessment on human health and safety has regard to the Environmental Protection Agency's (EPA US) Human Health Risk Assessment process which provides information on potential human health impact.

CSO data (2016) and reports published by the Department of Health were examined to establish a baseline health profile of the study area. Criteria of potential effects on human health was extracted from this literature in order to assess potential effects on human health as a result of the proposed development. A desktop examination of potential hazardous land uses in the study area was carried out and vulnerability of the project to natural disaster was assessed through a desktop geographical study and literature review. The assessment was further informed by field surveys and assessments which were completed as part of the EIA process. Potential effects to human health as described throughout this EIAR are detailed in this Chapter, including potential effects on air quality, noise and traffic and potential effects on human safety including potential for flood risk and slope failure.

Renewable Resources, Non-renewable Resources and Utility Infrastructure

An examination of material assets was carried out which includes renewable and non-renewable resources and utility infrastructure. A desktop study established material assets of the area such as quarries, peat bogs and other natural resources, in line with Geological Survey Ireland's scoping response as detailed in Chapter 5. Infrastructure and various telecommunications companies were contacted during the scoping process to identify infrastructure in the area. Potential effects on the identified material assets as a result of the proposed development were then examined.

As outlined in Chapter 5: EIA Scoping, Consultation, and Key Issues, prior to preparing the EIAR, statutory authorities and other relevant bodies were consulted. Key items of relevance to Population, Human Health and Material Assets, as raised by these parties have been addressed and referenced within this Chapter of the EIAR where relevant.

Consultation responses of relevance to the population, human health and material assets assessment were received from the Department of Agriculture, Food and the Marine, Failte Ireland, Gas Networks Ireland and Geological Survey Ireland as well as from the wider community through public consultation. The consultation responses received have been given due consideration in the formation of this chapter.

Cumulative Effects

In relation to cumulative effects for Population, Human Health, and Material Assets, the potential effect of the proposed project 'in combination' with other projects, constructed, proposed or permitted has been assessed. The cumulative impact assessment provides a baseline from which a full environmental assessment of the potential effects arising from the project in combination with other plans and projects can be considered comprehensively. A search for proposed, consented and existing projects was conducted within 15km of the proposed project, to identify development in proximity to the Wind Farm Site, GCR and TDR.

A 20km distance was considered a reasonable zone of influence for the purpose of assessing potential cumulative effects on population, human health and material assets, considering the limited size and extent of the project, the nature of the impacts and the relatively non-sensitive receiving environment. The geographic extent of the cumulative assessment is considered on a case-by-case basis, in line with the Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions (European Commission, 1999).

The 20km radius from the proposed turbines is considered relevant in line with the recommended study area for the zone of theoretical visibility of proposed wind farm projects as set out in the Wind Energy Development Guidelines (2006) which cites the use of a 20 km radius for blade tips greater than 100m.

This represents a visual study area for potential cumulative projects but also represents an appropriate study area for other potential cumulative effects including traffic, noise, water quality and air quality. It is considered that potential impacts beyond this distance are imperceptible.

Other less significant projects were also examined in close proximity to the Wind Farm Site, TDR and GCR where construction and operation of proposed, consented or existing projects may be effected by the construction activities of the proposed Annagh project. All development within 250m of the TDR nodes and the GCR were examined for potential cumulative effects. And all development within 2km of the wind farm site was also examined. It is considered that potential impacts posed by small scale projects beyond this distance will be imperceptible.

Monthly planning searches from November 2020 to September 2021 were carried out to identify proposed development in proximity to the Wind Farm Site, GCR and TDR. This included a search for major infrastructure projects in the zone of influence; large residential, renewable energy or commercial developments in the zone of influence; proposed or consented development within the immediate environs of the proposed project; as well as an examination of relevant plans and policies for the area as detailed in Chapter 4: Policy. Cumulative impact is further detailed in Section 11.10.

Mitigation Measures

Where potential significant effects have been identified, mitigation measures have been proposed. Residual impact is then considered which details potential effects following implementation of mitigation measures.

Do-nothing Scenario

A do-nothing scenario is outlined, in line with requirements of the EIA Directive 2014 which states: “The environmental impact assessment report to be provided by the developer for a project should include a description of …. an outline of the likely evolution of the current state of the environment without implementation of the project”. This section details the receiving environment as it would be in the future should the proposed project not be carried out.

References

Finally, all materiel which contributed to the establishment of the baseline conditions and assessment of potential impacts are referenced in Section 11.2, in line with requirements set out in the EIA Directive 2014.

Path: R:\Map Production\2020\P2359\Workspace\EIAR\P2359_GIS_Fig11-1_StudyArea_A3.mxd

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
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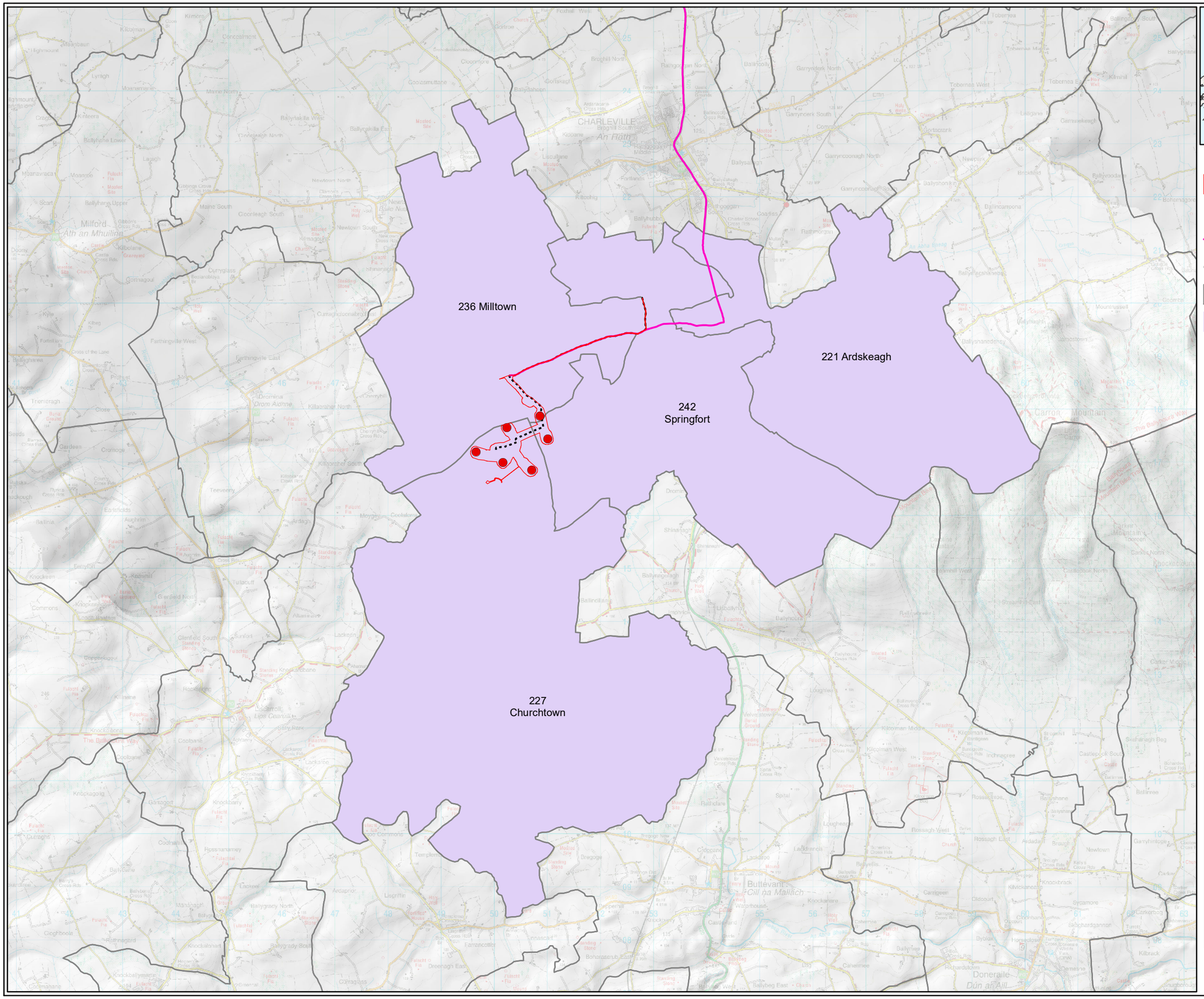

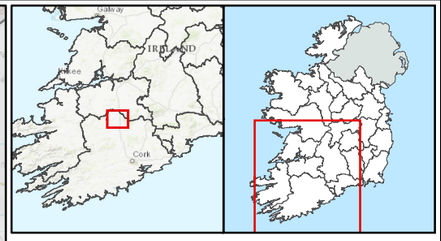

Legend

- Site Boundary
- Turbine Layout
- Turbine Delivery Route
- Underground Cable Route
- Electoral Divisions
- Site Electoral Divisions

N W E S

0 2.5 5 10 Kilometers

TITLE:	Site Location Map		
PROJECT:	Annagh Wind Farm, Co. Cork		
FIGURE NO:	11.1		
CLIENT:	EMPower		
SCALE:	1:70000	**REVISION:**	0
DATE:	14/10/2021	**PAGE SIZE:**	A3

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11.3 Population

Population relates to the people living in an area. Assessing the demographic makeup of an area can reveal insightful information to guide environmental considerations of a proposed development. This section provides an overview of the population profile for the Study Area, County Cork and the State between the Census years of 2006 and 2016 in order to create a baseline demographic profile of the receiving environment and identify potential effects on demographic trends arising as a result of the proposed project.

The study area for the purpose of assessing population has been chosen based on Electoral Divisions (EDs) within which the proposed project is located. As illustrated in Figure 11-1, this encompasses the EDs as set out in Table 11-1:

Table 11-1: Electoral Divisions Associated with the Study Area

Electoral Divisions of the Study Area
Ardskeagh
Churchtown
Milltown
Springfort

11.3.1 Existing Environment - Population

Population Growth

The proposed project is located in north County Cork directly west of the Ballyhoura Mountains. The wind farm site is located north west of Buttevant and south west of Charleville. The most proximate settlement is the village of Churchtown, located approx. 3km south of the wind farm site. The area is rural in character with settlement consisting of one-off houses and farmsteads focused around the local road network.

According to Eircode data 2020, there are 73 no. dwelling located within 1.5km of the turbine locations[1]. Of these 73 dwellings, 16 no. are also registered as commercial (farmsteads). There are no permitted dwellings yet to be constructed within 1.5km of the proposed turbine locations. There are 30 no. dwellings located along the proposed GCR. Figure 11-2 illustrates the residential receptors within the vicinity of the Wind Farm Site according to Eircode (2020) and Geodirectory data. This information is supported by the ground proofing survey and planning application search.

Population statistics for the State, Cork County and the 'Study Area' (EDs associated with the proposed wind farm site, GCR and TDR) are set out in Table 11-2.

[1] Based on straight line distance from centre of the proposed turbine locations

Table 11-2: Population Statistics 2006-2016

Area	Population			% Population Change		
	2006	2011	2016	2006-2011	2011-2016	2006-2016
State	4,239,848	4,588,252	4,761,865	8.2%	3.8%	12.3%
Cork County	361,877	399,802	417,211	10.5%	4.4%	15.3%
Study Area	2179	2477	2585	13.7%	4.3%	18.6%

The data presented in Table 11-2 demonstrates that the population of the Study Area increased by 13.7% between the 2006 and 2011 census years, with stronger growth in comparison to the State and County Cork. This growth greatly reduced between 2011 and 2016, in line with both the State and County figures, however the population growth rate of the study area remained higher than the State and County averages between 2006 and 2016. The village of Churchtown is located within the Study Area. The 2016 population of Churchtown was 598 persons.

Population Density

The population density recorded within the State, County Cork and the Study Area during the 2006, 2011 and 2016 Census are set out hereunder in table 11-3. Overall, the Study Area has a low population density associated with sparse rural settlement. This is contrast to the State-wide and County-wide population densities which show greater figures, with Cork County population density over double that of the Study area and State population density approximately 2.5 times that of the study area.

Table 11-3: Population Density between 2006 – 2016 (Persons per square kilometre)

Area	Population Density (Persons per square kilometre) 2006	Population Density (Persons per square kilometre) 2011	Population Density (Persons per square kilometre) 2016
State	60.3	65.3	67.8
Cork County	48.2	53.3	55.6
Study Area	22.1	25.2	26.3

Population - Existing Environment

As demonstrated above, the Study Area of the proposed Annagh Wind Farm is a rural area, with low population numbers and low population density when compared to the averages of the State and County Cork. Overall, the Study Area has a low population density associated with its rural nature. The settlement of Churchtown, located approx. 3km south of the wind farm site accounts for 23% of the total population of the study area.

The baseline population statistics presented above do not show any substantial rise or fall in population trends and therefore the study area is considered stable with respect to population growth and population density.

Path: R:\Map Production\2020\P2359\Workspace\EIAR\P2359_GIS_Fig11-2_NearbyResidentialReceptors_A3.mxd

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
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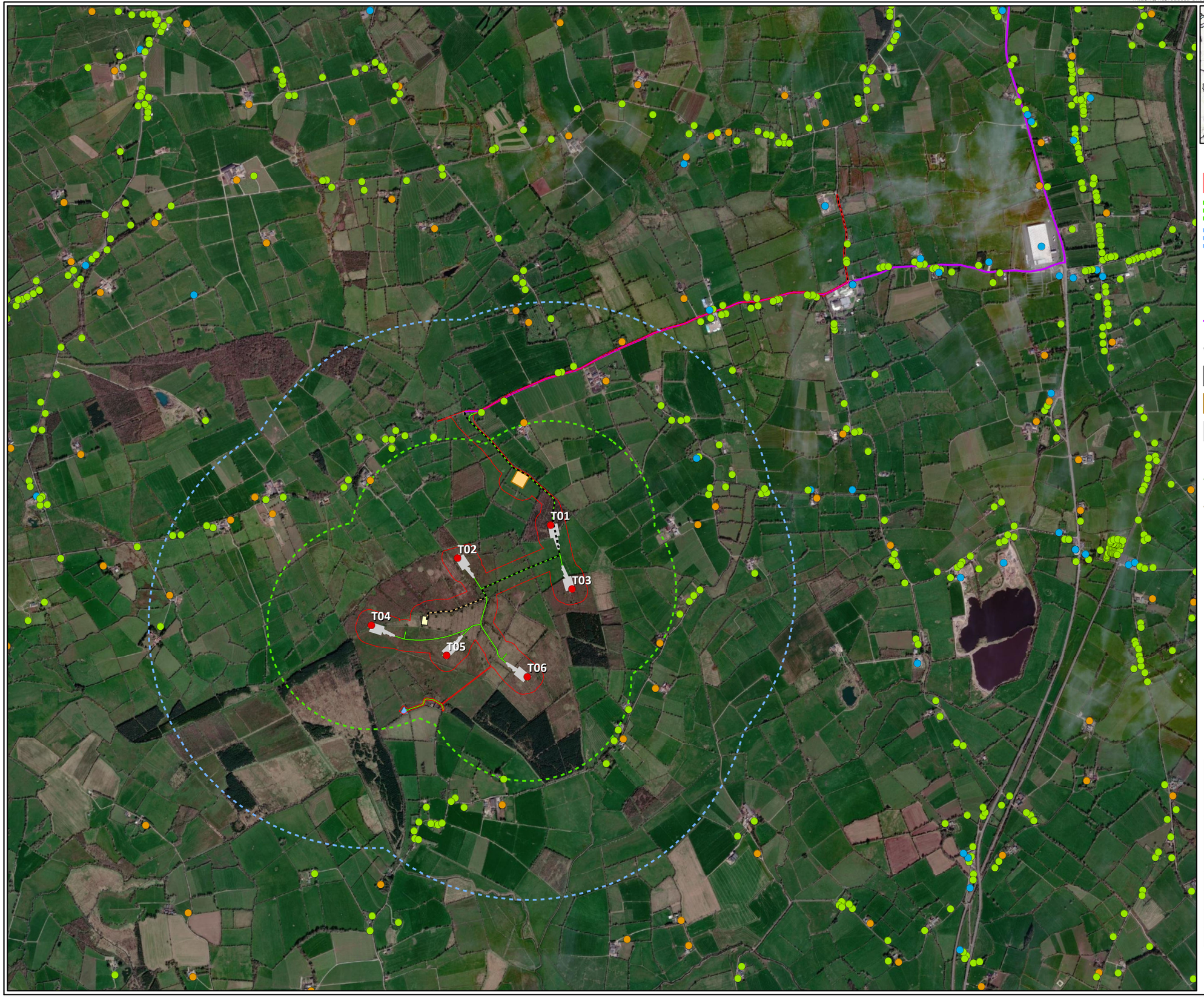

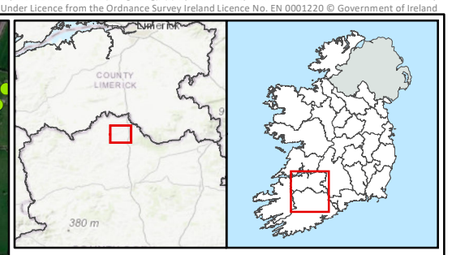

Legend

- Site Boundary
- Turbine Layout 700m Buffer
- Turbine Layout 1.5km Buffer
- Turbine Layout
- Met Mast
- Turbine Delivery Route
- Underground Cable Route
- Substation
- Construction Compound
- Turbine Hardstanding Area

Roads

- New
- Upgrade

Eircode

- Residential
- Commercial
- Residential and Commercial
- Unknown

N W E S

0 0.5 1 2 Kilometers

TITLE: Nearby Residential Receptors			
PROJECT: Annagh Wind Farm, Co. Cork			
FIGURE NO:	11.2		
CLIENT:	EMPower		
SCALE:	1:25000	**REVISION:**	0
DATE:	14/10/2021	**PAGE SIZE:**	A3

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Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
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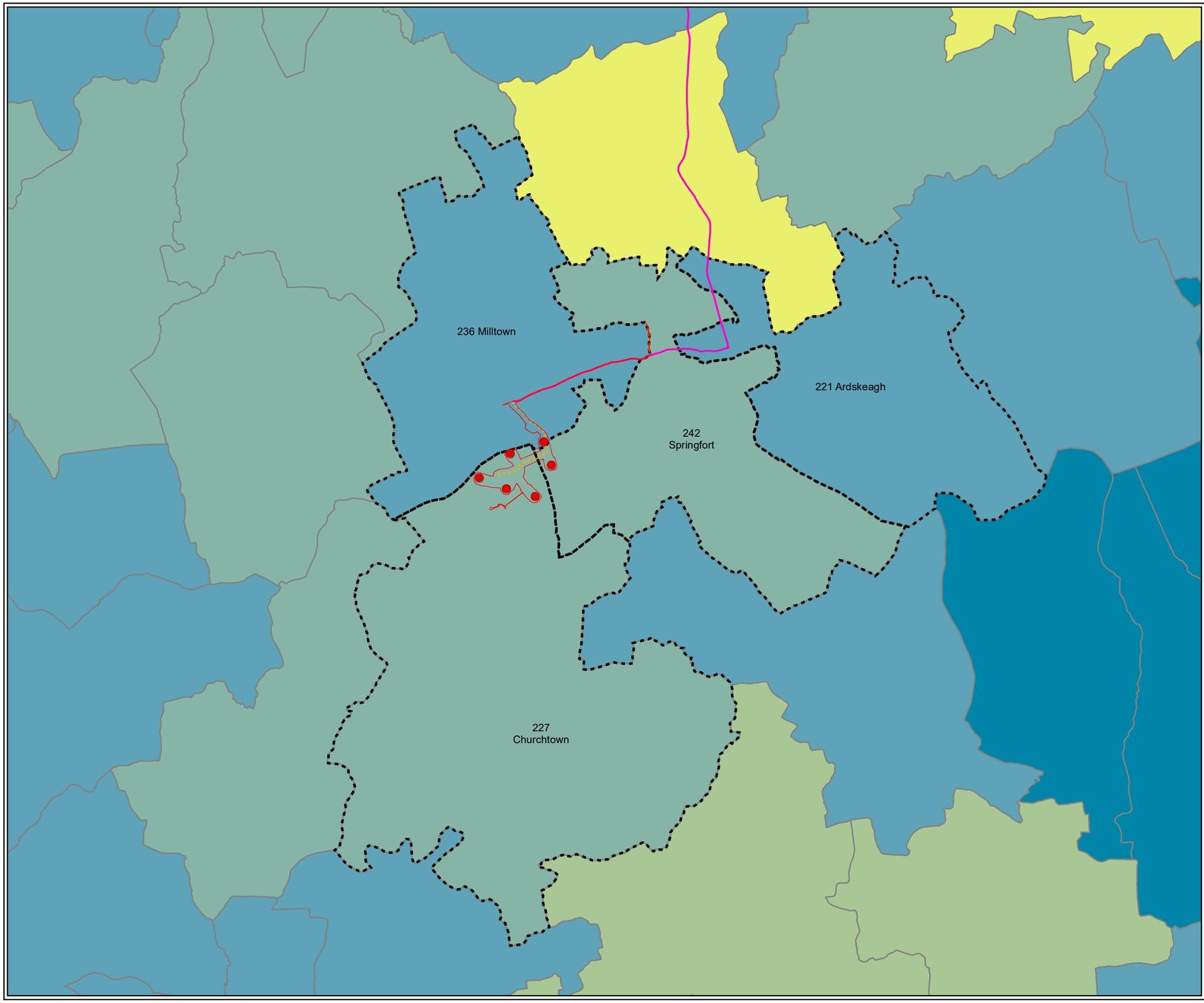

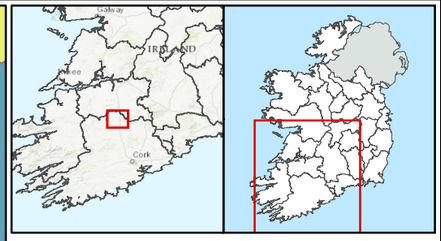

Legend

- Site Boundary
- Turbine Layout
- Turbine Delivery Route
- Underground Cable Route
- Electoral Divisions
- Site Electoral Divisions

Population Density 2016 by ED (sqkm):

- 1 - 10
- 11 - 25
- 26 - 50
- 51 - 75
- 101 - 250

TITLE: Site Location Map			
PROJECT: Annagh Wind Farm, Co. Cork			
FIGURE NO:	11.3		
CLIENT:	EMPower		
SCALE:	1:70000	**REVISION:**	0
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11.3.2 Potential Impacts on Population - Construction

The potential effects on population and demographic trends arising from the proposed project during its construction phase relate to potential population increase or decrease.

During the construction phase of the project, it is likely that many of the workers travelling to the site will do so from outside of the area. This is due to the large numbers expected to be employed at the project site. It is expected that workers from the locality within the immediate area will also be employed, however, the relatively low population available in the area, combined with a high percentage of employed persons, as identified in Table 11-5 in the following section, indicates that there is a limited available work force in the project area and therefore many workers employed at the construction site are likely to travel from the surrounding catchment of County Cork.

