Knockastanna Wind Farm Extension of Operational Life

Chapter 7: Water

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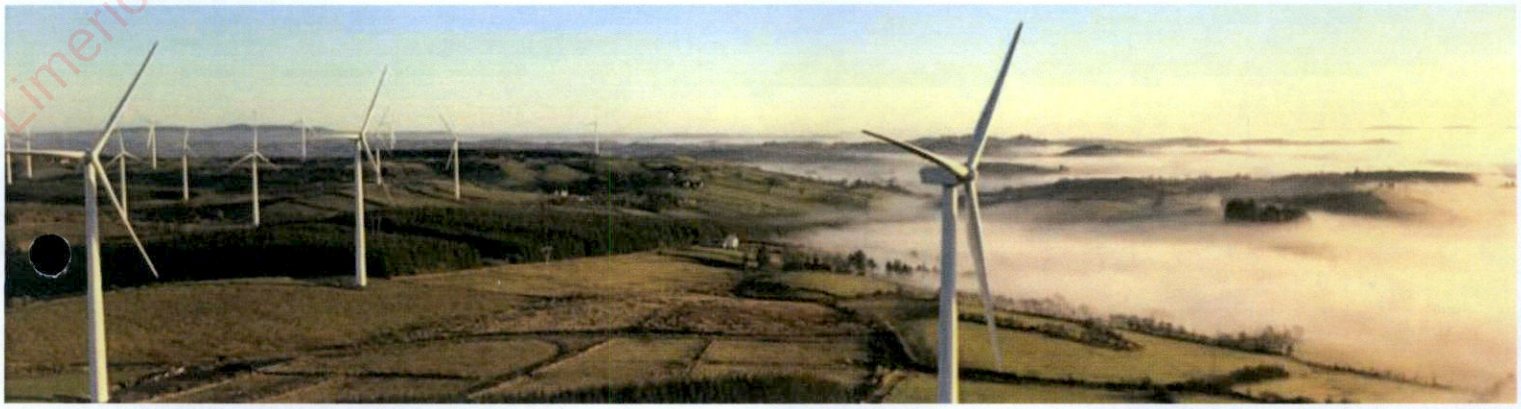

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7.1 Introduction

This chapter describes the surface water (hydrology) and groundwater (hydrogeology) conditions **of the proposed development site ('the site') and its** environs, and assesses the likely significant effects on the water environment associated with the continued operation and decommissioning of the Knockastanna Wind Farm.

The specific objectives of the chapter are to:-

- describe the assessment methodology and significance criteria used in completing the impact assessment;
- describe the baseline hydrological and hydrogeological conditions;
- describe the likely effects, including direct, indirect and cumulative effects;
- identify any required mitigation measures to address likely significant effects; and
- assess the residual effects remaining following implementation of mitigation.

Given the close association of the hydrological, hydrogeological and geological environments; this assessment also draws on information and findings presented in **Chapter 6**. A site-specific flood risk assessment has also been completed and is presented at **Annex 7.1**.

7.1.1 Statement of Authority

This chapter has been prepared by SLR Consulting Ltd and has been overseen by a Technical **Director with more than 20 years' experience assessing similar** developments.

Katy Rainford is a hydrologist with SLR with over 3-**years' expe**rience in the sector, specialising in hydrology and hydrogeology environmental assessments for planning applications. She has undertaken and prepared flood risk assessments and the water environment chapters of EIARs for a wide range of projects across Ireland and the UK, including numerous wind farm and electricity transmission projects.

Peter Glanville is a Technical Director (Hydrology) with SLR and has over 20-**years'** experience in the area of Hydrology and Flood Risk Assessments. Peter has undertaken and prepared flood risk assessments for a wide range of projects and has also prepared Section 4 Discharge Licences for a variety of developments. He has also been involved as a hydrologist in a range of environmental monitoring projects for Environmental Baseline Studies, exploration operations, quarry site operations and infrastructure projects – this work has typically included hydrology monitoring (flow) and water quality sampling and testing.

7.1.2 Summary of the Proposed Development

In summary, the proposed development comprises the continued operations of the existing wind farm for a further period of 15-years. The existing development, including secondary ancillary developments, consists of the following main components:-

- 4 no. wind turbines;
- Associated turbine foundations and crane hard standings;
- 1 no. electrical control building with a total footprint of 66 square metres (m^2), including welfare facilities and associated electrical equipment enclosure;
- Underground electrical cabling between each of the existing wind turbines and the electrical control building;
- 1 no. site entrance and 2km of site access tracks; and

- Site drainage infrastructure.