This will give rise to short-term/brief population growth at the wind farm site during working hours. This is associated with the direct employment of construction workers, trades people, labourers and specialised contractors. The construction phase of the wind farm site has potential to create between approximately 39 and 44 jobs. The employment projections are set out in section 11.4.2.

The population of the Study Area recorded in the 2016 Census was 2585 persons. An estimate of between 39 and 44 jobs associated with the construction works has potential to increase the population of the Study Area by between 1.4% and 1.5%. However, this increase is associated with daily construction works and therefore the population of the Study Area will increase daily during construction hours and return back to normal outside of working hours resulting in a brief increase to population numbers on a daily basis over the 12-18 month construction period. As construction work is temporary, it is unlikely that workers will take up residence in the area of the Wind Farm Site, however, it is likely that some workers will stay in accommodation within the Study Area or at nearby towns. Overall, this will result in a slight, short-term increase in population resulting in a slight, short-term neutral impact.

The construction works associated with the grid route will be undertaken on a rolling basis with short sections of road closed for short periods before moving onto the next section. It is expected that these works will be conducted over a 2-month period. Population of the GCR area will receive a slight increase in numbers during working hours. However, due to the transient nature of the grid route works, this is expected to have an insignificant temporary and neutral impact on the population of the GCR area.

Similarly, the temporary accommodation works associated with the TDR route are limited to 18 no. points along the route. It is expected that there will be a slight increase in numbers at these points along the TDR route during working hours for the construction of the accommodation works and temporary removal of signage/poles, however, as the works are limited, this temporary increase in population is considered brief to temporary and insignificant.

It is unlikely that permanent effects to population at the Wind Farm Site, GCR or TDR will occur, in terms of changes to population trends or population density as a result of the construction phase.

11.3.3 Potential Impacts on Population - Operational

Once constructed, it is envisaged that there will be direct and indirect employment associated with the operational phase of the proposed project. Opportunities for mechanical-electrical contractors and craftspeople to become involved with the operation and maintenance of the project will arise.

As set out in section 11.4.3 it is expected that the operational phase of the proposed development (wind farm site) could create between 12 and 14 long term jobs (with an installed capacity of approximately 37.2MW). These jobs include operations and maintenance, back office support and indirect jobs created by other activities related to installed turbines including IPP/utilities, consultancy firms, research institutions, universities and financial services.

Although only a small proportion of these jobs are likely to be based in the Wind Farm Site, the operational phase will give rise to temporary, slight population increase at the wind farm site during working hours as a result of operations and maintenance occurring at the site. This effect is expected to be brief and imperceptible.

It is unlikely that the population in proximity to the GCR and TDR will be affected during the operational phase of the Annagh Wind Farm as further works and activities in these areas are not envisaged.

11.3.4 Potential Impacts on Population - Decommissioning

The decommissioning phase of the proposed project is described in Section 3.8 of this EIAR and provides for the removal of turbines and associated infrastructure from the site. The potential effects associated with the decommissioning phase in relation to population trends will be similar to those associated with construction phase but of a reduced magnitude.

A construction crew will be required for dismantling the infrastructure and carrying out remediation where necessary. As the decommissioning of the project is expected to be less intensive than the construction phase, it is likely that less construction workers will be required for this phase. During the decommissioning phase, the population of the Wind Farm Site will increase daily during working hours and return back to normal outside of working hours.

As removal works will be of relatively short duration, it is unlikely that workers will take up residence in the Study Area, however, it is likely that some workers will stay in accommodation within the area of the Wind Farm Site or nearby towns, resulting in potential brief to temporary population increases. The decommissioning phase is therefore likely to result in a slight, brief/temporary increase in population at the Wind Farm Site and nearby towns, producing a slight temporary impact on population trends. It is not likely that the decommissioning phase will result in any permanent impact to population in terms of changes to population trends and density.

The grid route element of the project will remain in situ following decommissioning. There is no expected effect on population along the GCR area as a result of the decommissioning phase. Similarly, there is no expected effect on population trends along the TDR as a result of the decommissioning phase.

11.3.5 Mitigation Measures - Population

As there are no significant effects predicted on population trends and population density, no mitigation measures are required.

11.3.6 Residual Impacts - Population

The residual effects of the proposed project with respect to population are associated with operation and maintenance jobs during the operational phase of the Annagh Wind Farm. This is likely to result in a temporary slight, neutral impact on population statistics due to population increase in Study Area during working hours.

As per the assessment of operational impacts, any impact to the population of the Wind Farm Site in terms of changes to population trends will be imperceptible. It is therefore unlikely that long term residual effects will occur to population and demographic trends as a result of the proposed project.

11.4 Socio-economics, Employment and Economic Activity

This section provides a comprehensive overview of the socio-economic, employment and economic activity associated with the receiving environment, including the Study Area, together with County Cork and the State as a whole. This provides an understanding of the overall socio-economic profile of the receiving environment and the potential effects arising from the proposed Annagh Wind Farm Project.

11.4.1 Existing Environment – Socio-economic, Employment and Economic Activity

Live register data (CSO, 2019) provides information relating to the number of people registering for Jobseekers Benefit, Jobseekers Allowance, or for various other statutory entitlements. The figure is useful to gauge unemployment estimations for an area, however, it is noted that the Live Register data includes part-time workers (working up to three days per week), seasonal workers and casual workers who are entitled to Jobseekers Benefit or Jobseekers Allowance and therefore, cannot be relied upon entirely for conclusive employment data. Furthermore, 2020 saw a significant increase in unemployment throughout the country due to the COVID-19 pandemic. Live register data is presented below in Table 11-4 for the State and County Cork.

Table 11-4: Live Register Data for Cork County and the State March 2018 – March 2021

	March 2018	March 2019	March 2020	March 2021
Cork County	20,582	15,598	15,810	15,059
State	232,366	192,407	205,209	184,550[2]

Source: CSO & data.gov.ie

Between 2018 and 2021 unemployment trends in County Cork and the State as a whole experienced a significantly reduction, where numbers recorded on the live register dropped by 21% throughout the State and 23% in County Cork. Likely part-due to the negative economic impact associated with COVID-19, numbers of people on the live register increased from 2019 to 2020 by 7% across the State and by 1.5% across County Cork. These numbers have since decreased by 10% across the State and by 4.7% across County Cork between March 2020 and March 2021.

Taking account of 2016 Census population figures as detailed in section 11.3.1, this represents an unemployment rate of 4% across the State, and an unemployment rate of 3.6% across County Cork, indicating a greater average unemployment for the State as a whole compared to County Cork.

The Census (2016) has published figures of Ireland's working population aged 15 to 64 for Electoral Divisions, allowing for a greater insight into the Study Area's socio-economic profile.

[2] Totals for 2021 do not include persons in receipt of the Pandemic Unemployment Payment (PUP)

The basic indicator for employment is the proportion of the working-age population aged 15-64 who are employed. Table 11.5 sets out the percentage of the total population aged 15+ who were in the labour force during the 2016 Census. Table 11.5 also sets out those who were not in the labour force, this includes students, retired people, those unable to work, persons performing home duties etc.

Table 11-5: Economic Status of the Total Population Ages 15+ in 2016

	Status	State	County Cork	Study Area
% of Population aged 15+ which are:	At Work	53%	56%	52%
	First time job seeker	1%	1%	0%
	Unemployed	7%	5%	6%
	Student	11%	11%	10%
	Home duties	8%	9%	10%
	Retired	15%	14%	17%
	Unable to work	4%	4%	5%
	Other	0%	0%	0%

As set out in Table 11-5, overall, the principal employment status in 2016 across the State, County Cork and the Study Area is 'at work' with between 52% and 56% at work across the State, County Cork and the Study Area. The Study Area has a smaller percentage of persons 'at work' compared to County Cork with 4 percentage points less, while the percentage of persons 'at work' within the Study Area is approximately the same as the State with 1 percentage point difference. Unemployed persons within the Study Area is similar to that of the State and County while the Study area has slightly higher percentage of retired persons compared to the State and County.

The Census (2016) also indicates the employment composition of Electoral Divisions, an important element of the socio-economic profile of an area. As detailed in Table 11-6, the employment sectors for each of the areas show similarities with professional services and commerce and trade being the largest share across the State, County and Study Area. The Study Area has a higher percentage of employment from the Manufacturing Industry compared to the State and County.

Overall, the economic profile of the Study Area does not show any major disparities when compared to the National and County-wide average socio-economic statistics. County Cork has a slightly lower unemployment rate compared to the State. This is reflected in the unemployment numbers recorded in the 2016 Census for the Study Area which are on average lower than the State. In general, the baseline conditions of the study area shows healthy socio-economic characteristics.

Employment activities within the Study Area consists mainly of agriculture and forestry as detailed in Section 11.5: Land Use. Large manufacturing and distribution centres are also located within the study area. Centres of employment in the greater area include Charleville, Buttevant and Mallow which have a range of town centre services and industry.

Smaller villages in proximity to the study area including Churchtown, Ballyhea, Liscarrol and Dromina which provide local services including shops, pubs and food places.

Table 11-6: Industry Distribution by Area

Persons at Work by Industry	State	County Cork	Study Area
Agriculture forestry & fishing	4%	16%	16%
Building & construction	5%	6%	5%
Manufacturing industries	11%	10%	17%
Commerce and trade	24%	21%	20%
Transport and communications	9%	6%	5%
Public administration	5%	6%	5%
Professional services	24%	24%	24%
Other	18%	12%	8%

11.4.2 Potential Impacts – Socio-economics, Employment and Economic Activity - Construction

The site preparation and installation of the Annagh Wind Farm will create temporary employment within the study area.

According to the European Wind Energy Association's (EWEA) Report 'Wind at Work' (2009), 1.2 jobs per MW are created during installation of wind energy projects. Using this figure, a projection of approximately 44 jobs could be created as a result of the construction of the proposed development (for an installed capacity of approximately 37.2MW).

The Sustainable Energy Authority of Ireland' 2015 report 'A Macroeconomic Analysis of Onshore Wind Deployment to 2020' puts direct construction jobs from wind farm developments at 1.07 jobs per MW. Using this figure, a projection of approximately 39 jobs could be created as a result of the construction of the proposed development (for an installed capacity of approximately 37.2MW).

Therefore, considering the minimum and maximum figures, it is estimated that between approximately 39 and 44 staff/contractors could be employed during the construction phase of the proposed project. The employment of tradespeople, labourers, and specialised contractors for the construction phase will have a direct, short-term significant, positive effect on employment in the study area.

It is likely that there will be direct employment for people living in the Study Area who may be qualified for construction related roles. Materials will also be sourced in the general locality where possible. This will assist in sustaining employment in the local construction trade.

Furthermore, local businesses in the nearby towns of Charleville, Buttevant and Mallow and villages including Churchtown, Ballyhea, Liscarrol and Dromina will likely receive a slight indirect positive economic impact due to the influx of workers to the area who will require services such as shops and food places.

As a result, the construction phase of the proposed development will have a short-term, significant positive effect on the employment profile of the Study Area and a short-term slight, positive effect on local businesses and services in the nearby towns and villages in proximity to the Study Area.

11.4.3 Potential Impacts – Socio-economics, Employment and Economic Activity - Operational

11.4.3.1 Economic Value & Employment Potential

The proposed project will contribute to achieving Ireland's energy targets as set out in the Climate Action Plan 2019, which has a target of 70% of electricity generated from renewable sources by 2030. With a target increase in onshore wind of 8.2GW by 2030, the Annagh Wind Farm has the potential to contribute to 0.4% of this total.

The Sustainable Energy Authority of Ireland's (SEAI) Energy in Ireland 2020 Report states that wind energy provided Ireland with 32% of its electricity in 2019, up 4% from 2018. The use of renewables in electricity generation reduced CO2 emissions by 4.8 million tonnes in 2019, avoiding approximately €297 million in fossil fuel imports for that year. It is estimated that wind energy alone resulted in the avoidance of approximately €248 million in fossil fuel imports and avoided 3.9 million tonnes of CO2 emissions in 2019. These savings will continue to rise with the installation of further wind energy and other renewable energy developments. Increased renewable electricity production as a result of the operational phase of the proposed development will likely have a positive medium to long-term economic effect due to the cost savings associated with the avoidance of fossil fuel imports. This will also act cumulatively with other proposed, consented and existing renewable energy projects throughout the country in providing cost savings, as discussed in section 11.10.

Once the proposed Annagh Wind Farm is constructed, it is envisaged that there will be direct and indirect employment associated with the operational phase of the proposed development. Opportunities for mechanical-electrical contractors and craftspeople to become involved with the operation and maintenance of the project will arise.

According to the European Wind Energy Association's (EWEA) Report 'Wind at Work' (2009), 0.4 long-term jobs are created per MW of total installed capacity. These jobs include operations, maintenance, back office support and indirect jobs created by other activities related to installed turbines including IPP/utilities, consultants, research institutions, universities and financial services.

A study carried out by the Institute for Sustainable Futures (2015) estimates that the operational and maintenance job output for a wind farm is 0.3 jobs per MW of total installed capacity based on an average of 7 studies examined. Based on this estimate, the proposed development. SEAI's 2015 report 'A Macroeconomic Analysis of Onshore Wind Deployment to 2020' estimates 0.34 jobs per MW for operations and maintenance of new wind turbines and in the wider electricity supply sector.

Therefore, based on these estimates and considering an installed capacity of up to 37.2MW, the operational phase of the proposed Annagh Wind Farm could produce between 12 and 14 jobs.

Although only a small proportion of these jobs are likely to be directly based at the Wind Farm Site, it is likely that the indirect jobs the operational phase will support, such as consultants, research institutions, universities and financial services, will provide an indirect, long-term slight, positive effect to the employment profile of the wider economy of County Cork.

It is likely that there will be direct employment available for people living in the Study Area who may be qualified for jobs associated with operation and maintenance. It is therefore considered that the operational phase of the proposed development has potential for an indirect, long-term slight, positive effect on employment in the Study Area, nearby towns and wider County Cork.

Rates and development contributions paid by the developer will contribute significant funds to Cork County Council which will likely be used to improve the services available to the people of the County. Business rates will also contribute significantly throughout the lifetime of the windfarm. General council services will benefit from rates and development contributions which include road upkeep, fire services, environmental protection, street lighting, footpath works etc., along with other local community initiatives and supports. This is likely to have a slight positive, long-term effect on resources of the Local Authority during the operational phase.

The terms of the Renewable Energy Support Scheme (RESS) states that all projects looking for support under the new RESS will need to meet pre-qualification criteria including the provision of a community benefit fund. This is discussed further in the following section.

11.4.3.2 Proposed Community Benefit Scheme

As set out in the terms of the Renewable Energy Support Scheme (RESS), all renewable energy projects applying for RESS will require a Community Benefit Fund prior to commercial operations of the project. The contribution for RESS 1 (2020), the first renewable energy auction under the new support program, required a contribution of €2/MWh for all projects. Furthermore, as part of RESS 1, the Community Benefit Fund will provide a minimum payment per annum of €1,000 to all dwellings located within a distance of 1 kilometre radius from RESS 1 projects and a minimum of 40% of the funds shall be paid to not-for-profit community enterprises, focusing on education, energy efficiency, sustainable energy and climate action, in line with UN Sustainable Development Goals, 4, 7, 11 and 13.

A draft Good Practice Principles Handbook was published in March 2021 setting out a range of principles, including the need to ensure community participation in fund decision-making via the establishment of a local committee which should ensure successful dispersal of funds throughout the community.

It is expected that for each megawatt hour (MWh) of electricity produced by the wind farm, the project will contribute €2 into a community benefit fund for the RESS period i.e. the first 15 years of operation. If this commitment is revised in upcoming Government Policy, the figures will be adjusted accordingly.

Assuming that the export capacity of the proposed development will be approximately 37.2MW and is contracted under the RESS, it is anticipated that the community benefit fund for the proposed Annagh Wind Farm has potential to deliver over €180,000[3] per year to the local community for the first 15 years of operations following the commissioning of the project.

The provision of the Community Benefit Fund will have a significant long-term, positive effect on the socio-economic profile of the study area and wider area, providing a regular payment to near neighbours of the project and providing for projects which will benefit the community as a whole, bringing long-term socio-economic benefits.

[3] Calculated using a capacity factor of 29.3 (2019 capacity factor for wind energy in Ireland, SEAI, 2020)

11.4.3.3 Property Values

In the absence of any Irish studies on the effect of wind farms on property values, this section provides a summary of the largest and most recent studies from the United States and Scotland.

The largest study of the impact of wind farms on property values has been carried out in the United States. 'The Impact of Wind Power Projects on Residential Property Values in the United States: A multi-Site Hedonic Analysis' (Hoen, et al. 2009), was carried out by the Lawrence Berkley National Laboratory (LBNL) for the U.S Department of Energy. This study collected data on almost 7,500 sales of single-family homes situated within ten miles of 24 existing wind farms in nine different American states over a period of approximately ten years. The conclusions of the study are drawn from eight different pricing models including repeat sales and volume sales models. Each of the homes included in the study was visited to demonstrate the degree to which the wind facility was visible at the time of the sale, and the conclusions of the report state that "The result is the most comprehensive and data rich analysis to date on the potential impacts of wind energy projects on nearby property values."

The main conclusion of this study is as follows:

> "Based on the data and analysis presented in this report, no evidence is found that home prices surrounding wind facilities are consistently, measurably, and significantly affected by either the view of wind facilities or the distance of the home to those facilities. Although the analysis cannot dismiss the possibility that individual or small numbers of homes have been or could be negatively impacted, if these impacts do exist, they are either too small and/or too infrequent to result in any widespread and consistent statistically observable impact."

This study has been recently updated by LBNL who published a further paper entitled "A Spatial Hedonic Analysis of the Effects of Wind Energy Facilities on Surrounding Property Values in the United States", (Hoen, et al. 2013). This study analysed more than 50,000 home sales near 67 wind farms in 27 counties across nine U.S. states, yet was unable to uncover any impacts to nearby home property values. The homes were all within 10 miles of the wind energy facilities - about 1,100 homes were within 1 mile, with 331 within half a mile. The report is therefore based on a very large sample and represents an extremely robust assessment of the impacts of wind farm development on property prices. It concludes that:

> "Across all model Specifications, we find no statistical evidence that home prices near wind turbines were affected in either the post-construction or post announcement/pre-construction periods."

Both LBNL studies note that their results do not mean that there will never be a case of an individual home whose value goes down due to its proximity to a wind farm – however if these situations do exist, they are considered to be statistically insignificant. Therefore, although there have been claims of significant property value impacts near operating wind turbines that regularly surface in the press or in local communities, strong evidence to support those claims has failed to materialise in all the major U.S. studies conducted thus far.

A further study was commissioned by RenewableUK and carried out by the Centre for Economics and Business Research (Cebr) in March 2014. Its main conclusions are:

- Overall the analysis found that the county-wide property market drives local house prices, not the presence or absence of wind farms.

- The econometric analysis established that construction of wind farms at the five sites examined across England and Wales has not had a detectable negative impact on house price growth within a five-kilometre radius of the sites.

A relatively new study issued in October 2016 'Impact of wind Turbines on House Prices in Scotland' (Heblich, et al. 2016) was published by Climate Exchange, Scotland's independent centre of expertise on climate change which exists to support the Scottish Governments policy development on climate and the transition to a low carbon economy.

The report presents the main findings of a research project estimating the impact on house prices from wind farm developments. It is based on analysis of over 500,000 property sales in Scotland between 1990 and 2014. The key findings from the study are:

- No evidence of a consistent negative effect on house prices: Across a very wide range of analyses, including results that replicate and improve on the approach used by Gibbons (2014), they do not find a consistent negative effect of wind turbines or wind farms when averaging across the entire sample of Scottish wind turbines and their surrounding houses. Most results either show no significant effect on the change in price of properties within 2km or 3km or find the effect to be positive.
- Results vary across areas: The results vary across different regions of Scotland. The data does not provide sufficient information to enable them to rigorously measure and test the underlying causes of these differences, which may be interconnected and complex.

Although there have been no empirical studies carried out in Ireland on the impacts of wind farms on property prices, the literature described above demonstrates that at an international level, wind farms have not impacted property values in the local areas. It is a reasonable assumption based on the available international literature, that the provision of a wind farm at the proposed location would not impact on the property values in the area and will therefore have a long-term imperceptible impact.

11.4.4 Potential Impacts – Socio-economics, Employment and Economic Activity - Decommissioning

The potential impacts associated with the decommissioning phase in relation to socio-economics, employment and economic activity will be similar to those associated with the construction phase but of a reduced magnitude.

A construction crew will be required for dismantling the infrastructure and carrying out remediation where necessary. As the decommissioning of the project is expected to be less intensive than the construction phase, it is likely that less construction workers will be required for this phase. During the decommissioning phase employment opportunities will be available at the Wind Farm Site and outlying areas. The influx of construction workers to the Wind Farm Site will have a temporary to short-term indirect positive impact on local businesses and services contributing to the local economy, similar to that of the construction phase but of lesser magnitude.

There will be a temporary to short-term slight, positive impact to socio-economics, employment and economic activity in the Wind Farm Site associated with the employment of construction workers within the vicinity of the development during the decommissioning phase.

11.4.5 Mitigation Measures – Socio-economics, Employment and Economic Activity

Given that potential effects of the proposed development at construction, operation and decommissioning phases are predominantly positive in respect of socio-economics, employment and economic activity, no mitigation measures are considered necessary.

11.4.6 Residual Impacts – Socio-economics, Employment and Economic Activity

The residual effects of the development with respect to socio-economics is considered to be slight positive effect with respect to employment. This is as a result of the employment opportunities associated with the operation and maintenance of the development. There will also be a temporary slight positive economic effect from income spent by construction workers in the local area.

As detailed in section 11.4.3.2, the Community Benefit Fund associated with the Renewable Energy Support Scheme (RESS) will provide a significant long-term, positive impact to socio-economic profile of the Wind Farm Site and greater community.

The terms of the Community Benefit Fund will also promote social-inclusion across the community as a minimum of 40% of the funds shall be paid to not-for-profit community enterprises, focusing on UN Sustainable Development Goals, 4, 7, 11 and 13 which include education, energy efficiency, sustainable energy and climate action.

Rates payments and development contributions have potential to improve service provision throughout County Cork and in the local area. This will likely have a slight positive, residual effect on resources of the Local Authority.

A positive residual effect is also envisaged in that wind energy decreases the cost of electricity. A cost benefit analysis of wind energy in Ireland was published by Baringa in association with IWEA in January 2019 (Baringa, 2019). The study indicates that the more renewable energy (low-cost) produced, the less dependency on fossil fuels is required which costs more per MW. The report states that the savings involved with wind energy outweigh the amount of funding provided to support wind energy through the public service obligation levy, therefore the more wind power produced, the less electricity will cost. The proposed project will result in a slight long-term positive impact for electricity users throughout the country.

Overall, the residual effect associated with socio-economics, employment and economic activity as a result of the proposed development is considered long-term significant and positive.

11.5 Land Use

This section assesses the compatibility of the land use of the proposed project with the current land use. The determination of the potential effects on the existing land use is assessed for the construction, operation and decommissioning phases of the proposed project. Potential impact on sensitive land uses in the area of the proposed development have been examined in this section.

11.5.1 Existing Environment – Land Use

The proposed Wind Farm site is located in an area of private agricultural lands with areas of commercial broadleaf forestry throughout. The lands of the wind farm site are accessed by existing agricultural entrances. The site has existing agricultural tracks currently used for farming activities. The primary agricultural activity at the wind farm site is pasture farming. The greater area of the wind farm site consists of arable and pastoral lands, one-off housing and farmsteads. There are 75 dwellings located within 1.5km of the proposed turbines.

There are two wind farms located in proximity to the site. These consist of the Boolard Wind Farm (2 wind turbines) and the Rathnacally Wind Farm (2 wind turbines). There is a quarry located approximately 2.5km east of the wind farm site. The closest settlement is the village of Churchtown, located approximately 2.5km to the south.

According to the Corine Landcover Database (2018) and confirmed by investigation surveys carried out during environmental assessment, the site consists of the following landcover:

- 231 – Agricultural pastures.
- 243 – Land principally occupied by agriculture with significant areas of natural vegetation.
- 311 – Broadleaved forestry and semi-natural areas.

The proposed GCR will be installed in the public road. Land use observed along the grid route consists of arable and pasture farmlands, one-off houses and farmsteads. The Rathnacally Wind Farm is located to the north of the GCR. The GCR also passes the Dawn Meats Factory. The Corine Landover data shows the grid route extending over agricultural pastures (code 231). There are 30 no. one-off houses along the 5.9km grid route. The proposed point of connection to the national grid is the Charleville Substation which is a long-standing electricity substation and compound located in an area of farmland located directly east of the Rathnacally Wind Farm.

The TDR begins at Foynes Port in County Limerick. The route follows the national road network, passing by residential dwellings and businesses and passing through small villages. The TDR passes through Charleville Town Centre which consists of a range of residential, industry, commercial premises and town centre services. The TDR then enters onto local roads on the approach to the wind farm site on the L1322 at Ballyhea. Due to the narrowness of the L1322, this 4.2km section of the TDR is the location where the majority of the works are required to accommodate the delivery of turbine components. Land use along this section of the TDR is similar to the GCR as much of this route is shared. In addition to arable and pasture farmlands, one-off houses and farmsteads, the Rathnacally Wind Farm and the Dawn Meats Factory, the TDR also passes a large transport distribution centre at the junction of the L1322 and N20 at Ballyhea where temporary accommodation works are required to allow for turbine delivery. The temporary works associated with the TDR are described in Section 3.5.6.1 of Chapter 3 and consist of vegetation trimming, temporary removal of fences and road markers and the temporary removal of utility poles.

The Corine Landcover mapping for the Wind Farm Site, TDR and Grid Connection is illustrated in Figure 11-4.

Path: R:\Map Production\2020\P2359\Workspace\EIAR\P2359_GIS_Fig11-4_CorineLandCover_A3.mxd

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
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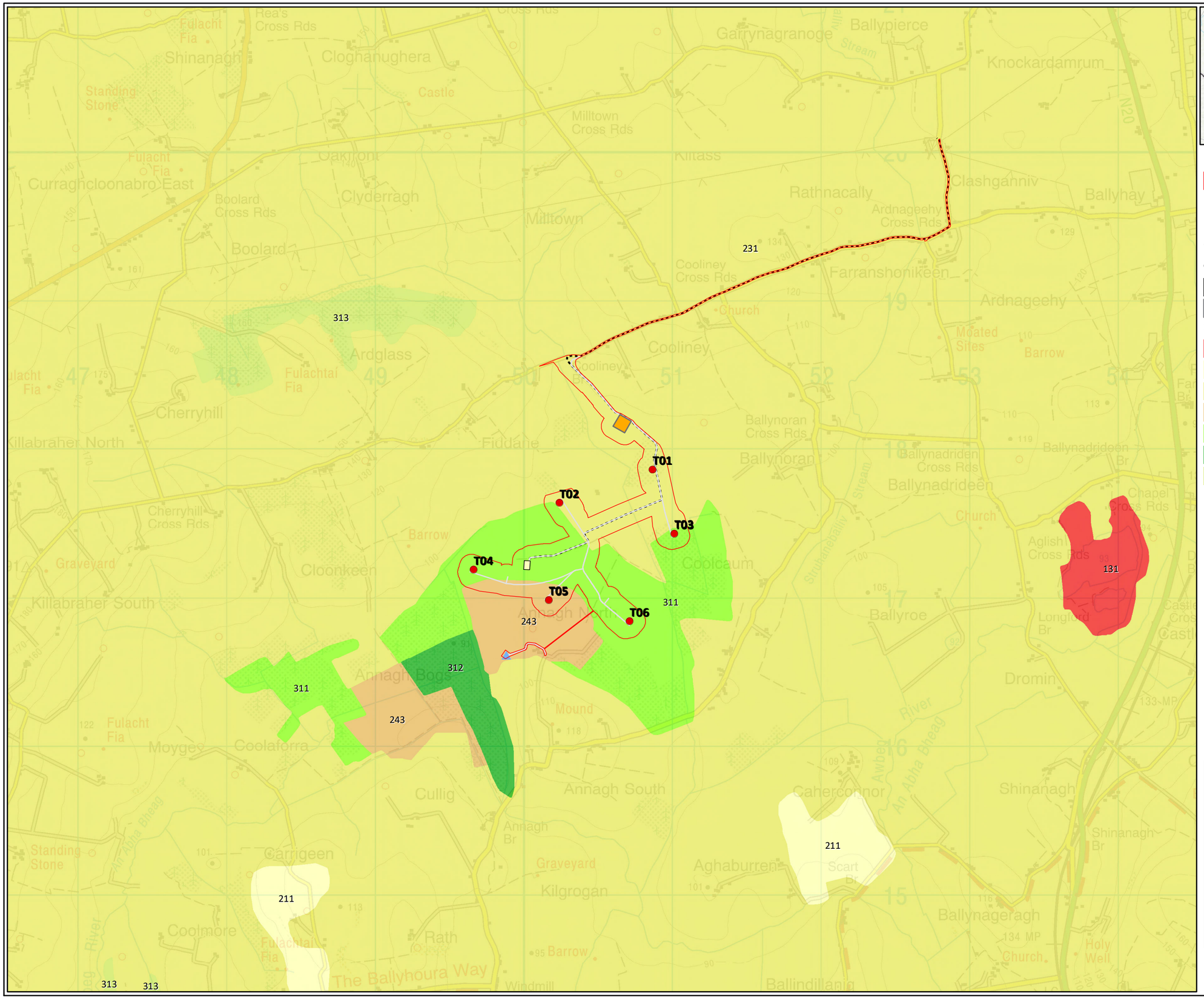

Legend

- Site Boundary
- Turbine Layout
- Met Mast
- Site Internal Roads
- Underground Cable Route
- Substation
- Construction Compound

CORINE Land Cover 2018

- 131 Mineral extraction sites
- 211 Non-irrigated land
- 231 Pastures
- 243 Agriculture (mainly) with natural vegetation areas
- 311 Broad-leaved forest
- 312 Coniferous forest
- 313 Mixed forest

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0 0.5 1 2 Kilometers

TITLE:	Corine Land Cover		
PROJECT:	Annagh Wind Farm, Co. Cork		
FIGURE NO:	11.4		
CLIENT:	EMPower		
SCALE:	1:25000	**REVISION:**	0
DATE:	14/10/2021	**PAGE SIZE:**	A3

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11.5.2 Potential Impacts – Land Use - Construction

The existing land-uses in proximity to the proposed Annagh Wind Farm will remain broadly unchanged during the construction phase of the project, however, some land use in close proximity to the site will be temporarily disrupted during the construction phase as a result of construction activity. The land uses located within the footprint of the wind farm will be disrupted in the long-term due to the presence of the proposed wind farm. This will occur on the agricultural and forestry lands where turbines and associated infrastructure are proposed.

There are 4 no. proposed wind turbines and associated hardstandings located within commercial forestry areas or partly in forestry areas. The remainder of the proposed development at the wind farm site is located on agricultural lands. A section of the proposed site entrance at the north of the site is located adjacent an existing dwelling which will result in the loss of approximately 0.1 hectares of private open space.. The access track associated with the met mast at the south of the site passes adjacent an active farmyard.

Approximately 0.38km of existing agricultural access tracks will be upgraded and utilised during the construction phase. Approximately 4.57km of new tracks will be required in both forested lands and agricultural lands. This will result in temporary interruption to these land uses during the construction phase. Agricultural practice can continue during the construction phase, however, sections of lands adjacent the proposed infrastructure may be temporarily inaccessible due to construction activities. The temporary compound area will be utilised during the construction phase for construction activity, storage, parking and welfare facilities. This is likely to have a temporary slight negative effect on agricultural practice at the site. This will occur on involved land owners' lands only.

Felling of approximately 12.6 hectares of broadleaf forestry is required within and around the wind farm infrastructure to accommodate the construction of the turbines, hardstands and crane pads, access tracks, turning heads and on-site substation. This will result in a long-term moderate, negative impact to forestry in the area. As part of the project, replant lands have been identified at Emlagh, County Clare. This is a requirement as part of the felling licence. Due to the nature of broadleaf forestry, it is unlikely that forestry activities will take place at the wind farm site during the construction phase as the crop is not close to maturity.

Temporary effects on land use will arise as a result of the installation of the grid connection along the grid route which will be constructed within the public road corridor. Full road closures will be put in place to facilitate cabling works in combination with lane closures, partial road closures and stop/go systems. This will allow for the works to be completed efficiently and minimise disruption time for residents. This will result in temporary slight, negative impact to residential, agricultural and commercial land use where access may be temporarily restricted. Traffic management measures will be put in place as detailed in Chapter 13 of this EIAR, resulting in limited disruption to land use along the grid route. The grid route is expected to be installed over a 2-month period.

TDR node upgrade activity has potential for slight, brief to temporary impacts to land use in proximity to each node. The majority of works have potential to cause non-significant brief impacts where street furniture and wall removal, temporary load bearing surfaces and vegetation trimming is required. Brief impact may also occur to the supply of electricity and telecommunications to homes and businesses as a result of temporary removal of services to accommodate turbine delivery. Turbine delivery may effect land use temporarily or briefly due to the transportation of oversized loads on the public road. This is likely to have a brief to temporary slight, negative impact on residential land-use due to noise nuisance as a result of use of machinery. The effects of noise is further considered in Chapter 7 – Noise and Vibration.

11.5.3 Potential Impacts – Land Use - Operation

Given that the footprint of the proposed development will occupy a small proportion of the development site area when operational, as illustrated in figure 11-2, it is anticipated that there will be minimal impact on existing land uses arising from the operational phase.

The operational phase of the Annagh Wind Farm will result in a change of land use in areas where access tracks, turning heads wind turbine bases, hardstanding areas, met mast, substation, and drainage infrastructure will be located. The lands affected are currently in use for agriculture and commercial forestry. The removal of approximately 12.6 hectares of commercial forestry lands will have a long-term slight, negative impact on the existing forestry land use, however, the remaining forested area adjacent the wind farm site, consisting of approximately 110 hectares of mixed forestry, will continue as a commercial crop throughout the operational life of the proposed project.

The project will consist of replant lands as detailed in section 3.5.18 of this EIAR. This will act to offset the loss of forested lands and will also result in the change in land use of existing scrub land to commercial forestry at the location of the proposed replant lands. An ecological assessment of the replant lands is included in Appendix 3.3 of Volume 3 of this EIAR and the replant lands are further considered in this Chapter with respect to potential cumulative effects.

The area of lands which will change use from open field agricultural use to wind farm use will be approximately 4 hectares. This will consist of turbine hardstands, access tracks, turning heads and meteorological mast. This will result in a long-term slight negative impact on available agricultural lands, however, the proposed upgraded and new access tracks can be utilised for the ongoing agricultural activity on the site and therefore is likely to result in a slight positive impact to agricultural land use at the wind farm site.

The operational phase of the Annagh Wind Farm will not negatively impact on agricultural practices on lands adjacent to the site. There are no peer reviewed studies which indicate that wind energy development has a negative impact on the health of livestock. There are numerous examples of renewable energy developments throughout the country and internationally where livestock coexist and routinely graze in the same fields as wind turbines (AWEA, 2019). This includes the adjacent Boolard Wind Farm and Rathnacally Wind Farm. Existing land-use, such as grazing livestock or crops can continue on the site as normal. As such, there will be no likely significant negative impact to agricultural practice as a result of the proposed development.

Activity is not expected at the Grid Connection and TDR during the operational phase of the proposed project. There is potential for repair works along the grid connection to take place, however, these will likely be brief or temporary and insignificant. It is unlikely that the TDR route will be required during the operational phase of the project, unless in the unlikely event a turbine component requires to be transported for replacement or repair. In this case, there is potential for slight temporary negative impact on residential land-use due to noise nuisance as a result of the use of machinery.

11.5.4 Potential Impacts – Land Use – Decommissioning

The decommissioning phase of the proposed development is described in Section 3.8 of this EIAR and provides for the removal of turbines and associated infrastructure from the site. The potential effects associated with the decommissioning phase in relation to land use will be similar to those associated with construction phase but of a reduced magnitude.

Decommissioning works will include removal of all above ground structures including the turbines and met mast. The on-site substation will be taken in charge by ESB and therefore will remain in situ. The turbine foundations will be covered over and allowed to re-vegetate naturally and access tracks will be left in situ to continue to be used for agricultural and forestry land uses. This will result in a direct benefit from the new and upgraded access tracks left in situ throughout the site resulting in a long-term slight, positive impact on forestry and agricultural uses at the site.

The decommissioning works will require a construction crew on-site and may cause temporary disruption to surrounding land uses. Removal of infrastructure from the site may temporarily affect forestry and agricultural practices. During decommissioning works forestry and agricultural access tracks within the wind farm site may be in use by construction crews which may temporarily prohibit access to certain areas of forestry or hinder access to areas of agricultural pasture. Impact to these land uses during the decommissioning phase is expected to be temporary to short-term slight, negative.

The underground grid connection will remain in situ following decommissioning and form part of the national grid. Therefore, impact to land use along the grid route is unlikely during the decommissioning phase.

11.5.5 Mitigation Measures – Land Use

Mitigation measures for land use are primarily related to preliminary design stage, which has allowed for the prevention of unnecessary or inappropriate ground works or land use alterations to occur. The construction and operational footprint of the proposed development has been kept to the minimum necessary to avoid negative effects on existing land uses as so far as possible.

Existing agricultural tracks have been incorporated into the design in order to minimise the construction of new tracks and roads and minimise the removal of agricultural and forested areas. Where new access tracks are required, these have been sensitively designed in order to minimise impact on agriculture and forestry so far as possible. Electricity cables will be installed underground in or alongside access tracks to avoid negative effects on agricultural and forestry practices.

The construction and decommissioning works will be planned and controlled by a Construction and Environmental Management Plan (CEMP). The CEMP for the construction phase is included in Appendix 3.1 of Volume 3 of this EIAR. This provides details on day to day works and methodologies. As part of these works, the public and other stakeholders will be provided with updates on construction activities which will affect access to lands. This will be communicated to members of the public through a community liaison officer employed for the duration of the construction period.

Prior to the grid connection installation works within public roads, it is proposed that all access points (domestic, business, agriculture) are considered when finalising the temporary road closures and diversions, in order to maintain local access as much as possible and avoid impacts on various land uses. All proposed works and deliveries along the TDR route will also be controlled by a Construction and Environmental Management Plan to avoid undue negative effects to adjacent land uses.

11.5.6 Residual Impacts – Land Use

Once mitigation measures are in place and the appropriate design measures are incorporated, as proposed, there will be no significant adverse negative residual effects arising from the project on land use.

Benefits to forestry and agricultural practices as a result of the upgrading of access tracks throughout the site will cause a slight, positive impact for forestry and agriculture at this location.

Other infrastructure that will remain in situ includes turbine foundations and hardstands which will be covered over and re-vegetated. The on-site substation will be taken in charge by ESB. The grid route cable will remain in situ and form part of the national grid. The residual impact on land use as a result of the in-situ hardstands, foundations, substation and grid connection following decommissioning is likely to be permanent, imperceptible and neutral due to the small extent of land affected.

The loss of 12.6 hectares of commercial forestry will have a long-term slight negative residual impact on forestry land use in the area of the proposed wind farm, however, the provision of replant lands located at Emlagh, County Clare, consisting of a total area approximately 12.6 hectares of replanted forestry will result in a neutral residual impact on forestry land use at a national scale. An Appropriate Assessment Screening Report and Natura Impact Assessment of the replant lands is included in Appendix 3.3 of Volume 3 of this EIAR and is further considered cumulatively in each chapter of the EIAR, including Section 11.10 of this Chapter.

11.6 Recreation, Amenity and Tourism

This section provides a comprehensive overview of the recreation, amenity and tourism value for the study area, County Cork and the State in order to assess the potential effects arising from the proposed development. As 2020 and 2021 have experienced an unprecedented negative impact on international tourism due to the COVID-19 epidemic, this section focuses on statistics from 2018 and 2019 as a reasonable scenario for tourism potential for the County. The preparation of this section had regard to Fáilte Ireland's 'EIAR Guidelines for the Consideration of Tourism and Tourism Related Projects'. Consultation has taken place with local recreation groups, as detailed in Chapter 5 of this EIAR, in order to thoroughly understand potential affects to recreation activity in the area.

11.6.1 Existing Environment – Recreation, Amenity and Tourism

Tourism is one of the major contributors to the national economy and is a significant source of full time and seasonal employment. Tourism statistics for 2019 as published by Fáilte Ireland (March 2021) state that overseas tourism grew by 0.7% on 2018 figures with over 9.7 million visitors. Expenditure from overseas tourism was estimated to be down by -0.8% remaining strong at €5.1 billion. Fáilte Ireland's 2019 survey results indicate the top 5 most popular recreation activity for tourists in Ireland:

1. Hiking and cross country walking
2. Cycling
3. Golf
4. Equestrian
5. Angling

Fáilte Ireland's Regional Tourism performance figures for 2018 and 2019 are set out in Table 11-7 and 11-8 for the South West Region which includes Counties Cork and Kerry. As demonstrated in the tables, tourism numbers for the South West Region for both over-seas and domestic trips fell by 6% between 2018 and 2019, however, maintaining a similar revenue with a fall of 0.8% revenue between 2018 and 2019.

Table 11-7: South West Regional Performance (Tourists in 2018)

Region		Britain	Mainland Europe	North America	Other Areas	All Overseas	Northern Ireland	Domestic Trips
South West[4]	Tourists (000s)	616	924	803	169	2,512	72	2,401
South West	Tourist Revenue (€mn)	179	347	384	77	987	48	474

Table 11-8: South West Regional Performance (Tourists in 2019)

Region		Britain	Mainland Europe	North America	Other Areas	All Overseas	Northern Ireland	Domestic Trips
South West	Tourists (000s)	541	877	751	166	2,335	38	2,316
South West	Tourist Revenue (€mn)	166	371	335	98	970	25	511

Tourism is considered an important industry for County Cork. Chapter 8: Tourism, of the Cork County Development Plan (2014), identifies that:

> 'Tourism in County Cork is based on its rich natural and built heritage. The principal features of the area's tourism product include; mountains and upland habitats; rivers and lakes, over 1100 km's of scenic rugged coastline and peninsulas with long stretches of sandy beaches, fertile agricultural land and many upland peatlands and forest/woodland areas. These natural assets combined with a rich heritage of archaeological and historical sites, built environment including manor homes and gardens, attractive towns and villages offer a unique tourism product. [Section 8.1.11: Tourism Product in County Cork].

Top attractions in the Cork area in 2019, listed by Fáilte Ireland, include Blarney Castle, Doneraile Park and Fota Wildlife Park, which are 42km, 13km and 52km from the proposed wind farm site, respectively. Other recreation and tourism amenities located in the area of the proposed wind farm include:

- Ballyhoura Way, ca. 2km from the wind farm site.
- Churchtown GAA Club, ca. 3km from the wind farm site.
- Charleville Gold Club, ca. 4km from the wind farm site.
- Dromina GAA Club, ca 4km from the wind farm site.
- Ballyhea GAA Club, ca. 4km from the wind farm site.
- Charleville GAA Club, ca. 5km from the wind farm site.

[4] County Cork and County Kerry

- Charleville Playground and Pitch & Putt Club, ca. 5km from the wind farm site.
- Newtownshandrum GAA Club, ca. 5km from the wind farm site.
- Ballyhoura Mountains (trails walking), ca. 6km from the wind farm site.
- Charleville Football Club, ca. 6km from the wind farm site.
- Equestrian centre at Mountcorbett, ca. 6km from the wind farm site.
- Liscarroll Donkey Sanctuary, ca. 6km from the wind farm site.
- Liscarroll GAA Club, ca. 7km from the wind farm site.
- Liscarroll Castle, ca. 7km from the wind farm site.
- Liscarroll Village Green Park, ca. 7km from the wind farm site.
- Ardskeagh Church, ca. 7km from the wind farm site.
- Buttevant Friary, ca. 8km from the wind farm site.
- Buttevant GAA Club, ca. 8km from the wind farm site.
- Buttevant Football Club, ca. 8km from the wind farm site.
- Buttevant Playground, ca. 9km from the wind farm site.
- Buttevant Castle, ca. 9km from the wind farm site.
- Kilcolman Castle, ca. 9km from the site.
- Ballybeg Castle and Priory, ca. 10km from the wind farm site.
- Kilguilkey Equestrian Centre, ca. 12km from the wind farm site.
- Doneraile Park, ca. 13km from the wind farm site.
- Ballyhoura Mountain Bike Trails, ca. 14km from the wind farm site.
- Killmallock Castle, ca. 15km from the wind farm site.

Overall, the most significant recreation activity/attractions in proximity to the Annagh Wind Farm site is trail walking, mountain biking, equestrian activity and sports grounds. The Ballyhoura Mountains to the east of the wind farm site include a network of forestry tracks, walking and mountain biking trails, including the Streamhill Loop and Ballyhoura - Garanne Loop. The Ballyhoura Mountains are an elevated landscape feature in an otherwise generally flat area.

There are 23 recorded archaeological sites, including associated demesne lands of one country house, located within 1km of the elements of the proposed wind farm. The majority of these archaeological sites are either completely or partially levelled and are all located within private lands which are not accessible to the public and have no discernible existing tourist or amenity attributes. The most proximate national monuments to the wind farm site are Liscarroll Castle and Ardskeagh Church, both located approximately 7km from the site. See Chapter 14: Archaeological, Architectural and Cultural Heritage for further details.

The Ballyhoura Way passes approx. 2km south of the site running east to west. The route is a National Waymarked Trail long-distance trail measuring approx. 89km from St John's Bridge, near Kanturk, County Cork to Limerick Junction, County Tipperary, via the Ballyhoura Mountains. The terrain consists mainly of tarmac roads, forestry tracks, and open moorland and field paths. Attractions along the route include Liscarrol Castle and the villages of Kilfinane, Ballygorgan, Ballylanders and Galbally and Tipperary Town.

Community Facilities & Services

Community facilities and services in proximity to the proposed Wind Farm Site are centred on towns and villages in the area. The closest settlement to the wind farm site is the village of Churchtown, located 3km to the south. Facilities and services within the village include food places, public houses, convenience store, guest house, two nursing homes, national school, church and GAA club. The village of Dromina is located approx. 4km north west of the wind farm site. Facilities and services here include convenience store, public houses, post office, national school, community hall, national school and church.