A full description of the proposed development is presented in **Chapter 3**.

7.2 Methodology

7.2.1 Scope of the Assessment

7.2.1.1 Spatial Scope

The study area for this assessment includes the site and a buffer of c. 2km beyond the site boundary as per Institute of Geologists Ireland (IGI) *Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements* (2013). The study area encompasses bodies of water and their catchments which could be affected by the continued operation and decommissioning of the existing wind farm.

The study area for cumulative effects uses the catchments within the study area, with a maximum downstream distance of 2km from the site boundary.

7.2.1.2 Temporal Scope

The temporal scope considers the potential for climate change to impact on future baseline conditions. Climate change studies predict a decrease in summer precipitation and increase in winter precipitation, alongside slightly higher average temperatures. These changes suggest that there could be greater pressures on water supplies and water levels in summer months in the future. In addition, summer storms are predicted to be of greater intensity. Therefore, peak fluvial flows associated with extreme storm events could also increase in volume and velocity.

7.2.2 Legislation Policy and Guidance

The assessment has been undertaken with regard to relevant environmental legislation, planning policy and general guidance. The key legislation which applies to this assessment is:-

- Environmental Impact Assessment Directive (2011/92/EU);
- Directive 2014/52/EU amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment;
- S.I. No 296 of 2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 which transposes the provisions of Directive 2014/52/EU into Irish Law;
- S.I. No. 94 of 1997: European Communities (Natural Habitats) Regulations, resulting from EU Directives 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and 79/409/EEC on the conservation of wild birds (the Birds Directive);
- S.I. No. 293 of 1988: Quality of Salmon Water Regulations, resulting from EU Directive 78/659/EEC on the Quality of Fresh Waters Needing Protection or Improvement in order to Support Fish Life;
- S.I. No. 272 of 2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009 as amended (2012, 2015 and 2019);
- S.I. No. 722 of 2003 European Communities (Water Policy) Regulations which implement EU Water Framework Directive (2000/60/EC) and provide for implementation of 'daughter' Groundwater Directive (2006/118/EC). Since 2000 water management in the EU has been directed by the Water Framework Directive (WFD). The key objectives of the WFD are that all water bodies in member states achieve (or retain) at least 'good' status by 2015. Water bodies comprise both surface and groundwater bodies, and the achievement of

'Good' status for these depends also on the achievement of 'good' status by dependent ecosystems. Phases of characterisation, risk assessment, monitoring and the design of programmes of measures to achieve the objectives of the WFD have either been completed or are ongoing. In 2015 it will fully replace a number of existing water related directives, which are successively being repealed, while implementation of other Directives (such as the Habitats Directive 92/43/EEC) will form part of the achievement of implementation of the objectives of the WFD;

- S.I. No. 41 of 1999: Protection of Groundwater Regulations, resulting from EU Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the Groundwater Directive);
- S.I. No. 249 of 1989: Quality of Surface Water Intended for Abstraction (Drinking Water), resulting from EU Directive 75/440/EEC concerning the quality required of surface water intended for the abstraction of drinking water in the Member States (repealed by 2000/60/EC in 2007);
- S.I. No. 439 of 2000: Quality of Water intended for Human Consumption Regulations and S.I. No. 278 of 2007 European Communities (Drinking Water No. 2) Regulations, arising from EU Directive 98/83/EC on the quality of water intended for human consumption (the Drinking Water Directive) and WFD 2000/60/EC (the Water Framework Directive);
- S.I. No. 122/2014 - European Union (Drinking Water) Regulations 2014;
- S.I. No. 9 of 2010: European Communities Environmental Objectives (Groundwater) Regulations 2010; and,
- S.I. No. 296 of 2009: European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009.

A suite of guidance documentation has also been examined to inform this assessment, including:-

- *Guidance Document on Wind Energy Developments and EU Nature Legislation* (European Commission, 2020);
- *Guidance on the preparation of the EIA Report* (Directive 2011/92/EU as amended by 2014/52/EU);
- Environmental Protection Agency (2022): *Guidelines on the Information to be Contained in Environmental Impact Assessment Reports*;
- Environmental Protection Agency (2017): *Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports*;
- Environmental Protection Agency (September 2015): *Draft - Advice Notes on Current Practice (in the preparation on Environmental Impact Statements)* where relevant;
- Environmental Protection Agency (2003): *Advice Notes on Current Practice (in the preparation on Environmental Impact Statements)* where relevant;
- Institute of Geologists Ireland (2013): *Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements*;
- National Roads Authority (2005): *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*;
- *Wind Energy Development Guidelines for Planning Authorities* (2006);
- *Draft Revised Wind Energy Development Guidelines (2019)*;
- Forestry Commission (2004): *Forests and Water Guidelines*, Fourth Edition. Publ. Forestry Commission, Edinburgh;
- Coillte (2009): *Forest Operations & Water Protection Guidelines*;