The most proximate town to the wind farm site is Charleville, ca. 6km north east. The TDR passes through the centre of the town. Community facilities and services within the town include a range of town centre retail, supermarkets, food places and public houses, pre-school, primary and secondary schools, further education centre, accommodation, church, garda station, fire station, sports grounds, care centres, medical centres, post office and park and playground.

The TDR also passes through the village of Kildimo, County Limerick, and passes through the periphery of the village of Mungret, County Limerick. These villages have services including convenience stores, food places, filling stations, post office, national school, church and sports grounds.

The proposed GCR does not pass by any significant community facilities.

11.6.2 Potential Impacts – Recreation, Amenity and Tourism - Construction

There are no significant tourism attractions located in proximity to the proposed Annagh Wind Farm site, grid route and TDR, and as such, the construction phase of the proposed development is not expected to impact on major tourism attractions, tourism numbers or tourism revenue.

The proposed works associated with the wind farm site and GCR will avoid negative impact on nearby community facilities, town centre services and amenities due to lack of proximity. The proposed works, including the construction haul routes do not interact with nearby recreation and tourism amenities as listed in section 11.6.1 and therefore there are no expected direct impacts on these features.

The TDR passes through the villages of Kildimo and Mungret, County Limerick and the town of Charleville, County Cork. During turbine delivery there is potential for indirect impact to town/village centre services due to the transportation of large and bulky loads through the settlements. This will likely be as a result of traffic calming measures during the escorting of the turbine components. Temporary accommodation works will not be required in these settlements and therefore impact is likely to be temporary to brief, negative and non-significant. Mitigation is set out in Chapter 13: Traffic and Transportation in order to avoid indirect impact so far as possible on town and village centre facilities and services during turbine delivery.

11.6.3 Potential Impacts – Recreation, Amenity and Tourism - Operation

In relation to tourism and wind energy development, the Wind Energy Development Guidelines for Planning Authorities (2006) states the following:

> "Wind Energy developments are not incompatible with tourism and leisure interests, but care needs to be taken to ensure that insensitively sited wind energy developments do not impact negatively on tourism potential. The results of survey work indicate that tourism and wind energy can co-exist happily"

The Draft Revised Wind Energy Development Guidelines (2019) also maintain that wind energy development "can co-exist happily" with tourism and go on to detail the survey results as also cited in the 2006 guidelines.

The survey results referred to in the guidelines is Sustainable Energy Ireland's (SEI's) Attitudes towards the Development of Wind Farms in Ireland (2003). The SEI (now SEAI) report found that the overall attitude towards wind farms is positive.

> "The overall attitude to wind farms is very positive, with 84% of respondents rating it positively or very positively (Chart 2.6). Only 1% rate it negatively ('fairly bad'), with 14% not having an opinion either way, and no one rating wind farms 'very negatively'. Interestingly, this time it is those from Dublin who are most positively disposed; this could arise from the fact that Dubliners are less likely than others to have a wind farm built in their locality."

Where negative attitudes were voiced towards wind farms, the visual impact of the turbines on the landscape was the strongest influence. The report also notes however that the findings obtained within wind farm catchment areas showed that impact on the landscape is not a major concern for those living near an existing wind farm (SEI, 2003).

With regard to the economic and environmental impacts of wind farm development, the national survey reveals that attitudes towards wind energy are influenced by a perception that wind is an attractive source of energy:

> "Over 8 in 10 recognise wind as a non-polluting source of energy, while a similar number believe it can make a significant contribution to Ireland's energy requirements. People therefore seem to have little difficulty with the concept of wind energy".

This report concludes that based on the detailed study of attitudes, it is clear that there is "widespread goodwill towards wind farm developments".

More recent independent research conducted by BiGGAR Economics in 2016 entitled 'Wind Farms and Tourism Trends in Scotland', assessed the relationship between wind farm developments and the tourist industry in Scotland. An analysis was carried out on eight local authorities which had witnessed a higher increase in wind energy developments than the Scottish average. Of the eight local authorities, five also witnessed a greater increase in sustainable tourism employment than that of the National Average with just three witnessing less growth than the Scottish average. The research concluded that at local authority level, no detrimental impact occurred on the tourism sector as a result of wind energy development, rather that, in the majority of cases, sustainable tourism employment performed better than other areas.

Fáilte Ireland conducted research titled "Visitor Attitudes on the Environment", which was first published in 2008 and updated in 2012. The research surveyed both domestic (25%) and overseas (75%) holidaymakers to Ireland to determine their attitudes to wind farms. The survey results indicate the following:

- Most visitors are broadly positive towards the idea of building more wind farms on the island of Ireland. A minority (one in seven) were negative towards wind farms in any context.
- Despite the fact that almost half of the tourists interviewed had seen at least one wind farm on their holiday, most felt that their presence did not detract from the quality of their sightseeing.
- The largest proportion (45%) said that the presence of the wind farm had a positive impact on their enjoyment of sightseeing, with 15% claiming that they had a negative impact.

- Almost three quarters of respondents claimed that potentially greater numbers of wind farms would either have no impact on their likelihood to visit or would have a positive impact on future visits to the island of Ireland.

The updated survey, 2012, found that over half of tourists surveyed had seen a wind turbine while travelling the country. The survey results were as follows:

- 32% said that the wind turbines enhanced the surrounding landscape.
- 47% said that it made no difference to the landscape.
- 21% claimed wind turbines had a negative impact on the landscape.
- 71% of respondents claimed that potentially greater numbers of wind farms would either have no impact on their likelihood to visit or have a positive impact on future visits to the island of Ireland.

In 2011, Fáilte Ireland's guidelines on tourism and environmental impacts stated in Chapter 4 titled 'Project factors affecting tourism' that 'some types of new or improved large scale infrastructure – such as roads – can improve the visitor experience – by increasing safety and comfort or can convey a sense of environmental responsibility – such as wind turbines.'

Further research has been undertaken in Scotland in 2011 by Visit Scotland who have produced a Wind Farm Consumer Research report which showed that 83% of those surveyed said a wind farm would not affect their decision about where to stay when on a holiday or short break in Scotland. Also, against a backdrop of increased wind farm deployment, Visit Scotland's statistics showed the number of visits to Scotland last year and the amount of spending by visitors both increased while their 'Scotland National Visitor Survey 2011' made no mention of the issue of wind farms affecting tourism in Scotland.

From a review of literature as detailed above, it is concluded that the majority of tourists surveyed had a generally positive view on wind energy development in the landscape. Further analysis of the potential visual impact of the proposed Annagh Wind Farm is described in Chapter 15 – Landscape and Visual.

The most proximate major tourist attraction to the Annagh Wind Farm Site is Doneraile Park, located ca. 13km to the south west. The Zone of Theoretical Visibility (ZTV) map included in Chapter 15 – Landscape and Visual shows that there is possible visibility of all or some of the proposed turbines from the park. However, the ZTV map does not account for foliage or structures and therefore it is likely that the proposed turbines will not be visible from the park. Visual impact on Doneraile Park as outlined in Chapter 15 is therefore likely to be imperceptible and long-term.

The proposed turbines will be visible from the Ballyhoura Mountains to the east of the wind farm site. The mountains have a network of walking and cycling trails used for recreation. View Point (VP) 3 as detailed in Chapter 15 shows the view of the proposed Annagh Wind Farm and its surroundings taken from the Ballyhoura Mountains. The proposed wind turbines are viewed in the context of the nearby Boolard and Rathnacally Turbines and therefore do not represent a brand new visual element to the landscape. Furthermore, the proposed turbines will not be visible from all areas of the trail network. Considering the research on perception of wind energy projects as set out above, it is unlikely that the proposed development will negatively impact on the enjoyment of the amenity trails at the Ballyhoura Mountains. As set out in Chapter 15, the potential visual impact on the Ballyhoura Way trail is considered to be slight.

In relation to community facilities and amenities, the village of Churchtown is the most proximate settlement to the proposed wind farm. As detailed in Chapter 15: Landscape & Visual, a 'slight' impact of significance is associated with the settlement of Churchtown which has the potential for near distance views of the proposed turbines. This is not expected to negatively impact on the amenity of the community facilities and services in the village. If consented, a community benefit fund will be associated with the project, as detailed in section 11.4.3.2. There is potential for the community facilities of the village of Churchtown to benefit from the community fund if the proposed project is consented, potentially resulting in a long-term moderate, positive impact to recreation and amenity in the village.

It is unlikely that works will be required on the TDR or grid route during the operational phase of the proposed development, unless maintenance is required on the grid connection, or in the unlikely event that a turbine component requires replacement.

Overall, it is expected that the operational phase of the proposed development will have a non-significant neutral impact on recreation and tourism in the area due to the distance of the proposed turbines from significant features. The provision of the community benefit fund will likely have a moderate positive long-term impact on the amenities of the nearby village of Churchtown.

11.6.4 Potential Impacts – Recreation, Amenity and Tourism - Decommissioning

The decommissioning phase of the proposed development is described in Section 3.8 of this EIAR and provides for the removal of turbines and associated infrastructure from the site. The potential impacts associated with the decommissioning phase in relation to recreation, amenity and tourism will be similar to those associated with construction phase but will likely be of a reduced magnitude.

Decommissioning works will include removal of above ground structures including the turbines, mountings and fencing and will see increased traffic in the area of the wind farm site. The decommissioning works will not interact with nearby recreation and tourism amenities and therefore it is expected that the decommissioning phase of the proposed Annagh Wind Farm will have a non-significant impact on recreation, amenity and tourism.

11.6.5 Mitigation Measures – Recreation, Amenity and Tourism

Mitigation measures for recreation, amenity and tourism are primarily related to the preliminary design stage of the proposed Annagh Wind Farm, which has allowed for the prevention of unnecessary or inappropriate development to occur that would significantly affect any recreational or tourist amenity. In designing the proposed Annagh Wind Farm, careful consideration was given to the potential impact on landscape amenity. The magnitude of visual impact on the landscape is assessed in Chapter 15 – Landscape and Visual.

The most significant potential for tourism and recreation activity at the wind farm site and surrounding area was identified as trail walking, mountain biking, equestrian activity and sports activities (sports grounds). During the construction, operation and decommissioning phases it is unlikely that the proposed development will impact on these activities as the proposed site and works do not directly interact with any facilities or trails associated with these tourism and recreation activities, therefore mitigation is not required.

Chapter 13: Traffic and Transportation sets out mitigation measures for potential effects associated with increased traffic volumes of the construction and decommissioning phases of the proposed development which may have an indirect impact on recreation and amenity in the area of the wind farm site and also potential indirect impact on town centre and village centre facilities and services along the TDR during transportation of turbine components.

11.6.6 Residual Impacts – Recreation, Amenity and Tourism

There are no expected significant, adverse impacts to recreation, amenity and tourism in the surrounding area as a result of the development of the proposed Annagh Wind Farm due to the distance from major tourism attractions and the short-term/temporary nature of the construction works.

The community benefits gained during the operational phase due to the capital investment in the area are expected to last beyond the decommissioning phase resulting in a likely residual permanent significant, positive impact on the amenities of the area of the wind farm site.

11.7 Human Health & Safety

This section provides a comprehensive overview of the health profile of the receiving environment and the State, in order to provide for the assessment of potential impacts that the proposed development may have on human health. An assessment of peer reviewed literature has been carried out to provide a sound, scientific basis for the potential impacts arising from the proposed Annagh Wind Farm.

11.7.1 Existing Environment – Human Health & Safety

Human health in relation to this assessment refers to the nature and possibility for adverse health effects on humans. In the context of existing human health, The Department of Health (2019) has published a report entitled 'Health in Ireland, Key Trends 2019' which provides statistics relating to human health in Ireland over a 10 year period (2009 to 2019). Generally speaking, Ireland's population has a high level of good health as demonstrated in self-evaluation statistics included in Census data (see Table 11.9 below).

From analysis of the health statistics below, the general health of the Study Area is recorded as very good or good. This is in line with State and County-wide averages. The Study Area has approximately the same averages, as County Cork with 88% of respondents of the 2016 Census indicating that their health was 'good' or 'very good' and between 1% and 2% indicating their health was 'bad'. Less than 0.5% of respondents indicated their health was 'very bad' for these areas. This shows a slight greater percentage of persons 'very good' general health when compared to the State which has 2 percentage points lower than that of the Study Area and County Cork. Overall, the Census data indicates that the population of the Study Area is generally in good health.

Table 11-9: Population by General Health (Census, 2016)

General Health (Census 2016)	State	County Cork	Study Area
Very Good	59%	61%	61%
Good	29%	27%	27%
Fair	8%	8%	8%
Bad	1%	1%	2%
Very Bad	0%	0%	0%
Not Stated	3%	3%	2%

With respect to health and safety, the Health and Safety Authority of Ireland monitor fatal workplace injuries throughout Ireland. In relation to construction activities, in the past 10 years (2011 to 2020) an average of 8.9 fatal workplace injuries have occurred throughout Ireland per annum. This is above average in relation to other economic sectors. The average number of fatal workplace injuries throughout all economic sectors for the past 10 years in Ireland has been 2.4 fatal workplace injuries per year. This indicates the above average danger levels which workers are exposed to on construction sites when compared to other economic sectors.

With regard to the control of major accident hazards involving dangerous substances, on examination of upper and lower tier Seveso Establishments in the surrounding region of the proposed development, no Seveso Establishments were identified in proximity to the site. The closest Seveso site is located approx. 20km south at the LP Gas Filling Services lower tier Seveso Site, south of Mallow town.

From a review of the GSI Landslide Susceptibility database, the proposed development and proposed infrastructure locations are located within areas of 'Low' susceptibility. No historical records of landslide activity have been identified within or close to the site, according to the GSI database. According to the OPW (floodinfo.ie), no major flood incidents are recorded at the wind farm site or grid route. A past flood event was recorded in the Annagh Bogs area west of the proposed wind farm. This is recorded as a recurring flood event. Flood events have been recorded along or adjacent to sections of the TDR, however, no flood events have been recorded at the TDR node upgrades where works are required.

There is no record of wildfires at the proposed Wind Farm Site, Grid Route or TDR.

11.7.2 Potential Impacts – Human Health & Safety - Construction

The construction phase of the proposed development has potential to create health and safety hazards for both construction workers and the general public. This is as a result of construction activities and the associated impacts including increased traffic, transport of heavy or bulky materials, noise emissions, dust emissions, construction activities on public roads, excavation and general site-safety.

Aspects of the construction works that may present health and safety issues, are as follows:

- General construction site safety (e.g., slip/trip, moving vehicles etc.);
- Lifting of heavy loads overhead using cranes;

- Working at heights;
- Working in confined spaces;
- Ground conditions and soil stability;
- Road safety due to increased traffic numbers and transport of oversized loads to the site along turbine delivery routes and proposed haul routes;
- Pedestrian safety;
- Installation of electrical cables on-site and in the public road corridor;
- Potential emissions impacting air quality and noise;
- Substation construction involving high voltage electricity;
- Working with electricity during commissioning.

The works proposed as part of the proposed Annagh Wind Farm will pose a risk to construction workers on-site especially during adverse weather conditions. This has potential to cause significant impact on human health in the short term during the 12-18 month construction period throughout the construction site if proper construction and safety protocols are not followed.

Construction and accommodating works taking place on the public road and the delivery of heavy/bulky goods (TDR) and machinery on narrow roads may lead to temporary limited access to farmlands, forestry lands and residential properties creating a potential hazard. This may cause a potential temporary moderate, negative impact to public safety along the TDR route and grid route during the construction phase.

The delivery of turbine components will require transport of heavy/bulk goods from Foynes Port in County Limerick via the N69, N18, M20, N20, before entering the L1322 local road on approach to the proposed wind farm site. Due to the abnormality of the turbine components, there is potential human safety risks associated with their delivery including traffic safety and pedestrian safety at special manoeuvring points. This has potential for temporary significant, negative impacts to human safety during the delivery of turbine components if unmitigated.

Potential impacts on air quality has the potential to affect human health. This has been assessed in Chapter 6: Air and Climate Change. No significant impacts on air quality have been identified with regard to the emissions of construction related traffic. The impact on air quality due to emissions from construction works (construction machinery) has been identified as imperceptible. Due to the distance between the nearest receptor and source of emissions at the wind farm site, the temporary negative impact on air quality at nearby dwellings will be imperceptible.

Construction works associated with the grid connection have potential to impact on nearby dwellings with regard to air quality. Due to the nature of construction along the proposed grid route, which works as a “rolling” construction site, meaning that these works will not be concentrated in any one area of the route, these effects are considered to be brief to temporary slight, negative. Therefore, the construction phase of the Annagh Wind Farm will not have a significant impact on air quality.

The potential impacts from noise during the construction phase at the Wind Farm site and TDR is expected to have a temporary slight, negative impact on nearby residential receptors. The works will remain below the construction noise limit of 65dB as detailed in Chapter 7: Noise and Vibration. Vibration is not expected to be perceived at nearby residences.

Impacts from noise along the grid route during the construction phase has potential to cause temporary significant, negative impact at nearby dwellings, however, given the nature of the grid connection works, construction activities will not occur over an extended period at any one location (less than three days).

Potential impacts on human health associated with land, soils and geology during the construction phase relate to potential contamination of ground water which can be caused by hydrocarbon spills, siltation and landslide. Furthermore, landslides have the potential to cause injury and fatality. As set out in Chapter 9: land, Soils and Geology, the wind farm site is within an area of 'Low' susceptibility to slope failure. Following implementation of mitigation the risk of slope failure at the wind farm site is considered negligible.

Potential impacts on human health associated with hydrology during the construction period relate to standing water caused by blocked drains, water collecting in excavated areas or diverted water resting in an undrained area. This has potential to cause drowning with particular risk to on-site staff. There is also potential for blockage of roadside drains causing potential hazard to traffic. A flood risk assessment has been carried out and a drainage design has been incorporated into the proposed development as detailed in Chapter 10: Hydrology and Water Quality. As a result, the proposed development is expected to have a non-significant impact on flood risk in the surrounding area of the wind farm site or along the GCR and TDR. The increased surface water runoff due to addition of hardstanding areas is not significant and these flows are further reduced with the proposed drainage system. The likely impact of flooding on human health and safety as a result of construction activities is therefore temporary and imperceptible.

At the time of preparation of this chapter, the COVID-19 virus represents a significant risk to human health. Similar to any construction site, potential for spread of the virus during the construction phase of the proposed development may occur due to potential transmission from worker to worker due to construction activities and potential for close quarter working conditions. Up to date HSE guidance will be consulted regularly in line with HSA recommendations and all reasonable on-site and travel precautions will be taken if COVID-19 remains a significant health issue during the construction phase.

Overall, if unmitigated, the construction phase of the proposed development has potential for temporary significant, negative impact to human health and safety for construction workers and members of the public in proximity to the site, if proper construction safety protocols and traffic management are not applied. Mitigation measures to prevent potential impact to human health and safety are set out in section 11.7.5. Once mitigation is put in place, impacts to human health and safety during the 12-18 month construction period are unlikely.

11.7.3 Potential Impacts – Human Health - Operation

11.7.3.1 Site access and usability of lands

During the operation phase of the proposed development, there is potential for impact to human health and safety if appropriate mitigation measures are not put in place.

Potential human safety issues can occur due to the falling ice as a result of the icing of turbine blades in cold weather conditions. This is unlikely to present safety problems as wind turbines are fitted with anti-vibration sensors. These sensors detect any imbalance caused by the icing of the blades. The sensors will cause the turbine to shut down until the blades are de-iced prior to beginning operation again.

Potential impacts to the safety of operation and maintenance staff are associated with working at heights, working at steep gradients or uneven ground, moving vehicles and machinery and working with high-voltage electricity.

Properly qualified staff will be employed at the wind farm site and safety protocol will be followed at all times. Therefore, impact to the safety of operation and maintenance staff is unlikely.

Under normal conditions, operational wind turbines do not pose a threat to public safety or the safety of animals. Section 5.7 of the Wind Energy Development Guidelines (2006) states the following:

> "There are no specific safety considerations in relation to the operation of wind turbines. Fencing or other restrictions are not necessary for safety considerations. People or animals can safely walk up to the base of the turbines. There is a very remote possibility of injury to people or animals from flying fragments of ice or from a damaged blade."

There are no expected works to take place along the grid route or TDR during the operational phase of the proposed development. If maintenance works are required in these areas or bulk equipment is required to be delivered, proper safety protocols will be put in place in line with the mitigation measures set out in section 11.7.5. Therefore, impact to human safety on public roads during the operation phase is unlikely, as a result of the proposed development.

11.7.3.2 Health and Safety Standards and Procedures

As part of the human health assessment of the proposed Annagh Wind Farm, an analysis of peer-reviewed literature on potential health impacts arising from wind energy projects was undertaken. Anecdotal reports were identified of negative health impacts in people living in close proximity to wind turbines, however, the literature review demonstrates that peer-reviewed research generally does not support these statements.

The review of literature did not find any published, credible scientific sources that link wind turbines to adverse health effects. The key documents that have been taken into consideration with respect of potential effects on human health are as follows:

- 'Wind Turbine Sound and Health Effects - An Expert Panel Review', American Wind Energy Association and Canadian Wind Energy Association, December, 2009.
- 'Wind Turbine Syndrome – An independent review of the state of knowledge about the alleged health condition', Expert Panel on behalf of Renewable UK, July 2010.
- 'A Rapid Review of the Evidence', Australian Government National Health and Medical Research Council (NHMRC) Wind Turbines & Health, July 2010.
- 'Position Statement on Health and Wind Turbines', Climate and Health Alliance, February 2012.
- 'Wind Turbine Health Impact Study - Report of Independent Expert Panel' – Massachusetts Departments of Environmental Protection and Public Health, 2012.
- 'Wind Turbines and Health, A Critical Review of the Scientific Literature Massachusetts Institute of Technology', Journal of Occupational and Environmental Medicine, Vol. 56, Number 11, November 2014.
- 'Wind Turbine Noise and Health Study', Health Canada, 2014.
- 'Wind Turbines and Human Health', Front Public Health, 2014
- 'Position paper on wind turbines and public health', Health Service Executive, February 2017
- 'Environmental Noise Guidelines for the European Region', World Health Organisation, 2018

'Infrasound' has been cited as a cause of potential health impacts as a result of wind turbine development. This is discussed in detail in Chapter 7: Noise and Vibration, Section 7.2.4. It states that infrasound is noise occurring at frequencies below that at which sound is normally audible, that is, less than about 20 Hz, due to the significantly reduced sensitivity of the ear at such frequencies. In this frequency range, for sound to be perceptible, it must be at very high amplitude, and it is generally considered that when such sounds are perceptible then they can cause considerable annoyance. However, wind turbines do not produce infrasound at amplitudes capable of causing annoyance as outlined in the following paragraphs.

The UK Department of Trade and Industry study, 'The Measurement of Low Frequency Noise at Three UK Windfarms' (2006) , concluded that:

> "infrasound noise emissions from wind turbines are significantly below the recognised threshold of perception for acoustic energy within this frequency range. Even assuming that the most sensitive members of the population have a hearing threshold which is 12 dB lower than the median hearing threshold, measured infrasound levels are well below this criterion."

It goes on to state that, based on information from the World Health Organisation, 'there is no reliable evidence that infrasound below the hearing threshold produce physiological or psychological effects' and that 'it may therefore be concluded that infrasound associated with modern wind turbines is not a source which may be injurious to the health of a wind farm neighbour'.

In terms of perceived effects from shadow flicker and noise, a shadow flicker assessment has been conducted and is included in Chapter 12 of this EIAR and a Noise assessment is included in Chapter 7. In relation to shadow flicker, there will be no exceedances to the guideline limits as set out in the Wind Energy Development Guidelines (2006). A shadow flicker control system will be used on each turbine in line with the mitigation measures as set out in Chapter 12. Therefore, the impact of shadow flicker on nearby dwellings will be imperceptible.

In terms of noise, operational wind farm noise levels meet the derived night and daytime noise limits at all residential properties surrounding the proposed Annagh Wind Farm. However, for some receptors a new source of noise will be introduced into the soundscape and it is expected that there will be a long-term slight to moderate significance of impact, with dwellings closest to the proposed wind turbines receiving a long-term moderate significance of impact.

Following a review of literature regarding the potential impact of operational wind farms on human health, it is concluded that there is no scientific consensus to support an association between negative health impacts and responsible wind turbine development. The operational phase will therefore likely have a long-term, imperceptible, neutral impact on human health in proximity to the wind farm site.

With respect to safety, only trained and licenced employees will be permitted to access the turbines. Appropriate training will be provided for potential emergencies; therefore, the operational phase of the proposed development will have a negligible impact on public health and safety.

11.7.3.3 Potential Health and Safety Impacts from Proposed Cables and Electromagnetic Interference

Wind turbines, like all electrical equipment, produce electro-magnetic radiation. The provision of underground electricity cables similar to the proposed capacity is however commonplace throughout Ireland and the installation to the required specification does not give rise to health concerns. The following research outlines the potential for health impacts caused by electromagnetic interference.

The EirGrid document 'EMF & You: Information about Electric & Magnetic Fields and the electricity transmission system in Ireland' (EirGrid, 2014) provides information on studies which have been carried out on the health impact of electromagnetic fields (EMF). This report notes that since 1979, many scientific studies have been carried out on the possible effects of EMF on people. Agencies include the World Health Organisation (2006), the National Radiological Protection Board of Great Britain (2004), and the International Agency for Research on Cancer (IARC) (2002).

In 2009 the International Commission on Non-Ionising Radiation Protection (ICNIRP) issued guidelines for exposure for members of the public to DC magnetic fields. Other more recent reviews have been performed for the UK's Health Protection Agency (2012) and the European Union's Scientific Committee on Emerging and Newly Identified Health Risks (2015). The Eirgrid (2014) report notes that:

> "These agencies concluded that exposure to only very strong DC magnetic fields can cause biological effects. The exposures required to produce such effects, however, are extraordinarily high relative to levels of DC magnetic fields produced by common sources."

The Eirgrid (2014) report concludes that exposure to extremely low frequency (ELF)-EMF from power lines or other electrical sources is not a cause of any long-term adverse effects on human, plant, or animal health. A 2019 Eirgrid report titled 'The Electricity Grid and Your Health' states that:

> "The consensus from health and regulatory authorities is that extremely low frequency EMFs do not present a health risk."

To ensure such adverse effects do not occur, the WHO (World Health Organisation) monograph recommended that policy-makers establish guidelines for ELF-EMF exposure for both the general public and workers, and that the best source of guidance is the ICNIRP guidelines.

In 2010, ICNIRP issued updated guidelines, which reviewed the research since the 1998 report and replaced previous recommendations given by ICNIRP for this frequency range. The revised range is detailed in table 11.10. The underground cable to be installed complies with these ICNIRP guidelines.

> ICNIRP Guidelines for limiting exposure to time varying electric and magnetic fields (1Hz–100kHz) Health Physics 99(6):818-836; 2010.

Magnetic flux densities for Alternating Current (AC) magnetic fields are reported using units of microtesla (µt) and electric fields in kilovolts per meter (Kv/m). The ICNIRP guidelines formed the basis of the EU guidelines for human exposure to EMF (EU, 1999) and the EU Directive 2013/35/EU on the minimum health and safety requirements regarding the exposure of workers to the risks from EMFs.

Table 11-10: ICNIRP Guidelines

Exposure Characteristics	Electric Field Strength (kV/m)	Magnetic Flux Density (µT)
ICNIRP 2010 General Public Reference Level	5	100

The magnetic fields associated with underground cables decrease rapidly with distance. For underground cables, the fields decrease with the square of distance. The electric field emissions from underground cables are negligible as the ground absorbs the field.

As the proposed cable does not pass under housing, the exposure levels will be extremely low. Most homes have average magnetic field levels in the range 0.2 µT to greater than 0.4 µT. These magnetic fields are attributable to low voltage sources such as wiring, appliances, and distribution circuits (Mastanyi et al, 2007). In dwellings and other properties with electricity, the levels will not exceed the ICNIRP guidelines by a significant margin.

Based on the details of the proposed development, there will be no impact on residential properties at any distance from the proposed development as the ICNIRP guidelines are not exceeded at all relevant distances including directly above the cables. The magnetic field associated with an underground 110kV cable is 2.32 µT directly above ground and 0.15 µT at 10 meters from the cable (EirGrid, 2019), significantly below the ICNIRP Guidelines levels of 100 µT. The ESB state that exposure to electrical fields associated with underground cables are considered negligible (ESB, 2017).

The HSE, in their 2017 report 'Position paper on wind turbines and public health' state the following with regard to Electromagnetic radiation:

> "There is no direct evidence from which to draw any conclusions on an association between electromagnetic radiation produced by wind farms and health effects. Extremely low-frequency electromagnetic radiation is the only potentially important electromagnetic emission from wind farms that might be relevant to health. Limited evidence suggests that the level of extremely low-frequency electromagnetic radiation close to wind farms is less than average levels measured inside and outside suburban homes."

In the case of the proposed grid connection between the proposed Annagh Wind Farm and the Charleville substation, the electric and magnetic fields expected to be associated with the operation of the proposed cable fully complies with the ICNIRP and EU guidelines on exposure of the general public to ELF EMF. Therefore, the potential impact to human health as a result of electromagnetic interference associated with the operational phase of the proposed Annagh Wind Farm will be negligible and imperceptible.

EU Directive 2013/35/EU on the minimum health and safety requirements regarding the exposure of workers to the risks from EMFs was transposed into Irish law on 1st July 2016 by the Safety, Health and Welfare at Work (Electromagnetic Fields) Regulations 2016 (S.I. No. 337 of 2016). The regulations impose a number of duties on employers to maintain safety during work procedures. This includes the carrying out of risk assessment, avoiding and reducing risk, employee information, training and consultation and health surveillance where appropriate. The proposed development will comply with both EU and Irish law and will result in a negligible impact to human health on employees at the Annagh Wind Farm during the operational phase.

11.7.3.4 Vulnerability of the Project to Major Accidents and Natural Disasters

EU Directive 2014/52/EU which amends Directive 2011/92/EU states the following in relation to vulnerability of a project to natural disaster:

> In order to ensure a high level of protection of the environment, precautionary actions need to be taken for certain projects which, because of their vulnerability to major accidents, and/or natural disasters (such as flooding, sea level rise, or earthquakes) are likely to have significant adverse effects on the environment.
>
> For such projects, it is important to consider their vulnerability (exposure and resilience) to major accidents and/or disasters, the risk of those accidents and/or disasters occurring and the implications for the likelihood of significant adverse effects on the environment.

The following section considers the proposed project's vulnerability to major accidents and natural disasters, potential adverse impacts on human health and the environment, the magnitude of potential impacts, the likelihood of potential impacts and considers the preparedness of the project in case of accident, disaster or emergency.

Should a major accident or natural disaster occur, the potential sources of pollution onsite during the construction and operational phases of the Annagh Wind Farm are limited. The primary sources with the potential to cause significant environmental pollution and associated negative impacts on human health and the environment include the bulk storage of hydrocarbons, chemicals and wastes. In the case of the proposed Annagh Wind Farm development site, the storage of chemicals of this kind are strictly limited.

There is limited potential for significant natural disasters to occur at the Annagh Wind Farm as Ireland does not suffer from extreme temperatures like that of many countries at a similar latitude due to the dominant influence of the Gulf Stream. This provides Ireland with a mild temperate climate. Potential vulnerabilities relevant to the proposed project are limited to:

- Flooding;
- Fire;
- Major incidents involving dangerous substances;
- Catastrophic events; and
- Landslides.

Flooding

In the event of extreme weather conditions there is potential for the proposed development to negatively impact on human health and safety and the surrounding environment due to increased surface water runoff as a result of additional impermeable surfaces such as wind turbine hardstands and new access tracks. This has potential to add to flood risk which may negatively impact on human safety (including traffic), water quality, biodiversity, soil stability, material assets and archaeological or architectural heritage. It is unlikely that potential increase in flood risk will impact on noise and vibration, air and climate, landscape and visual and telecommunication and aviation. The magnitude of these consequences has potential to be significant, resulting in potential injury or fatality, property damage, infrastructure damage and damage to ecosystems.

The risk of flooding is addressed in Chapter 10: Hydrology and Water Quality, which concludes that the wind farm site will have a negligible impact on flood risk in the surrounding area, as a result of the proposed development. Furthermore, there is no expected increase to flood risk along the grid route or TDR.

In the event of extreme weather conditions, the proposed surface water drainage will manage storm water avoiding significant negative impact on the project's infrastructure. Therefore, it is unlikely that the proposed development will result in increased flood risk, and it is unlikely that flood risk would result in effects on human safety (including traffic), water quality, biodiversity, soil stability, material assets and archaeological or architectural heritage, as the increased flood risk is considered negligible.

Mitigation measures are set out in Chapter 10: Hydrology and Water Quality to avoid potential negative impacts during the construction stage with respect to flood risk.

Fire

In respect of fire, in May 2017 a major gorse/ground vegetation fire incident took place in proximity to the 169MW Galway Wind Park. This incident highlights fire as a potential significant negative impact for the proposed Annagh Wind Farm, in particular, given that much of the proposed infrastructure is located adjacent to forestry. It should be noted that a substantial number of wind farms are built within forestry in Ireland. In order to avoid negative impact from potential forest fires, buffers have been applied between the proposed infrastructure and tree lines. This is aimed at reducing potential impact on bat species but also acts as a fire break between treelines and proposed turbines.

In the event of electrical equipment catching fire at the proposed Annagh Wind Farm, there is potential for negative impact on human health and safety, air quality, water quality, biodiversity, soils, material assets, archaeological or architectural heritage and landscape and visuals. The magnitude of these consequences has potential to be significant and negative, resulting in potential injury or fatality, property damage, infrastructure damage, loss of forested lands and damage to ecosystems. It is unlikely that potential fire at the Annagh Wind Farm will have an effect on noise and vibration and telecommunication and aviation.

The potential for fire at the proposed Annagh Wind Farm is mitigated against by design. Furthermore, the wind farm will be remotely monitored, and potential accidents will be quickly identified and reported.

In line with IWEA Health and Safety Guidelines for the Onshore Wind Industry (2011), Emergency Response Plans will include emergency response procedures for initial actions in the event of a fire. Records will be kept for testing of fire alarms and drills and maintenance/inspection of fixed and portable firefighting equipment. Information will be provided to employees on fire safety and fire prevention, including risks of and control measures to prevent fire outbreak, evacuation procedures and those responsible for their implementation, and the use of firefighting equipment, in line with HSA guidance.

During the construction phase of the proposed development, an emergency response plan will be in place as set out in Section 6 of the CEMP, included in Appendix 3.1 of Volume 3 of this EIAR.

Major Incidents Involving Dangerous Substances

Major industrial accidents involving dangerous substances pose a significant risk to human health and to the environment both on and off the site of an accident. The Health and Safety Authority (HSA) of Ireland list all upper and lower tier SEVESO establishments throughout Ireland.

The proposed Annagh Wind Farm site is not in proximity to any site regulated under the Control of Major Accident Hazards Involving Dangerous Substances Regulations i.e. SEVESO site, that would fall within the consultation radius distance from a SEVESO site as per County Development Plan Policy Objective ZU 5-2. The most proximate SEVESO site located 20km south of the proposed wind farm site at the Quartertown Industrial Estate, Mallow (LP Gas Filling Services lower tier Seveso Site).

Given the nature of the proposed development, coupled with the lack of proximity to established Seveso sites, there is a negligible potential risk of negative impact to the proposed development and its receiving environment, as set out throughout this EIAR, arising from the occurrence of such a potential accident.

Catastrophic Events

According to the Health and Safety Authority (HSA), operational wind farms are still considered a workplace (albeit not permanently occupied). All persons who have control to any extent over the wind-farm have duties to ensure, so far as reasonably practicable, that the wind-farm does not pose a risk to those working there or to anyone not employed there but who may be affected by activities on the wind-farm.

Each wind-turbine, incorporating the tower, blades, gearbox and ancillary equipment in the tower and nacelle are considered to be machines under the European Machinery Directive [2006/42/EC]. The duties on designers and manufacturers of machinery are set out in the Machinery Directive, which has been transposed into national law by the 2008 European Communities (Machinery) Regulations [S.I.No.407/2008]. All wind turbines will be CE marked, which is in effect, a mark of assurance that the wind-turbine complies with the essential health and safety requirements (EHSRs) of EU supply law. In all cases, the manufacturer or the manufacturer's authorised representative must compile information in a technical file confirming how the machine complies with these requirements.

The maintenance of turbines and ancillaries must only be carried out by competent, trained and qualified personnel. The system of work for operation and maintenance must be planned, organised, maintained and revised to ensure safety of personnel.

Potential catastrophic events associated with operational wind turbines include:

- Wind turbine toppling (due to foundation or tower failure);
- Wind turbine rotational failure in extreme wind conditions (due to control system or rotor break failure); and,
- Fire.

The primary mitigation against a catastrophic event that may endanger the health and safety of the public has been implemented at design stage through adequate siting of wind turbines which provide sufficient set back distances from occupied buildings and other infrastructure to avoid the risk of negative impact in the event of wind turbine collapse.

The proposed tip height for wind turbines at the Annagh Wind Farm is 175m. No wind turbine is located within 500m of a residential dwelling. The most proximate occupied dwelling (involved landowner) is 690m from a proposed turbine location. No turbines have been located within 1.5 x tip height of the proposed on-site substation. A minimum setback distance of 3.5 x rotor diameter has been imposed between wind turbines and existing HV overhead lines in accordance with EirGrid general functional specifications.

Turbines have been sited with consideration for existing ground conditions to minimise the risk of turbine foundation failure, toppling and landslide. Intrusive site investigations have been carried out to confirm ground conditions at turbine locations as well as slope stability analysis throughout the wind farm site. Other design mitigation measures employed for the siting of wind turbines include the following:

- Areas mapped by GSI as having a high susceptibility to landslides have been avoided;
- Turbine locations have been assessed by site investigation and visually by geotechnical engineers prior to confirmation of final siting;
- Care has been taken in design of road and hard standing alignments, cutting and filling and drainage;
- Peat probing has been carried out at turbine locations. No peat was identified within the wind farm site.

See Chapter 9: Land, Soil and Geology for more information on ground conditions.

Wind turbines are fitted with sophisticated remote monitoring and control systems to manage rotational speed. Turbines also have the capability to shut down in storm conditions through adjustment of blade pitch. Turbines are also fitted with emergency power supply (EPS) units to provide backup power in the event of a loss of mains power supply that could impact the control system.

Wind turbines shall be fitted with fire suppression systems and will have emergency escape procedures in place for operational staff in the event of fire in a wind turbine. An emergency response plan is contained in the CEMP included in Appendix 3.1 of Volume 3 of this EIAR.

The proposed turbines have been sited to avoid potential impact on the adjacent consented solar farm (Charleville Solar) so far as possible. T02 is located approximately 110m from the nearest consented panels. T04 is located approximately 170m from the consented panels. None of the proposed turbines are located within toppling distance of transformers or the consented ESB control room/on-site substation. In the unlikely event of a foundation or tower failure, there is potential for turbine components to damage the consented solar panels. In the unlikely event of this happening, it is unlikely that significant damage will occur to the consented solar farm due to the distance between the proposed turbines and the margins of the solar arrays and the limited extent of the solar arrays within toppling distance of the proposed turbines.

Landslides

Landslides pose a risk to a range of environmental receptors including human safety (including traffic), hydrology and water quality, biodiversity, land, soil, geology and hydrogeology, material assets and archaeological and cultural heritage. The negative impacts associated with landslides can have a significant to profound effect on environmental sensitivities, depending on the scale of the landslide and the receiving environment.

As detailed in Chapter 9: Land, Soils and Geology, a slope stability assessment was carried out at the proposed Annagh Wind Farm site to investigate the lands for potential slope failure. Susceptibility to slope failure is considered ‘low’ on the site. Site investigations were conducted which revealed no peat on the site. As such, potential peat stability issues were ruled out at the proposed infrastructure locations.

Mitigation by design has been incorporated into the project to avoid potential effects from landslides. Mitigation measures for potential landslide/slope failure are set out in Chapter 9: Land, Soils and Geology. Mitigation measures relating to flood risk which could have a bearing on potential landslides are detailed in Chapter 10: Hydrology and Water Quality.

During the construction phase of the proposed development, an emergency response plan will be in place as set out in Section 6 of the CEMP in the unlikely event of a landslide/slope failure.

In relation to potential vulnerability of the project to major accidents and natural disasters it is concluded that the potential susceptibility to major accidents and natural disaster of the proposed Annagh Wind Farm is negligible.

11.7.4 Potential Impacts – Human Health – Decommissioning

The decommissioning phase of the proposed development, as described in Section 3.8 of this EIAR, provides for the removal of turbines and associated infrastructure from the site. The potential impacts associated with decommissioning phase in relation to human health will be similar to those associated with construction phase as detailed in Section 11.7.2.

Decommissioning works will include removal of above ground structures including the turbines, mountings, and fencing. The proposed on-site substation will be taken in charge by ESB following decommissioning. During the decommissioning works there is potential for significant impact to human health and safety for construction workers on site. These impacts are similar to those set out in section 11.7.2. Potential impacts to human health and safety on-site will be prevented through best practice methods as per the construction phase CEMP and will include staff training and knowledge of the site-specific decommissioning plan.
Once mitigation measures and best practice construction site methods are followed, potential negative impact on human health and safety is expected to be imperceptible and temporary.

During the decommissioning works there is potential for negative impact on health and safety of the public. Similar to Section 11.7.2, impacts are associated with the presence of a construction crew, increased traffic, presence of heavy goods vehicles and machinery and potential obstructions on the public road. Potential impact to public health and safety during the decommissioning phase is considered temporary moderate and negative. However, a Construction and Environmental Management Plan for decommissioning works will be followed, clear signage will be utilized on public roads and walkways and the community will be informed of works prior to commencement to avoid any potential negative impact to public health and safety. Once good practice is followed, the potential for negative impact on public health and safety is expected to be temporary and not significant.

11.7.5 Mitigation Measures – Human Health & Safety

11.7.5.1 Mitigation Measures – Construction & Decommissioning

To maintain safety and avoid health impacts on construction workers and the general public, best practice site safety and environmental management will be maintained. The proposed development will be designed, constructed, operated and decommissioned in accordance with the following:

- Safety, Health & Welfare at Work (Construction) Regulations 2013
- Safety, Health & Welfare at Work Act 2005
- Safety, Health & Welfare at Work (General Applications) Regulations 2007

All construction staff will be trained to the correct Health and Safety standards in order to carry out their duties and will be informed and aware of potential hazards. A Construction and Environmental Management Plan is included in Appendix 3.1, will be circulated to all construction workers which will detail safety protocol and methodology. Furthermore, site investigation has been completed and mitigation has been proposed as detailed in Chapter 9: Lands, Soils and Geology and Chapter 10: Hydrology and Water Quality.

All hazards will be identified, and risks assessed. Where elimination of the risk is not feasible, appropriate mitigation and/or control measures will be established. The contractor will be obliged under the construction contract and current health and safety legislation to adequately provide for all hazards and risks associated with the construction phase of the project.

FÁS Safe Pass registration cards are required for all construction, delivery and security staff. Construction operatives will hold a valid Construction Skills Certificate Scheme card where required.

The developer is required to ensure a competent contractor is appointed to carry out the construction works. The contractor will be responsible for the implementation of procedures outlined in the Safety & Health Management Plan.

In relation to COVID-19, up to date HSE guidance will be consulted regularly in line with HSA recommendations and all reasonable on-site precautions will be taken to reduce the spread of COVID-19 on construction sites, should the virus be prevalent at the time of construction.

Once mitigation measures and health and safety measures are followed, the potential for impact on human health on the construction site during construction and decommissioning is expected to be not significant and temporary to short-term.

Appropriate warning signage will be posted at the construction site entrance, directing all visitors to the site manager. Appropriate signage will be provided on public roads approaching site entrances and along haul routes to maintain public safety.

In relation to the TDR, extra safety measures will be employed when large loads are being transported, for instance, Garda escort will be requested for turbine delivery and a comprehensive turbine delivery plan will be utilised to avoid potential impact to human safety for road users and pedestrians. A traffic and transport assessment has been completed and is detailed in Chapter 13: Traffic and Transportation.

For the installation of the grid connection cable in the public road, a detailed traffic management plan will be developed in discussion with locals who will be directly impacted by the works, and in agreement with the Local Authority. Public consultation will be conducted along the grid cable route to inform local residents ahead of construction works.

Once mitigation measures and health and safety measures are implemented and followed, the potential for impact on human health for members of the public during construction and decommissioning of the proposed project is expected to be not significant and temporary to short-term.

11.7.5.2 Mitigation Measures - Operational

For operation and maintenance staff working at the proposed wind farm, appropriate site safety measures will be utilised during the operational phase by all permitted employees.

All personnel undertaking works in or around the turbines will be fully trained and will use appropriate Personal Protective Equipment (PPE) to prevent injury.

Equipment within high voltage substations presents a potential hazard to health and safety. The proposed substation will be enclosed by palisade fencing and equipped with intruder and fire alarms in line with ESB and EirGrid standards.

All electrical elements of the proposed development are designed to ensure compliance with EMF standards for human safety.

All on-site electrical connections are carried by underground cable and will be marked out above ground where they extend beyond the track or hardstanding surface. Details of cables installed in the public road will be available from ESBN.

Lightning conductors will be installed on each turbine as all structures standing tall in the sky require this protection. Turbines specifically require this to prevent power surges to electrical components.

Turbines will be fitted with ice detection systems which will stop the turbine from rotating if ice is forming on a turbine blade. This aims to prevent ice throw which can cause injury.

Rigorous statutory and engineering safety checks imposed on the turbines during design, construction, commissioning and operation will ensure the risk posed to humans is negligible. 24-hour remote monitoring and fault notifications are included as standard in the Turbine Operations and Maintenance Contracts.
In addition to scheduled maintenance, the maintenance contracts will allow for call out of local engineers to resolve any issues as soon as they are picked up on the remote monitoring system.