- Forest Services *(Draft) Forestry and Freshwater Pearl Mussel Requirements* – Site Assessment and Mitigation Measures;
- Forest Service (2000): *Forestry and Water Quality Guidelines*. Forest Service, DAF, Johnstown Castle Estate, Co. Wexford;
- COFORD (2004): *Forest Road Manual – Guidelines for the Design, Construction and Management of Forest Roads*;
- Inland Fisheries Ireland (2016): *Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters*;
- *Good Practice During Wind Farm Construction* (Scottish Natural Heritage, 2010);
- *PPG1 - General Guide to Prevention of Pollution* (UK Guidance Note);
- *PPG5 – Works or Maintenance in or Near Watercourses* (UK Guidance Note);
- *CIRIA 2006: Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors*. CIRIA C532. London, 2006.
- Department of Housing, Planning & Local Government (2018) *Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment*; and
- European Union (2017) Guidance *on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU)*.

The assessment also takes note of policies and development controls outlined in the Limerick County Development Plan 2010-2016 and *Draft Limerick Development Plan 2022–2028* relating to water.

7.2.3 Baseline Determination

7.2.3.1 Desk Based Research

An initial desk study has been undertaken to determine and confirm the baseline characteristics of the study area by reviewing available information on water.

The following sources of information have been consulted in order to characterise and assess the hydrology and hydrogeology of the area within and surrounding the site:-

- The Environmental Protection Agency website (www.epa.ie);
- Geological Survey Ireland website (www.gsi.ie);
- National Geospatial Data Hub (www.geohive.ie);
- Met Éireann Irish Meterological Services (www.met.ie/);
- National Parks and Wildlife Services (NPWS) Designations Viewer (https://www.npws.ie/);
- Groundwater Protection Schemes (www.gsi.ie); and
- Water Maps and Water Framework Directive online mapping (www.catchments.ie).

7.2.3.2 Field Study

A site walkover survey was undertaken by a SLR Technical Director (Hydrology & Hydrogeology) in May 2021. The field survey was undertaken in order to:-

- verify the information collected during the desk study;
- allow appreciation of the site, determine ground conditions and to assess the relative location of all the components of the existing development to soils, geology and water features; and
- undertake a visual assessment of the main surface waters and identify drainage patterns, areas vulnerable to erosion or sedimentation deposition and pollution risks.

The data obtained as part of the desk study and collected as part of the field work has been processed and interpreted to complete the impact assessment and recommend mitigation measures, where appropriate.

7.2.3.3 Cumulative Baseline

A likely significant cumulative effect is considered to be an effect on water arising in combination with other developments. Cumulative developments within the same water catchments as the site and within a distance of 2km of the site have been considered. Cumulative effects are assessed using the same methodology as for effects arising from the proposed development in isolation.

7.2.4 Assessment of Likely Effect Significance

7.2.4.1 Assessing Significance

The significance of likely effects of the proposed development has been assessed by considering two factors: the sensitivity of the receiving environment and the magnitude of impact, should that effect occur. The assessment methodology has also been informed by the assessor's experience of carrying out such assessments for renewable energy developments, knowledge of geology and water environment characteristics in Ireland and cognisance of good practice.

This approach provides a mechanism for identifying the areas where mitigation measures are required and for identifying mitigation measures appropriate to the significance of effects presented by the proposed development.

Criteria for determining the significance of effect are presented in **Table 7.1**, **Table 7.2**, and **Table 7.3.**

7.2.4.2 Sensitivity of Receptor

The sensitivity of the receiving environment (i.e. baseline quality of the receiving environment) is defined as its ability to absorb an effect without a detectable change and can be considered through a combination of professional judgement and a set of pre-defined criteria which are set out in **Table 7.1**. Receptors in the receiving environment only need to meet one of the defined criteria to be categorised at the associated level of sensitivity.