Access to the turbines inner structure will be locked at all times and only accessed by licenced employees for maintenance.

In line with the Health Service Executive's Emergency Planning recommendations, any incident which may occur at the site which requires emergency services, incident information will be provided in the 'ETHANE' format.

- Exact location;
- Type of incident;
- Hazards;
- Access and egress;
- Number of casualties (if any) and condition;
- Emergency services present and required.

The design of the proposed wind farm has considered the susceptibility to natural disasters. The proposed site drainage will mitigate against any potential flooding risk with the use of swales as described in Chapter 10 – Hydrology and Water Quality.

A nominated competent person shall carry out checks and routine maintenance work to ensure the reliability and safe operation of fire-fighting equipment and installed systems such as fire alarms and emergency lighting. A record of the work carried out on such equipment and systems will be kept on site at all times.

Shadow flicker detection systems will be installed on all turbines in order to reduce potential occurrence of shadow flicker on nearby receptors. This is further detailed in Chapter 12: Shadow Flicker.

In order to ensure the proposed wind farm is compliant with the noise limits, some of the turbines may need to be operated in noise reduced modes of operation in order to protect residential amenity. Details of these mitigation measures are set out in Chapter 7: Noise and Vibration.

The wind farm system shall include a kill switch that can be operated at any time with an overriding manual shutdown system in case of an emergency.

11.7.6 Residual Impacts – Human Health

Through various aspects of the design process for the proposed Annagh Wind Farm, negative residual impact on human health is expected to be imperceptible. This is due to the significant setback distance from nearby dwellings, the reduction of potential occurrence of shadow flicker on neighbouring dwellings through the use of shadow flicker detection systems, and noise control measures to reduce potential noise impacts on nearby receptors. Furthermore, the mitigation measures as set out throughout the EIAR will prevent any potential significant negative impacts on human health during the construction and decommissioning phases.

Long-term positive imperceptible residual impacts will occur due to the provision of clean, renewable electricity. The operation of the Annagh Wind Farm will result in the net displacement of c. 42,966 tonnes of CO2 per annum which would otherwise be emitted through the burning of fossil fuels.

11.8 Renewable, Non-Renewable Resources and Utility Infrastructure

This section provides a comprehensive overview of the material assets (renewable and non-renewable resources, and utility infrastructure) of the receiving environment in order to provide an understanding of the potential effects which the proposed development may have on renewable and non-renewable resources, and utility infrastructure. The waste produced as a result of the proposed development is also considered in this section.

The Geological Survey of Ireland in their scoping response for the Annagh Wind Farm Project highlighted potential impacts to mineral resources in the area of the site as a result of the proposed development. This has been considered with respect to non-renewable resources in this section. The Felling Section of the Department of Agriculture, Food and the Marine also set out the need to consider removal of areas of forestry and the replanting of this forested area in a sustainable manner. This is considered in this section with regard to renewable resources.

11.8.1 Existing Environment – Renewable, Non-Renewable Resources and Utility Infrastructure

A number of active and historic quarries and mineral occurrences are located within 20km of the Wind Farm Site, as detailed in the GSI Online Minerals Database accessed via the Public Data Viewer. These consist of aggregates for concrete, hardcore, earthworks/fill, sandstone and shale quarries and recorded mineral occurrences, none of which are located within the wind farm site boundary.

The GSI Aggregates Database indicates that there is a mixture of low, moderate to high potential for crushed rock or granular aggregate across much of the wind farm site. Following site investigation, peat was not found to be present on the site.

Renewable resources at the site include plantations of commercial broadleaf forestry which is subject to an ongoing maintenance, felling and replanting schedule. This plantation covers much of the area of the proposed wind farm site. Further commercial conifer plantations are present in the wider landscape south east and west of the wind farm site.

Wind resource is average at the site location. The 2013 Sustainable Energy Authority of Ireland (SEAI) Wind Speed Atlas identifies the site as having an average wind speed of between 7.4 m/s and 7.5 m/s at 100m above ground level.

A consented solar farm (Charleville Solar) is located to the north of the proposed Annagh Wind Farm. This consented development consists of a 67.8 hectare solar farm of ground mounted solar photovoltaic panels mounted on steel structures, ESB control room, 14 electrical transformation enclosures, underground cabling, CCTV poles and cameras, deer type security fencing, site entrance, hardstanding area, landscaping and grid connection.

No significant renewable and non-renewable resources have been identified along the GCR or in proximity to TDR node upgrades.

As part of the scoping and consultation process for the proposed project, searches of existing utility services were carried out to identify areas where major assets exist such as high voltage electricity cables or gas mains. Private utility and telecommunications companies were also consulted during this period. No major utility infrastructure was identified at the proposed wind farm site. The GCR passes beneath high voltage and medium voltage powerlines adjacent the Charleville substation.

An existing grid connection for a wind farm development was also identified entering the Charleville 110kV substation along the proposed GCR. No other major utility infrastructure was identified along the GCR. The TDR crosses a natural gas mains pipeline to the east of the wind farm site along the L1322. The Charleville to Mallow 110kV line crosses the L1322 along the TDR. A medium voltage powerline also crosses the TDR on the L1322 east of the Dawn Meats Factory.

Some minor elements of utility infrastructure and elements of public and private property were identified along the TDR route which will require alteration or removal. This includes temporary removal of street furniture, lighting, road signage and overhead utilities, application of load bearing surfaces to existing roundabouts and treeline and hedgerow trimming. These elements are identified in section 3.5.6.1 of this EIAR and further detailed in Chapter 13: Traffic and Transportation.

11.8.2 Potential Impacts – Renewable, Non-Renewable Resources and Utility Infrastructure - Construction

11.8.2.1 Non-renewable Resources

The construction of the proposed Annagh Wind Farm will impact on natural resources such as aggregates which will be sourced from batching plants, quarries and pits in proximity to the site. The quarry identified in proximity to the site which can supply the appropriate grade of rock is as follows:

- Lackanamona, Mallow, Co. Cork. Located approximately 25km from the Annagh Wind Farm Site

Existing tracks have been used where possible and the layout was designed to minimise the length of new track required in order to reduce the requirement for stone material. The use of imported materiel will have a slight, permanent negative impact on non-renewable stone resources of the source quarry. This impact is considered to be imperceptible in the long-term.

11.8.2.2 Renewable Resources

The proposed development is intended to capture the renewable wind resource at the site. There will be no negative effects on the renewable wind resource of the receiving environment.

It is considered that the proposed development will have an overall long-term positive impact in terms of carbon reduction and climate change. It will assist Ireland in meeting its target of producing 70% of electricity from renewable sources by 2030 as set out in the Climate Action Plan 2019.

Trees felled for development purposes will be replanted at another unplanted location as required by Irish Forest Service Guidelines. The proposed development will require the felling of forestry within and around the infrastructure to accommodate the construction of turbine foundations, hard stands, crane pads, access tracks, and substation compound. The overall area of tree clearing required for the proposed development will be approximately 12.6 ha. A felling licence will be sought from the Forest Service prior to any tree felling and will include the provision of relevant replant lands. The impact on broadleaf renewable timber resources within the study area as a result of felling is considered long-term, slight and negative.

However, the overall effect of the proposed development on renewable timber resources at a national scale will be neutral. Replant lands have been identified at Emlagh, Co. Clare. The total area for replanting is approximately 12.6 ha. An environmental assessment of these replant lands is included in Appendix 3.3 of Volume 3 of this EIAR.

11.8.2.3 Utilities Infrastructure

There is no major utility infrastructure located within the wind farm site. During the construction phase the GCR will be constructed beneath high voltage and medium voltage powerlines leaving/entering the Charleville substation. The construction works for the GCR are not likely to impact on these powerlines.

Appendix 13.2 of this EIAR includes the Turbine Delivery Route Survey Report. This report indicates where overhead utilities, poles, lighting columns, bollards and signage will require temporary removal at certain points along the route to accommodate the delivery of wind turbine components.

The removal of overhead utility infrastructure has the potential to cause a brief to temporary non-significant negative impact on nearby dwellings and commercial/industrial activities in proximity to TDR nodes.

Lighting columns will require temporary removal at various points along the TDR. This is expected to have a temporary non-significant negative impact on utility infrastructure. The TDR Report details the locations and extent of the temporary removal works required.

The TDR passes beneath high voltage and medium voltage powerlines on the L1322. There is sufficient clearance below these lines to accommodate turbine delivery. The TDR also crosses a gas mains pipeline on the L1322. Accommodation works are not required at this point and therefore the gas pipeline will not be affected.

There is potential for turbine delivery to negatively impact on major road infrastructure if unmitigated. Turbine delivery could potentially cause traffic disturbance and damage to road infrastructure if not properly planned and assessed. Potential impact on road infrastructure is detailed in Chapter 13: Traffic & Transportation.

Potential effects on telecommunications are discussed in Chapter 16: Telecommunications and Aviation. As set out in Chapter 16, the proposed development will have no impact on the telecommunications signals during the construction of the project.

Desktop research and consultation with utilities providers identified an existing wind farm grid connection entering the Charleville Substation. The proposed GCR will cross this grid connection. The proposed GCR will be installed above or below the existing grid connection allowing for appropriate clearance. It is unlikely that the proposed GCR will impact on the existing grid connection entering the Charleville substation. The construction of the cable trenches along public roads will have a temporary, slight, negative impact on the roads concerned during construction, with some areas likely to require re-surfacing.

Importation of materials and equipment for the Annagh Wind Farm will also increase shipping traffic at the ports being used and increase freight on the motorway, national primary routes and local road network. This impact is assessed in Chapter 13: Traffic and Transportation.

The construction stage of the proposed development is not expected to impact on the adjacent consented Charleville Solar Farm development located in the townland of Fiddane. Potential for the construction phase of the Annagh Wind Farm and Charleville Solar Farm to occur simultaneously is considered in Section 11.10 in terms of potential cumulative effects.

The buildability of the Charleville Solar Farm will not be negatively affected by the proposed Annagh Wind Farm. As illustrated in Figure 11.5, the arrays of the solar farm are located north and north west of the proposed wind farm in separate agricultural fields. The most proximate proposed turbine is T02, located approximately 110m south of the nearest solar array. The site entrance of the consented solar farm is located approximately 800m west of the proposed wind farm site entrance. The solar farm and wind farm sites are not directly connected. During the construction phase of the Annagh Wind Farm, there will be no interaction between the wind farm site and the consented Charleville Solar Farm site.

Although the proposed wind farm and consented solar farm share the same grid route, running along the L1322 local road leading to the Charleville 110kV substation, both can be accommodated in the public road. The width of the route between the proposed wind farm and Charleville Substation measures between approximately 6.1m at its widest, and 4.2m at its narrowest section. The cable trenches will be 0.6m in width and will be located within the public road. This will allow for ample room to accommodate both grid connection trenches as well as additional services within the public road. Figure 5-6 illustrates an example of two grid connection trenches within a 4.2m carriageway, representing the narrowest section of the proposed grid route, and indicating the space within the carriageway to allow for both sets of cables to be accommodated.

Both grid connections will cross the Rathnacally Stream as indicated on Figure 5-5. The consented solar farm will cross the stream within the existing bridge deck using a flat formation. The proposed wind farm grid connection will utilise horizontal directional drilling to install the cable beneath the bridge, avoiding impact on the solar farm grid connection at the bridge point on the Rathnacally Stream. It is therefore considered that the proposed Annagh Wind Farm and associated proposed grid connection will have no negative effects on the buildability of the adjacent consented Charleville Solar Farm and its associated grid connection.

Path: R:\Map Production\2020\P2359\Workspace\EIAR\P2359_GIS_Fig11-5_CharlevilleSolarFarm_A3.mxd

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
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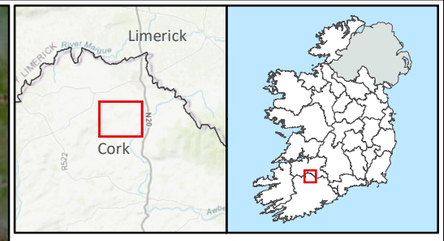

Legend

- Turbine Layout
- Met Mast
- Construction Compound
- Substation
- Turbine Hardstanding
- Turning Heads
- Solar Farm Arrays
- Proposed Grid Connection Route
- Solar Farm Grid Connection Route

Roads

- New
- Upgrade

N W E S

0.5 0.25 0 0.5 Kilometers

TITLE:	Proposed Annagh Wind Farm in relation to the consented Charleville Solar Farm
PROJECT:	Annagh Wind Farm, Co. Cork
FIGURE NO:	11.5
CLIENT:	EMPower
SCALE:	1:15000
REVISION:	0
DATE:	12/11/2021
PAGE SIZE:	A3

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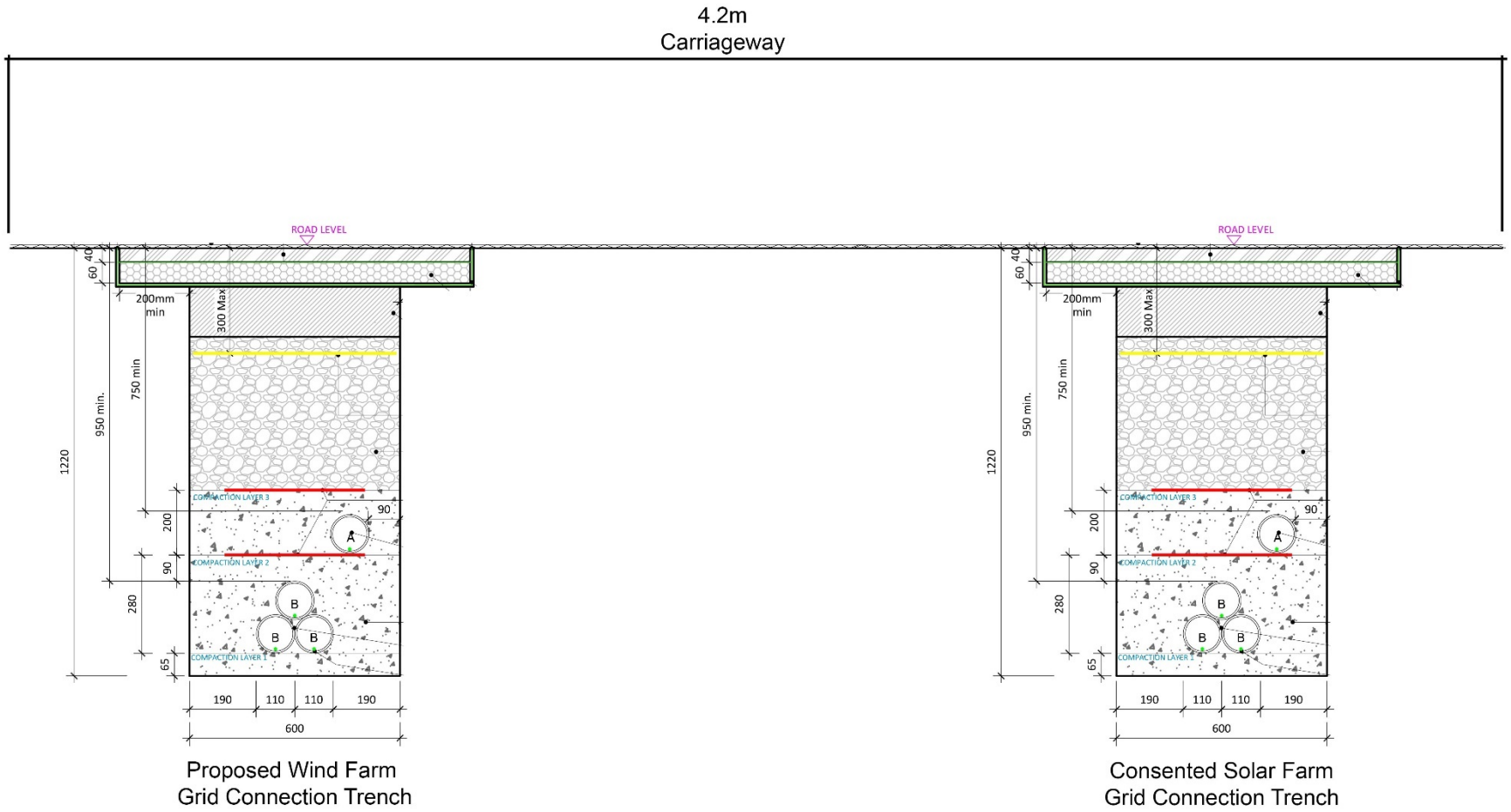

Figure 11-6: Grid Connection Trenches Accommodated Within the Public Road

11.8.2.4 Waste

During the construction phase of the proposed development, waste will be generated due to the various construction activities and materials required for the installation of infrastructure at the wind farm site, grid route and TDR.

In line with the National Waste Management Guidelines for the circular economy and European Waste Management Hierarchy, the developer and appointed contractor will aim to prevent, reduce, reuse and recover as much of the waste generated on site as practicable and to ensure the appropriate transport and disposal of residual waste off site.

Any waste generated during the development construction phase will be collected, source separated and stored in dedicated receptacles at the temporary construction compounds.

It is envisaged that the following categories of waste will be generated during the construction of the project:

- municipal solid waste (MSW) from the office and canteen;
- construction and demolition waste;
- waste oil/hydrocarbons;
- paper/cardboard;
- timber;
- steel.

A fully authorised waste management contractor will be appointed prior to construction works commencing. This contractor will provide appropriate receptacles for the collection of the various waste streams and will ensure the regular emptying/and or collection of these receptacles.

Waste will be reused onsite for other suitable purposes where possible. For example:

- re-use of shuttering etc. where it is safe to do so;
- re-use of rebar cut-offs where suitable;
- re-use of excavate materials for screening, berms etc.;
- re-use of excavated material etc. – will be used as suitable fill elsewhere on site for the new site tracks, the hardstanding areas and embankments where possible.

Receptacles will be provided for the separation and collection of dry recyclables (paper, cardboard, plastics etc.), biological waste (canteen waste) and residual waste. Receptacles will be clearly labelled, signposted and stored in dedicated areas. The following sourced segregated materials container will be made available on site at a suitable location:

- timber;
- ferrous metals;
- aluminium;
- dry mixed recyclables;

- packaging waste;
- food waste.

Residual waste generated on-site may require disposal. This waste will be deposited in dedicated receptacles and collected by the licensed waste management contractor and transported to an appropriate facility. Waste Facilities have been identified in Section 3.6.12 of Chapter 3 of the EIAR. All waste movements will be recorded, of which records will be held by the waste manager on-site.

Any contaminated soils will be handled, removed and disposed of in accordance with statutory requirements for the handling, transportation and disposal of waste.

Waste management during the construction stage is set out in the CEMP included in appendix 3.1 of Volume 3 of this EIAR. Once these best practice measures are put in place, waste produced during the construction stage will have an imperceptible impact on the receiving environment. Waste created on site and disposed of in licenced facilities will have a slight negative impact on the capacity of the facilities identified.

11.8.3 Potential Impacts – Renewable, Non-Renewable Resources and Utility Infrastructure - Operational

Once the Annagh Wind Farm is operational, the potential for negative effects on material assets is minimal. Maintenance of access tracks and infrastructure may require small amounts of imported fill, however, the impact of this is likely to be slight/imperceptible.

The direct effect of electricity generated by the proposed development will give rise to a reduction in the quantity of fossil fuels required for electricity generation across the State. This will give rise to a long-term slight positive impact on renewable energy resource and will contribute to reducing Ireland's dependency on imported fuel resources.

A minimum setback distance of 3.5 x rotor diameter has been imposed between the proposed wind turbines and existing 110kV overhead lines in accordance with EirGrid general functional specifications. No impact on existing major utility infrastructure is expected at the wind farm site during the operational phase.

As set out in Chapter 16, following a telecommunications assessment on potential impact to existing infrastructure, the proposed development will have no significant impact on existing telecommunications signals during the operational phase of the project.

Significant volume of waste is not expected to be produced during the operation phase of the proposed development. In the event that maintenance works are required at the wind farm site, grid route or TDR during the operational phase, a CEMP will be in place, and waste management procedures as set out in section 11.8.2.4 will be followed. Any waste produced during the operational phase of the wind farm will have an imperceptible impact on the receiving environment.

The operation phase of the proposed Annagh Wind Farm has potential to impact on the consented Charleville Solar Farm, located directly to the north of the Wind Farm Site in the townland of Fiddane. Due to the location of the proposed turbines positioned to the south of the consented solar farm, there is potential for loss of sunlight due to overshadowing of the consented solar arrays and therefore loss of power output. In order to avoid significant impact, elements of the design of the project were amended to create greater setback between the proposed turbines and the consented solar arrays as detailed in Section 11.8.5.

Furthermore, a production analysis and shading assessment was carried out to determine the potential impact on the consented solar farm. This analysis determined that the proposed Annagh Wind Farm will result in losses of 0.29% of total gross annual electricity production. It is therefore considered that the presence of the operational wind farm will have a non-significant impact on the electricity production of the adjacent consented Charleville Solar Farm. The Shading Assessment Report is included in Appendix 11.1.

11.8.4 Potential Impacts – Renewable, Non-Renewable Resources and Utility Infrastructure – Decommissioning

The potential impacts associated with decommissioning phase will be similar to those associated with construction but of a reduced magnitude.

Decommissioning works will include removal of above ground structures including the turbines and met masts. Turbine foundations and access tracks will be left in situ. The proposed on-site substation building will be taken in charge of by ESB which will have a long-term slight positive impact on electricity infrastructure provision in the area. Similarly, the underground grid cable will remain in situ and will become a part of the national grid resulting in a long-term slight positive impact on electricity infrastructure provision in the area.

There will be no significant negative impacts on renewable and non-renewable resources during the decommissioning phase. No likely negative impacts on utility infrastructure are expected during the decommissioning phase.

Increased traffic numbers on the local, regional and national roads will have a temporary slight negative impact on the road network due to increased traffic.

Waste will be produced as a result of the decommissioning activities. A decommissioning plan and associated CEMP, similar to that included in Appendix 3.1, will be followed during the decommissioning phase and waste management procedures as set out in section 11.8.2.4 will be followed. Decommissioned turbine components will be reused and recycled where possible and all non-reusable or recyclable materials will be disposed of in a licenced waste facility. Licenced waste facilities have been identified in Section 3.6.12 of Chapter 3 of the EIAR, however, decommissioning is expected to take place 35-years from commissioning of the proposed wind farm and therefore it is uncertain if the identified facilities will remain operational at this time. Through the use of a waste management plan, similar to that as detailed in the CEMP contained in Appendix 3.1, waste produced during the decommissioning phase will have an imperceptible impact on the receiving environment. Waste produced during the decommissioning phase will likely have a slight negative impact on the capacity of the licenced waste facilities used at the time of decommissioning.

11.8.5 Mitigation Measures – Renewable, Non-Renewable Resources and Utility Infrastructure

Existing services along the proposed grid connection cable route have been predicted through a desktop study and will be confirmed in the pre-construction surveys prior to construction. This will minimise the impact in terms of disruption or damage to existing utilities. It is not intended to divert existing services but instead, where possible, the cable will be laid above or below existing services. Communication with service providers will be maintained for the duration of the construction works where required.

Non-renewable resources of stone and fill will be sourced locally insofar as possible to minimise transportation distances.

The layout of the proposed Wind Farm includes mitigation by design in order to reduce potential impact on the adjacent solar farm located to the north of the wind farm site in the townland of Fiddane. T02 was relocated approximately 110m to the south of its original location in order to reduce shadowing effect on the solar array. This also reduced the requirement for tree felling as the movement of T02 reduced the felling requirement at this turbine location and also resulted in the movement of T05 from a forested area to an open agricultural field. As a result, the total felling required for the proposed project was reduced by 1.9 hectares.

The 12.6 hectares of commercial forestry which will be felled at the proposed Annagh Wind Farm site will be replanted at alternative lands under a felling licence. The proposed replant lands are located at Emlagh, Co. Clare. The total area of commercial forestry replanting is approximately 12.6 hectares.

Where services and street furniture are required to be removed temporarily to accommodate turbine delivery, residents and business in proximity to the works will be informed in advance.

The turbine delivery procedure will follow the steps outlined in the list of accommodation works as set out in Section 3.5.6.1, to avoid negative impact on roads and private property along the TDR including the N69, N18, M20, N20, and L1322 leading to the site. It is likely that turbine delivery will take place outside of regular travelling/commuting hours in order to avoid potential traffic impacts on major routes and will be supervised under Garda escort.

A Construction Waste Management Plan has been prepared for the proposed Annagh Wind Farm and is included in the CEMP in Appendix 3.1, in line with the ”Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects” (2006) as published by the Department of the Environment, Community and Local Government and supported by the Southern Region Waste Management Plan 2015-2021.

The Waste Management Plan will be finalised in accordance with the CEMP following the appointment of the contractor for the main construction works and will take cognisance of any newly published waste management policy.

11.8.6 Residual Impacts – Renewable, Non-Renewable Resources and Utility Infrastructure

Non-renewable resources such as aggregates and cement are required onsite during the construction phase. This will result in a permanent negative imperceptible residual impact on non-renewable resources.

The proposed development will result in a long-term slight positive residual impact on non-renewable resources by offsetting the use of fossil fuels in electricity generation over the lifetime of the project.

The proposed on-site substation and underground grid route cable will be taken in charge of by ESB following decommissioning, providing a long-term slight positive residual impact on electricity infrastructure in the area of the wind farm site.

Residual waste from the construction, operation and decommissioning phases will be disposed of at a licenced waste facility. This will result in a permanent slight negative impact to capacity of licenced waste facilities in the area of the proposed development. The waste facilities currently in operation in proximity to the site are identified in Section 3.6.12 of Chapter 3 of the EIAR.

11.9 Do-Nothing Scenario

In the event that the proposed Annagh Wind Farm does not proceed, the existing land use on the site will continue in its present form consisting of agricultural land and commercial forestry for the foreseeable future.

In the absence of renewable energy development, it is likely that there will be a continuance of excessive greenhouse gas emissions and consumption of fossil fuels. The opportunity to harness the wind energy capacity of the site would be lost, further constraining the State from achieving its renewable energy targets of 70% by 2030. The net displacement of c. 42,966 tonnes of CO2 per annum as a result of the operational phase of the proposed development will not be achieved.

Overall renewable energy supply was 12% of gross final consumption in Ireland in 2019 (SEAI, 2020). The remaining 88% of energy came from fossil fuels indicating Ireland's heavy dependency on the importation of fossil fuels to meet its energy needs in transport, heat and electricity. This dependency on energy imports leaves Irish consumers exposed to fluctuating international oil and gas prices. Harvesting renewable, indigenous resources such as wind will help diversify the Irish generation portfolio and reduce Ireland's dependency on imported fuel resources. In the do-nothing scenario, the proposed 37.2 MW wind farm will not contribute to reducing fossil fuel dependency.

It is also envisaged that if the Annagh Wind Farm Project does not proceed, opportunity for employment relating to the construction, operation and decommissioning of the proposed development will be lost, resulting in a lost opportunity for potential economic activity in the County Cork Area. Development contributions and considerable commercial rates would not be made payable to Cork County Council by the developer, and no Community Benefit Fund Scheme will be put in place in the locality resulting in a lost opportunity for benefit to community infrastructure.

11.10 Cumulative Impacts

As part of the cumulative impact assessment included throughout this EIAR, planned, proposed, consented and existing developments/projects in the area of the wind farm site, grid route and TDR were considered for potential cumulative impacts on the receiving environment. Projects and proposed developments within 20km of the wind farm site were considered for the purpose of this assessment. Projects and proposed developments were also identified within 250m of the GCR and TDR nodes.

As set out in Section 11.2, a 20km distance was considered a reasonable zone of influence for the purpose of assessing potential cumulative impacts on population, human health and material assets, considering the limited size and extent of the project, the nature of the impacts and the relatively non-sensitive receiving environment. Smaller projects were examined in closer proximity to the proposed project including development within 2km of the wind farm site, and within 250m of the GCR and TDR nodes.

The list of all projects considered for the cumulative assessment are included in Appendix 1.2 of Volume 3 of this EIAR. Each of the projects listed in Appendix 1.2 were considered with respect to potential cumulative impacts on Population, Human Health and Material Assets. Projects for which cumulative impacts were not identified were discounted from the impact assessment. Developments in the planning system within the vicinity of the wind farm site, GCR and TDR consisting of one-off housing and agricultural developments were identified for potential cumulative assessment, however, these developments are small in scale and will have an imperceptible cumulative impact with the construction and operation of the proposed wind farm, in relation to population, human health and material assets.

This is due to the significant setback of the proposed wind farm from nearby planned, proposed and existing projects and the brief to temporary nature of the proposed construction works associated with the GCR and TDR. Therefore, potential cumulative impacts associated with small scale development were considered to be imperceptible.

There are two existing wind farms in proximity to the proposed wind farm site. These are the Boolard Wind Farm, approx. 2.3km north west and the Rathnacally Wind Farm, approx. 2.3km north east. Furthermore, there are two consented solar farms in proximity to the site, the Charleville Solar Farm, located directly adjacent to the north of the Annagh Wind Farm site, and the Dromin Solar Farm located 1.2km to the south east of the site. The proposed development in combination with the Boolard and Rathnacally Wind Farms and the Fiddane and Dromin Solar Farms will have a cumulative impact on land use in the area, introducing additional renewable energy land use to an established agriculture area. The proposed Annagh Wind Farm will reduce the overall available agricultural land by approx. 4 hectares. This is expected to have a non-significant to slight long-term negative impact on agricultural land availability in the area of the wind farm site.

The cumulative impact of the proposed development in combination with the Boolard and Rathnacally Wind Farms and other wind farms within 20km on Landscape and Visuals is detailed in Chapter 15: Landscape and Visual. The cumulative visual impact of the proposed development is considered to contribute an additional cumulative effect that is in the order of medium-low, which will reduce to Low in the wider surrounds of the study area. This has potential cumulative impact on residential amenity in proximity to the site. The significant setback distance between the proposed turbines and existing dwellings along with the presence of thick treelines and hedgerows throughout the area will reduce potential cumulative visual impact between the proposed wind farm and the existing Boolard and Rathnacally Wind Farms with respect to residential amenity. Therefore, cumulative visual impact on residential amenity is considered long-term, non-significant and negative.

Cumulative noise impacts have been assessed for the proposed wind farm project cumulatively with the existing Boolard and Rathnacally Wind Farms, in relation to residential amenity. The cumulative predicted noise levels comply with the daytime and night-time noise limits derived using the Wind Energy Development Guidelines 2006, at all sensitive locations. However, for some receptors a new source of noise will be introduced into the soundscape and it is expected that there will be a slight to moderate significance of impact, with dwellings closest to the project with a long-term moderate significance of impact.

The consented Charleville Solar Farm is located directly adjacent to the north of the Annagh Wind Farm site in the townland of Fiddane. Should the consented solar farm be constructed at the same time as the proposed Annagh Wind Farm there is potential for temporary cumulative impact on human health as a result of construction works which may cause cumulative noise, vibration, dust and increased traffic at nearby dwellings, causing a negative impact on residential amenity. Due to the sparse population in proximity to the consented Charleville Solar Farm and the significant setback from the proposed wind farm to nearby dwellings, cumulative impact on human health and residential amenity is considered temporary, negative and non-significant.

The consented Charleville Solar Farm, located in the townland of Fiddane, utilises the same grid connection route as the proposed Annagh Wind Farm. The works associated with the Annagh GCR are expected to take place over a 2-month period and will be a “rolling” construction site, meaning that these works will not be concentrated in any one area of the route for a long period of time. However, should the Charleville Solar GCR be installed simultaneously or directly before or after the proposed Annagh GCR, this may have a cumulative impact on nearby dwellings due to prolonged impacts from noise and dust. This has potential to cause a temporary, moderate and negative impact to residential amenity as a result of construction activities.

The electricity generating capacity of the proposed development, in combination with the consented solar farms and existing wind farms in proximity to the Annagh site, will have a long-term significant positive cumulative impact on utility infrastructure and renewable energy resource in the greater area and will have a positive impact on national renewable energy resources as well as reduction in requirements for the use of non-renewable fossil fuels. This will increase national savings on fossil fuel imports.

The proposed M20 motorway project has been examined for potential in-combination effects with the proposed Annagh Wind Farm Project. The route options presented show two potential routes, both located over 3 km east of the Annagh Wind Farm site. There is potential for short-term positive socio-economic benefits to the study area and greater area as a result of the construction phase of both the Annagh Wind Farm and the M20 project due to employment opportunities associated with the construction of the proposed projects. There is also likely to be indirect cumulative impacts in terms of demands placed on local quarries for aggregate and concrete required during the construction phase of the proposed development in combination with the M20 motorway project. This is likely to be a moderate negative impact on non-renewable stone resources.

The replant lands identified at Emlagh, County Clare form part of the proposed project and have been examined for potential cumulative impact on population, human health and materiel assets. The replant lands site is in agricultural use and is located in an agricultural area with areas of commercial forestry located throughout the landscape. The addition of 12.6 hectares of broadleaf forestry at the Emlagh site is not expected to cause a significant impact on population, employment and economic activity, recreation, amenity and tourism, human health and safety, non-renewable resources and utility infrastructure. The addition of 12.6 hectares of forestry will have a slight positive impact on renewable forestry resources in the area of the site and will have an insignificant to slight negative impact on availability of agricultural lands in the area due to a change in land use from agriculture to forestry.

Planning applications on the Clare County Council Website, An Bord Pleanála Website and EIAR Portal Website have been examined to identify proposed or permitted developments with potential cumulative effects on the area in combination with the planting of 12.6 hectares of forestry at the Emlagh site. Planning applications in proximity to the site consist of residential one-off dwellings, various agricultural developments and forestry related development. It is unlikely that these proposed and consented developments will have a negative cumulative effect on population, human health and materiel assets in the area of the replant lands at Emlagh, County Clare due to their size and nature.

11.11 Conclusion

The assessment of Population, Human Health and Material Assets has established the existing environmental conditions of the study area, including the Wind Farm Site, the Grid Connection Route (GCR) and the Turbine Delivery Route (TDR) Area. Potential impacts were considered for the construction, operational and decommissioning phases of the proposed development as well as potential residual and cumulative impacts. Mitigation measures have been proposed where relevant. The Population, Human Health and Material Assets Chapter has been subdivided into the following topics for the purpose of the assessment:

- Population Trends;
- Socio-Economics, Employment and Economic Activity;
- Land Use;
- Recreation, Amenity and Tourism;
- Human Health and Safety;
- Renewable, Non-Renewable Resources and Utilities Infrastructure.

The population of the Study Area was found to be of low density and dispersed when compared to averages of County Cork as a whole and the State. The construction and decommissioning of the project will likely result in a short-term/temporary population growth in the Study Area during working hours due to the influx of construction workers during the construction and decommissioning phases. However, permanent impact on the population of the Study Area is considered unlikely as a result of the proposed development of the proposed Annagh Wind Farm due to the short-term nature of the construction works.

The economic profile of the Study Area does not show any major disparities when compared to the National and County-wide average socio-economic statistics. In general, the baseline conditions of the study area shows healthy socio-economic characteristics.

Positive direct and indirect benefits to economic activity are identified during the construction and decommissioning phases due to the creation of construction jobs based in the area which is likely to provide employment opportunities for those living in the study area and surrounding areas of County Cork. The construction and decommissioning phases are likely to have a temporary to short-term positive economic impact on local businesses and services.

The operational phase of the proposed development has been identified as having a positive economic and social impact on the Wind Farm Area with the provision of a Community Benefit Fund which will contribute to social infrastructure in the area and financially benefit those in closest proximity to the proposed wind farm. Other positive economic benefits as a result of the operational phase of the proposed Annagh Wind Farm includes reducing the State's reliance on fossil fuels which will reduce electricity prices, economically benefiting the consumer in the long-term throughout the State. Rates and development contributions will also benefit the local authority.

The land use of the Wind Farm Site consists of agriculture and commercial forestry. Two existing wind farms are located in proximity to the site. The Rathnacally Wind Farm located approximately 2.3km to the north east and Boolard Wind Farm located approximately 2.3km to the north west of the proposed wind farm site. The land use in proximity to the proposed grid connection is primarily agriculture and one-off housing and the land use along the TDR is agriculture and town centre/village centre including commercial, residential and industrial premises. Slight, temporary impacts to the existing land use along the GCR and TDR is expected during the construction phase.

At the proposed wind farm site, 12.6 hectares of commercial forestry will be removed to accommodate the proposed development. It is proposed to replant 12.6 hectares of forestry on alternative lands at Emlagh, County Clare. The proposed development will also see approximately 4 hectares of agricultural fields change use to renewable energy land use. The operational phase is not expected to have a significant impact on land use in the area of the proposed wind farm.

With respect to Recreation, Amenity and Tourism, trail walking, mountain biking, equestrian activity and sports grounds are the main activities and attractions in the greater area of the proposed wind farm site. There are no major tourist attractions in proximity to the site. It is expected that the construction, operational and decommissioning phases of the proposed development will have a non-significant neutral impact on recreation and tourism in the area due to the distance of the proposed turbines from significant features. The provision of the community benefit fund will likely have a moderate positive long-term impact on the amenities of nearby villages.

Potential effects on human health and safety have been identified for both construction workers and the general public as a result of the construction and decommissioning of the Annagh Wind Farm.

Best practice construction methods and improved safety measures on public roads have been identified as measures to prevent potential accidents during the construction and decommissioning works. Potential health effects from noise and electromagnetic fields during the operational phase are considered negligible. Furthermore, the proposed Annagh Wind Farm's potential susceptibility to major accidents and natural disaster is considered negligible.

It is anticipated that the proposed Annagh Wind Farm will avoid significant negative impact on renewable and non-renewable resources by sourcing local building materials where possible, therefore reducing the requirement of transport, reducing CO2 emissions. Replant lands are proposed at Emlagh to replace forestry lands required for the development of the wind farm. The proposed Annagh Wind Farm was found to have an overall positive impact on utility infrastructure providing clean energy to the national grid and reducing dependency on fossil fuels. Furthermore, the proposed development will have no expected impact on existing telecommunications signals during the operational phase of the project as confirmed through consultation with telecommunications providers and an assessment of potential impacts to service coverage as detailed in Chapter 16. The buildability and operation of the adjacent consented Charleville Solar Farm was also examined. No potential negative effects on the buildability of the solar farm were identified and effects on the operation of the consented solar farm are considered non-significant.

Cumulative impacts have also been considered in relation to proposed, consented and constructed projects located nearby the wind farm site, GCR and TDR. No significant cumulative impacts were identified in relation to population, human health and materiel assets.

In conclusion, once mitigation measures set out throughout this EIAR are implemented, it is unlikely that significant negative effects to population, human health and material assets will occur as a result of development of the proposed Annagh Wind Farm. Significant long-term positive socio economic effects have been identified through job creation and the provision of the community benefit fund as a result of the construction, operation and decommissioning of the proposed Annagh Wind Farm.

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ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR) FOR THE PROPOSED ANNAGH WIND FARM, CO. CORK

VOLUME 2 – MAIN EIAR

CHAPTER 12 – SHADOW FLICKER

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12. SHADOW FLICKER

12.1 Introduction

This chapter considers the potential for shadow flicker effects at nearby buildings associated with the operation of the proposed Annagh Wind Farm. The specific objectives of the chapter are to:

- describe the baseline;
- describe the assessment methodology and relevant guidance;
- describe the potential impacts;
- describe the need for any mitigation measures, if required; and
- assess the residual impacts remaining, following the implementation of any mitigation measures.

This assessment has been undertaken by Mark Tideswell and reviewed by Jim Singleton, both of TNEI Services Ltd.

Mark Tideswell has seven years' experience of undertaking shadow flicker assessments across Ireland and in the UK and has worked on both planning applications and complaints investigations. He is skilled in shadow flicker prediction and the specification of appropriate mitigation measures. Jim Singleton is the Team Manager of TNEI's Environment and Engineering Team. He has 14 years environmental consultancy experience and has worked on many wind turbine developments, ranging from single turbines to over 300 MW, and including feasibility studies, authoring of ES chapters, compliance surveys, due diligence and appeals.

A detailed description of the project assessed in this EIAR is provided in Chapter 3 which comprises four main elements:

- The wind farm (hereinafter referred to as the **'site'**);
- Turbine delivery route (hereinafter referred to as the **'turbine delivery route'** or **'TDR'**);
- Grid connection (hereinafter referred to as the **'grid connection' or 'GCR'**.
- Replant lands.

The main wind farm site as described in Chapter 3 includes 6 no. wind turbines, new and upgraded internal access tracks, hardstandings, foundations, permanent meteorological mast and associated access track, on-site substation, internal electrical and communications cabling, temporary construction compound, tree felling, drainage infrastructure and all associated works related to the construction of the wind farm. The grid connection includes the buried grid connection cable route from the on-site substation to the existing Charleville 110kV substation. The turbine delivery route includes all aspects of the route from the port of entry at Foynes, County Limerick to the proposed site entrance at the Annagh Wind Farm site. The temporary accommodation works required to facilitate the delivery of wind turbine components are described in Chapter 3. Replant lands at Emlagh, County Clare have also been assessed for potential cumulative impact.

12.1.1 Scope of Assessment

12.1.1.1 Conditions required for Shadow Flicker

Under certain combinations of geographical position, wind direction, weather conditions, times of day and time of the year, the sun may pass behind the rotors of a wind turbine and cast a shadow over the windows of nearby buildings. When the blades rotate and the shadow passes a window, to a person within that room the shadow appears to 'flick' on and off; this effect is known as 'shadow flicker'. The phenomenon occurs only within buildings where shadows are cast across a window aperture, and the effects are typically considered up to a maximum distance of 10 times the rotor diameter from each wind turbine. This criterion, which effectively sets the size of the study area, is detailed in a number of international publications including the German '*Guideline for Identification and Evaluation of the Optical Emissions of Wind Turbines' (2002),* the UK's '*Update of UK Shadow Flicker Evidence Base'* (Parsons Brinkerhoff for DECC, 2011) and Ireland's own Wind Energy Development Guidelines (WEDG 2006 and draft WEDG 2019).

Specifically, the WEDG 2006 state that *"At distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low"*.

12.1.1.2 Study Area

A study area of 1,500 m from each of the 6 wind turbines was selected for this assessment. This is based upon ten times the maximum rotor diameter (150 m) that would be used within the proposed development. The assessment considers all identified potential shadow flicker sensitive receptors within the study area[1], which includes inhabited residential buildings, commercial buildings, and buildings that are both residential and commercial, in line with the guidance in WEDG 2006.

For a receptor to be sensitive to shadow flicker, there must be windows with line of sight to the turbine rotor and the room where the window is located must have the potential to be occupied, e.g. a living or work space. The receptor locations are detailed on Figure 12-1, and presented in tabulated format in Appendix 12.1.

12.1.1.3 Effects to be Assessed

This chapter presents the predicted effects assuming both a worst-case scenario and a 'likely' scenario. The worst-case scenario assumes that the conditions required for shadow flicker to occur are present for all daylight hours throughout the year, which in reality will not happen. The likely scenario takes into account the annual average sunshine hours to provide a more realistic assessment; however, this is still inherently conservative as a number of factors such as turbine orientation, the blocking effects of foliage on trees etc. are not considered, so will still over-estimate actual shadow flicker effects.

[1] With reference to the study area, it should be noted that the suns path in the sky starts in the morning from the eastern horizon, continuing to increase in elevation until it is at its highest in the sky in the afternoon, before decreasing in elevation and setting in the western horizon in the evening. This path differs depending on the time of the year, where the suns angle (or azimuth) and elevation are higher during the summer months, and lower in the winter months. The general path of the sun across the sky will not change however, and due to the latitude of the site, the suns azimuth relative to the turbines and receptors is such that the conditions required for shadow flicker to occur in some of the southern areas of the study area never have the potential to occur (at any point throughout the year). As such, whilst receptors have been identified within the study area this does not necessarily mean they will have shadow flicker predicted to occur. The 'Maximum Extent of shadow coverage', where there is potential for shadow flicker to occur, is detailed in Figure 12.1.

12.2 Methodology

It is possible to predict the total theoretical number of hours per year that shadow flicker may occur in a building from the relative position of the turbines to that building, the geometry of the wind turbines, the latitude of the wind turbine site and the size & orientation of the windows potentially affected. These predictions can then be used to identify the times when curtailment may be required in order to mitigate the effects of shadow flicker. The assessment of total theoretical number of hours per year that shadow flicker may occur assumes that the sun is shining all day, every day during daylight hours.

The potential for shadow flicker to occur and the intensity and duration of any effects depend upon the following factors:

1. the location and orientation of the window relative to the turbines;
2. whether a window has direct, unobstructed line of sight to the turbine rotor;
3. the distance of the building from the turbines;
4. the turbine geometry;
5. the time of year (which impacts the trajectory of the sun's path across the sky);
6. the frequency of cloudless skies (particularly at low elevations above the horizon); and,
7. the wind direction (which impacts on turbine orientation).

Several specialist software packages are available that can take account of variables 1-5 listed above to determine the maximum theoretical number of shadow flicker hours that could occur at each window under worst-case conditions. Weather conditions (as detailed in items 6-7) cannot be accounted for accurately, therefore the software model assumes cloudless skies 100% of the time and that all turbines are face on to all receptors. This cannot happen in reality and the output from the model will be inherently conservative, although estimates of typical weather conditions can be factored in to the assessment at a later stage to provide a more realistic estimate of the likely occurrence of shadow flicker. Where obstructions are present between a window and turbine due to terrain, this is accounted for within the software model.

For this assessment, predictions of shadow flicker effects have been undertaken using industry standard software package ReSoft WindFarm, based on the proposed turbine locations and the maximum proposed turbine dimensions.

12.2.1 Relevant Guidance

'*International Legislation and Regulations for Wind Turbine Shadow Flicker Impact'* (Koppen, 2017) presents an overview of the assessment methodologies most commonly used in countries that have their own specific legislation or guidance with regards to shadow flicker effects. The paper states that nearly all countries base their guidance on the German guidelines *'Guideline for Identification and Evaluation of the Optical Emissions of Wind Turbines'(2002).*

The limit values within the German guidelines are 30 minutes per day and 30 days per year. These limits are, however, based on worst case conditions i.e. the total theoretical number of hours per year that shadow flicker may occur assuming that the sun is always shining during daylight hours. If it is found that mitigation measures are required, then a further limit value of 8 hours per year is set based on the real case shadow flicker i.e. what is actually occurring and not the theoretical maximum that may occur.

Many countries have adopted the German guideline limits, either directly or with some small adjustments. Australia, Belgium (Walloon region), Brazil, Canada, India, Sweden, and USA all have a worst-case limit of 30 hours a year or 30 minutes a day. The UK has no set limit but also typically adopts these guideline levels for assessment purposes.

Belgium (Flanders region) sets a real case limit of 8 hours a year or 30 mins a day, Denmark a real case limit of 10 hours a day and Netherlands a real case limit of 17 days a year where shadow flicker occurs for more than 20 minutes a day.

There is no standard for the assessment of shadow flicker in Ireland, although a maximum of 30 hours per year within 500 m of a turbine is recommended, as detailed in the following paragraphs.

12.2.1.1 Cork County Development Plan 2014

The Cork County Development Plan (Cork County Council, 2014) includes a Wind Energy Strategy Map, which identifies three categories of 'Wind Development Area' for large scale commercial wind energy developments. The categories are "Acceptable in Principle", "Open to Consideration" and "Normally Discouraged". The proposed Annagh Wind Farm is located within an area marked "Open to Consideration", for which the Cork County Development Plan 2014 states the following:

> *"Commercial wind energy development is open to consideration in these areas where proposals can avoid adverse impacts on … residential amenity particularly in respect of … shadow flicker"*

12.2.1.2 Wind Energy Development Guidelines (2006)

The current guidance provided by the Department of the Environment, Heritage and Local Government (DoEHLG) states:

> *"Careful site selection, design and planning, and good use of relevant software, can help avoid the possibility of shadow flicker in the first instance. It is recommended that shadow flicker at neighbouring offices and dwellings within 500m should not exceed 30 hours per year or 30 minutes per day.*
>
> *At distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low. Where shadow flicker could be a problem, developers should provide calculations to quantify the effect and where appropriate take measures to prevent or ameliorate the potential effect, such as by turning off a particular turbine at certain times."*

12.2.1.3 IWEA Best Practice Guidelines

In March 2012, the Irish Wind Energy Association (IWEA, now Wind Energy Ireland) issued a document detailing best practice guidance for wind farms (IWEA, 2012).

The document provides a preferred methodology to predict the worst-case shadow flicker conditions in order to provide the most robust results from the assessment.

With regards to shadow flicker, the IWEA guidelines support those given in the WEDG 2006, stating:

> *"The assessment of potentially sensitive locations or receptors within a distance of ten rotor diameters from proposed turbine locations will normally be suitable for EIA purposes"*

12.2.1.4 Draft Revised Wind Energy Development Guidelines (2019)

The DoEHLG published the Draft Revised Wind Energy Development Guidelines in December 2019. The draft revised guidelines set out a zero shadow flicker policy, encouraging the use of technology for shadow flicker control, to prevent it occurring at sensitive receptors.

The 2019 revised guidelines are currently at draft stage and following consultation are liable to change before the final version is issued.

12.2.1.5 Use of Guidelines in the Assessment

With due consideration of the above, the assessment has been made as follows:

- A study area of 10 rotor diameters has been defined;
- The WEDG 2006 assessment criteria has been adopted but extended out from 500 m to cover the entire study area; and,
- The Draft 2019 WEDG have been adopted with regard to mitigation i.e. mitigation is proposed to reduce shadow flicker to zero hours.

In comparison to both the current WEDG and international recognised guidance the assessment is therefore inherently conservative.

12.2.2 Field Assessment

Building location data was supplied by Fehily Timoney & Company that covered an area 10 rotor diameters from the proposed turbine positions. The dataset was then further refined through the use of aerial imagery to identify any additional buildings omitted from the dataset (one property was identified and added to the dataset as receptor 75), as well as identifying building condition (habitable, derelict etc.), and building dimensions. The data was reviewed to identify and remove any buildings that were clearly uninhabitable (such as a farm outbuilding) or derelict; no such buildings were identified.

No receptors have been identified within the 2006 WEDG 500 m assessment area, and in total 75 receptors have been identified within the 1,500 m shadow flicker study area, as shown on Figure 12-1. The closest receptor (ID 45) is approximately 695 m from a wind turbine (T3). This dwelling belongs to an involved landowner.

Appendix 12.1 contains the model input data for all of the receptors and their windows. Modelling parameters and assumptions are described in 12.2.4.

12.2.3 Extent of Shadow Flicker Assessment

The shadow flicker model calculates the total occurrence of shadow flicker at all receptors per year based on a theoretical worst-case scenario, which assumes the sky is always clear, the turbines are always aligned face-on to each window and that there is a clear and undisturbed line of sight between the windows and the turbines (except where this is prevented due to topography). In reality this cannot occur; the turbines will not always be orientated as described, and clouds will obscure the sun and line of sight may be obscured (for example, by leaves on trees). As such, the theoretical worst-case scenario allows predictions of all possible shadow flicker occurrences, however in reality actual shadow flicker effects will only be possible for some of this time and will only be experienced when a room where shadow flicker effects are present is occupied.

In order to provide a more realistic prediction of potential shadow flicker effects, historical weather data can be used to apply a correction factor, which considers the frequency of clear skies when shadows may be cast. Data compiled by Met Éireann from the nearest long-term weather station to Annagh Wind Farm (Shannon Airport) has been used to determine the average sunshine hours over the period 1981 to 2010; this data is presented in Table 12-1:

Table 12-1: Monthly Sunshine Hours at Shannon Airport Weather Station (1981-2010)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Sunshine Hours: Mean Daily Duration[i]	1.6	2.3	3.2	5.1	5.8	5.2	4.5	4.5	3.9	2.9	2	1.4	3.5
Daylight Hours[ii]	8.3	9.9	11.9	13.9	15.7	16.7	16.2	14.6	12.6	10.6	8.7	7.7	12.2
% Average Sunshine	19.3%	23.2%	26.9%	36.6%	36.9%	31.2%	27.8%	30.9%	31.0%	27.5%	22.9%	18.1%	28.6%

i Based on meteorological data from Shannon Airport 1981-2010 (https://www.met.ie/climate-ireland/1981-2010/shannon.html)

ii Based on sunrise and sunset times for Kilmallock 2021 (https://www.sunrise-and-sunset.com/en/sun/ireland/kilmallock)

The annual average percentage of sunshine hours is 28.6 %, therefore a correction factor of 28.6 % can be applied to the annual total theoretical levels of shadow flicker to account for the amount of time when the correct meteorological conditions are likely to be present for shadows to be cast. It is worth noting that this correction does not account for additional reductions that would occur as a result of variations in wind speed, wind direction, or by determining whether there is line of sight between a turbine and receiver. These 'likely' levels of shadow flicker are, therefore, still considered to be a conservative estimate.

12.2.4 Modelling Parameters

The levels of shadow flicker at each receptor have been calculated based on a 'greenhouse' modelling approach, where the full length of each façade of a building is modelled as a window (and is therefore sensitive to shadow flicker). Each modelled window is assumed to have a height of 2 m.

This approach has been taken in order to present a worst case estimate of shadow flicker in the absence of any detailed window location data. In reality only the glazed area of each façade would be sensitive to shadow flicker effects, therefore modelling the full façade will result in higher predicted levels than could actually occur.

The shadow flicker model accounts for screening effects due to topography only and does not consider other structures / buildings or vegetation, which may prevent line of sight between a receptor and the turbines.

12.3 Existing Environment

There are two wind farms located in proximity to Annagh Wind Farm; Boolard Wind farm and Rathnacally Wind Farm. Information on these developments and discussion on the potential for cumulative effects can be found in Section 12.7.

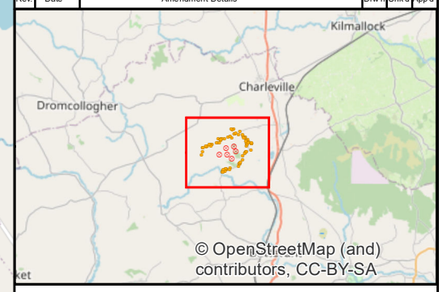
N

Legend

- Shadow Flicker Receptors
- Annagh Wind Farm
- Annagh 500m from Turbines
- Annagh Shadow Flicker Assessment Area
- Area Over Which Shadows May Be Cast From Annagh Turbines (up to 10RD)
- Boorland Wind Farm
- Rathnacally Wind Farm
- Boorland 10 Rotor Diameters from Turbines
- Rathnacally 10 Rotor Diameters from Turbines
- Area Over Which Shadows May Be Cast From Rathnacally Turbines (up to 10RD)

T01 T02 T03 T04 T05 T06

0 250 500 1,000 Metres



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Rev.	Date	Amendment Details	Drw'n	Chk'd	App'd
01	01/10/2021	Revised Layout	EW	JS	JS

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Client: EMpower

Project Title: Annagh Wind Farm

Drawing Title: Figure 12-1: Shadow Flicker Assessment

Scale	Designed	Drawn	Checked	Approved
1:20,000	EW	EW	JS	JS
Original Size	**Date**	**Date**	**Date**	**Date**
A3	01/10/2021	01/10/2021	01/10/2021	01/10/2021

Drawing Number: 14642-002

Revision: 1

12.4 Construction Phase Effects

Shadow flicker can only occur as a by-product of wind turbine operation; as such, there will be no shadow flicker effects during the construction phase.

12.5 Operational Phase Effects

The shadow flicker model calculates all possible instances of shadow flicker that may occur throughout the year, based on the sun's path across the sky relative to the turbine and receptor locations, i.e. the total theoretical amount of shadow flicker that may be possible.

There is the potential for shadow flicker to occur at 52 of the 75 receptors considered within the overall study area. At the remaining 23 receptors the suns angle (or azimuth) relative to the turbines and receptors never reaches the required position for shadow flicker effects to occur. Further detail is provided in footnote 1 of section 12.1.1.2.

A full listing of the worst-case total theoretical instances of shadow flicker by turbine can be found in Appendix 12.2. The calculated area over which shadows from the turbines may be cast (resulting in the potential for shadow flicker to occur) is shown on Figure 12-1.

12.5.1 Annual Impacts

The shadow flicker model does not account for weather conditions, which have a significant impact upon the amount of shadow flicker that may actually occur.

In order to consider a more realistic scenario, annual average sunshine hours for the region have been taken into account, as detailed in Table 12-1. The resultant predicted 'likely' levels of shadow flicker are above the WEDG (2006) threshold of 30 hours per year at 4 receptors and mitigation measures would need to be adopted to limit the number of days that shadow flicker occurs for these receptors. See Table 12-2 for a list of predicted levels of shadow flicker by receptor.

12.5.2 Daily Impacts

It is not appropriate to apply the annual average sunshine hours correction to the predicted daily totals as the data is based upon monthly averages, which cannot be applied to daily levels with sufficient accuracy. Furthermore, the infrequency of clear skies is more likely to reduce the overall number of instances of shadow flicker over the year, rather than reduce the length of each individual instance. As such, the assessment of daily impacts considers the maximum theoretical amount of shadow flicker only and is inherently conservative.

The predicted *maximum* theoretical hours per day of shadow flicker exceeds 30 minutes at 43 receptors[2] within the overall study area. The *average* theoretical hours per day[3] exceeds 30 minutes at 14 receptors. Accordingly, mitigation measures would need to be adopted to limit the maximum amount of shadow flicker occurring on any one day. Table 12-2 (overleaf) presents a list of the predicted levels of shadow flicker by receptor.

[2] Based on the worst case day of the year.

[3] Based on the average number of hours for any day where there is an occurrence of shadow flicker.

Table 12-2: Shadow Flicker Predicted Levels by Receptor

Receptor ID	Easting (IRENET 95)	Northing (IRENET 95)	Total Theoretical Days Per Year	Maximum Theoretical Hours Per Day	Average Duration of Shadow Flicker Effects (Hours)	Total Theoretical Hours Per Year	'Likely' Hours Per Year
1	550246	616015	0	0	0	0	0.0
2	550186	616078	0	0	0	0	0.0
3	551203	616310	67	0.56	0.48	32.2	9.2
4	549942	615916	0	0	0	0	0.0
5	549914	615805	0	0	0	0	0.0
6	550512	616206	0	0	0	0	0.0
7	550502	616033	0	0	0	0	0.0
8	550160	616056	0	0	0	0	0.0
9	550049	615904	0	0	0	0	0.0
10	550071	615898	0	0	0	0	0.0
11	549909	615857	0	0	0	0	0.0
12	550022	615907	0	0	0	0	0.0
13	551256	616464	100	0.8	0.64	63.9	18.3
14	550098	615909	0	0	0	0	0.0
15	551316	616474	106	0.86	0.67	71.1	20.3
16	551284	616537	112	0.95	0.74	82.9	23.7
17	551354	616673	130	0.9	0.62	80.8	23.1
18	549993	616018	0	0	0	0	0.0
19	549939	615800	0	0	0	0	0.0
20	549468	618216	114	0.73	0.49	55.7	15.9
21	548557	617898	55	0.56	0.44	24.1	6.9
22	549030	618103	67	0.54	0.36	24.4	7.0
23	548285	617845	38	0.46	0.37	14	4.0
24	549541	618505	99	0.62	0.47	46.4	13.3
25	549616	618216	151	0.85	0.63	94.6	27.1
26	549437	618168	106	0.75	0.5	53.3	15.2
27	548912	618087	87	0.55	0.43	37.4	10.7
28	548956	617987	105	0.65	0.5	52.7	15.1
29	548675	617948	93	0.61	0.4	37.4	10.7
30	548514	617910	53	0.53	0.41	21.6	6.2
31	548340	617846	40	0.47	0.37	14.8	4.2
32	548265	617443	37	0.5	0.38	14.2	4.1
33	548837	618103	57	0.59	0.5	28.5	8.2
34	548203	617232	36	0.48	0.38	13.6	3.9
35	551533	616815	63	0.94	0.68	43.1	12.3
36	551791	617441	214	0.8	0.52	110.7	31.7
37	551745	618625	75	0.62	0.47	35	10.0
38	551890	618119	108	0.61	0.47	51.1	14.6

Receptor ID	Easting (IRENET 95)	Northing (IRENET 95)	Total Theoretical Days Per Year	Maximum Theoretical Hours Per Day	Average Duration of Shadow Flicker Effects (Hours)	Total Theoretical Hours Per Year	'Likely' Hours Per Year
39	552050	618253	97	0.54	0.42	40.8	11.7
40	551763	617403	211	0.84	0.57	119.6	34.2
41	549760	618429	89	0.57	0.46	41.1	11.8
42	549717	618491	82	0.58	0.42	34.8	10.0
43	551819	617916	112	0.71	0.52	58.7	16.8
44	551700	617315	200	0.91	0.6	120.7	34.5
45	551563	617120	186	1	0.69	128	36.6
46	551833	617479	182	0.76	0.49	89.4	25.6
47	551937	618038	97	0.61	0.47	45.1	12.9
48	551901	618165	113	0.61	0.47	52.8	15.1
49	551704	618617	81	0.6	0.44	35.9	10.3
50	551963	618454	119	0.56	0.44	52.6	15.0
51	552005	618171	98	0.57	0.44	42.9	12.3
52	552247	618127	78	0.49	0.37	29.1	8.3
53	552283	618132	73	0.45	0.35	25.4	7.3
54	552202	617591	81	0.53	0.4	32.1	9.2
55	551572	618718	73	0.57	0.51	37.5	10.7
56	552267	618160	78	0.47	0.35	27.5	7.9
57	550364	618673	57	0.67	0.56	31.9	9.1
58	550041	618506	113	0.8	0.59	67	19.2
59	549786	618550	54	0.58	0.44	23.7	6.8
60	549847	618515	55	0.6	0.46	25.5	7.3
61	551201	618885	0	0	0	0	0.0
62	550903	618944	0	0	0	0	0.0
63	550878	618940	0	0	0	0	0.0
64	550648	618603	27	0.45	0.35	9.4	2.7
65	550830	619302	0	0	0	0	0.0
66	550680	619279	0	0	0	0	0.0
67	551643	618619	96	0.64	0.48	45.7	13.1
68	550595	619357	0	0	0	0	0.0
69	551310	619147	0	0	0	0	0.0
70	550516	618748	0	0	0	0	0.0
71	549759	618490	73	0.56	0.37	27	7.7
72	551825	618375	121	0.6	0.48	57.7	16.5
73	551810	618364	121	0.6	0.47	56.8	16.2
74	550983	618982	0	0	0	0	0.0
75	551546	618842	46	0.49	0.4	18.3	5.2
TOTALS				**Number of Receptors which May Experience:**			
				> 30 Minutes/Day		**> 30 Hours/Year**	
				43	14	36	4

Notwithstanding the 2006 WEDG recommendations, it is possible to ensure the elimination of shadow flicker at all receptors within 10 rotor diameters by ensuring that the turbines do not operate during the times and conditions that shadow flicker may occur. Further detail is provided in Section 12.8.

12.6 Decommissioning Phase Effects

Shadow flicker can only occur as a by-product of wind turbine operation; as such, there will be no shadow flicker effects during the decommissioning phase.

12.7 Cumulative Effects

The IWEA Guidelines recommend that all existing and/or permitted wind farm developments within 2 km of a proposed development should be considered in a cumulative shadow flicker assessment, however, the key factor to determine whether cumulative effects may occur is whether receptors are located within overlapping 10 rotor diameter areas around multiple wind farms. There are two wind farms in the vicinity of the proposed development:

- Boolard Wind Farm (Cork County Council planning ref. 125997) to the north west, comprising of two turbines with a 101 m rotor diameter, and;
- Rathnacally Wind Farm (Cork County Council planning ref. 124446) to the north east, comprising of two turbines with a 114 m rotor diameter.

Both developments are located greater than 2 km from the nearest Annagh wind turbine. A plot detailing the 10 rotor diameter areas around each development and the proposed development is shown on Figure 12-1.

There are no shadow flicker receptors located where the study areas for Annagh Wind Farm and Boolard Wind Farm overlap, therefore there will be no cumulative effects as a result of Boolard Wind Farm.

There are two shadow flicker receptors (ID 69 & 75 from Table 12-2) within the overlapping study areas of Annagh Wind Farm and Rathnacally Wind Farm, however, shadow flicker modelling has been undertaken which has found that no shadow flicker effects will occur at either property as a result of the Rathnacally turbines. It can therefore be concluded that there is no potential for cumulative shadow flicker impacts when considering Annagh Wind Farm, Boolard Wind Farm and Rathnacally Wind Farm.

12.8 Mitigation Measures

Shadow flicker control modules, consisting of light sensors and specialised software, will be installed on the turbines as part of a system to prevent operation during periods when shadow flicker may occur to attain 'zero shadow flicker'. The calculated potential shadow flicker periods will be input into the turbine control software and when the correct conditions are met i.e. the light intensity is sufficient and during a potential period of shadow flicker, and when the thresholds identified in Section 12.5.2 have been exceeded individual turbines will cease operation until the conditions for shadow flicker are no longer present. This method of mitigation will be used to fully mitigate all shadow flicker effects resulting in zero shadow flicker.

These are standard widely accepted control modules that are installed in most wind turbines. Appendix 12.2 contains a list of times when each turbine could be shut down to ensure zero hours of shadow flicker from Annagh Wind Farm.

Appendix 12.2 contains all calculated potential shadow flicker periods for each turbine, which will be input into the turbine control software. When a sufficient light intensity is measured during any of these periods, the corresponding turbine will be shut down if required, to ensure zero hours of shadow flicker from Annagh Wind Farm. The shadow flicker modelling has assumed the largest rotor diameter that may be incorporated into the development. Should the rotor diameter be reduced then shadow flicker effects will also be reduced.

12.9 Residual Effects

The results of the shadow flicker assessment predict that Annagh Wind Farm has the potential to result in shadow flicker at 52 receptors surrounding the site. The implementation mitigation to cease operation of the turbines during periods of potential shadow flicker will ensure that no shadow flicker effects are experienced at any sensitive receptor within 10 rotor diameters of a turbine.

Annagh Wind Farm will comply with the recommended limits of 30 hours per year and 30 minutes per day detailed within the Wind Energy Development Guidelines (2006) and the zero shadow flicker policy as set out in the Draft Revised Wind Energy Development Guidelines (2019). Following implementation of mitigation measures described in Section 12.8, the residual impact as a result of shadow flicker will be imperceptible. Accordingly, it is considered that there will be no residual impact as a result of shadow flicker.

12.10 Do-Nothing Scenario

In the 'Do-Nothing' Scenario, the proposed Annagh Wind Farm would not be constructed and the potential impacts from shadow flicker on receptors within the study area would not occur. No mitigation measures would be required.

12.11 Conclusion

A shadow flicker assessment has been undertaken on all receptors within 10 rotor diameters of the proposed Annagh Wind Farm.

Based on the WEDG 2006 thresholds, the predicted 'Maximum Theoretical Hours Per Day' of shadow flicker exceeds 30 minutes at 43 receptors. When considering the 'Average Theoretical Hours Per Day', (accounting for any day in which shadow flicker is predicted to occur) then shadow flicker exceeds 30 minutes at 14 receptors.

When considering the 'Total Theoretical Hours Per Year', 36 receptors are predicted to exceed the WEDG 2006 threshold of more than 30 hours per year. However, when accounting for a more *'likely'* scenario, where the average annual sunshine hours are taken into account, the levels predicted at only 4 receptors exceed more than 30 hours per year.

A scheme of mitigation will be implemented into the turbine control software to cease turbine operation during periods when shadow flicker is predicted, therefore, zero hours of shadow flicker will occur within 10 rotor diameters of the wind farm. As such, the proposed development will meet the requirements of both WEDG 2006 and the draft WEDG 2019.

No cumulative impacts with other proposed or operational wind farms in the area are predicted to occur on any receptors in the study area.

12.12 References

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ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR) FOR THE PROPOSED ANNAGH WIND FARM, CO. CORK

VOLUME 2 – MAIN EIAR

CHAPTER 13 – TRAFFIC & TRANSPORTATION

Prepared for: EMPower

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13. TRAFFIC AND TRANSPORTATION

13.1 Introduction

This section of the EIAR evaluates the proposed project in the context of the traffic and transportation within the study area. The assessment examines potential impacts and identifies mitigations for construction, operation and decommissioning of the project.

The proposed project will primarily consist of a wind farm of 6no. wind turbine generators (WTG's), 1 no. on-site substation compound along with ancillary civil and electrical infrastructure. The associated grid connection will consist entirely of underground cable and will connect the on-site substation to the existing 110kV Charleville Substation, Co. Cork. The assessed project also includes temporary accommodation works associated with the Turbine Delivery Route (TDR) and replanting lands identified at Emlagh, County Clare. Further details on the proposed project are contained in Chapter 3.

13.1.1 Study Area

The study area for the traffic and transportation chapter includes the main wind farm site along with the surrounding road network leading to and from the main wind farm site. The site entrance is also assessed.

The roads associated with the grid connection are assessed as is the turbine delivery route.

Replant lands are also assessed cumulatively with respect to traffic and transportation.

The site location and surrounding road network comprising the study area is identified in Figure 13-1