Sensitivity	Definition
High	• Water Framework Water Body Classification High – Good or is close to the boundary of a classification Moderate to Good, or Good to High; • receptor is of high ecological importance or national or international value (e.g. Site of Special Interest (SSSI), Special Area of Conservation (SAC), habitat for protected species which may be dependent upon the geology or hydrology of the development area; • receptor is at high risk from flooding above 1% Annual Exceedance Probability (AEP) and/or waterbody acts as an active floodplain or flood defence; • receptor is used for public and/or private water supply; and • groundwater vulnerability is classified as high.
Medium	• Water Framework Water Body Classification Moderate or is close to the boundary of a classification Low to Moderate; • receptor is at moderate risk from flooding (0.1% to 1% AEP) but

	does not act as an active floodplain or flood defence; and • moderate classification of groundwater aquifer vulnerability.
Low	• Water Framework Water Body Classification Poor or Bad; • receptor is at low risk from flooding (less than 0.1% AEP); and • receptor not used for water supplies (public or private).

Table 7.1: Criteria for Assessing Sensitivity of Receptor

7.2.4.3 Magnitude of Impact

The magnitude of impact would depend upon whether the likely effect would cause a fundamental, material or detectable impact. In addition, the timing, scale, size, and duration of the likely effect resulting from the proposed development are also determining factors. The criteria that have been used to assess the magnitude of impact are defined in **Table 7.2**.

Magnitude	Criteria	Definition
Major	Results in a loss of attribute	Fundamental (long term or permanent) changes to the baseline hydrology and hydrogeology such as:- • wholesale changes to watercourse channel, route, hydrology or hydrodynamics; • changes to the site resulting in an increase in runoff with flood potential and also significant changes to erosion and sedimentation patterns; • major changes to the water chemistry; and • major changes to groundwater levels, flow regime and risk of groundwater flooding.
Moderate	Results in impact or integrity of attribute or loss of part of attribute	Material but non-fundamental and short to medium term changes to baseline hydrology, hydrogeology and water quality, such as:- • some fundamental changes to watercourses, hydrology or hydrodynamics. Changes to site resulting in an increase in runoff within system capacity; • moderate changes to erosion and sedimentation patterns; • moderate changes to the water chemistry of surface runoff and groundwater; and • moderate changes to groundwater levels, flow regime and risk of groundwater flooding.
Minor	Results in minor impacts on attribute	Detectable but non-material and transitory changes to the baseline hydrology and hydrogeology such as:- • minor or slight changes to the watercourse, hydrology or hydrodynamics; • changes to site resulting in slight increase in runoff well within the drainage system capacity; • minor changes to erosion and sedimentation patterns; • minor changes to the water chemistry of surface water runoff and groundwater; and • minor changes to groundwater levels, flow regime

		and risk of groundwater flooding.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect the use/integrity	No perceptible changes to the baseline hydrology, hydrogeology and water quality such as: • no alterations, or very minor changes with no impact to watercourses, hydrology, hydrodynamics, erosion and sedimentation patterns; • no pollution or changes in water chemistry to either groundwater or surface water; and • no alteration to groundwater recharge or flow mechanisms.

Table 7.2: Criteria for Assessing Magnitude of Impact

7.2.4.4 Significance of Effect

The sensitivity of the receptor together with the magnitude of impact determines the significance of effect, which can be categorised into a level of significance as identified in **Table 7.3**.

The significance of effect provides a guide to assist in decision making. However, it should not be considered as a substitute for professional judgement and interpretation. In some cases, the sensitivity of the receiving environment or the magnitude of impact cannot be quantified with certainty and therefore professional judgement remains the most robust method of identifying the significance of a likely effect.

Sensitivity	Magnitude of Impact			
	Major	Moderate	Minor	Negligible
High	Major	Major	Moderate	Minor
Medium	Moderate	Moderate	Minor	Minor
Low	Moderate	Moderate	Minor	Negligible

Table 7.3: Significance of Effect

Effects of major significance are considered significant in EIA terms.

7.3 Description of Existing Environment

7.3.1 Site Setting

The site is located c. 29km east of Limerick City, Co. Limerick, 26km west of Thurles, Co. Tipperary, and c. 6km north of the village of Doon, Co. Limerick. It is centred at E585767 N656649 and the overall landholding encompasses an area of approximately c. 43.3ha.

The site location and local surface water features (streams/rivers) are shown in **Error! Reference source not found.**. The site layout and surface water features in the immediate vicinity of the site are shown in **Error! Reference source not found.**.

The site is situated in a rural area on the northern flanks of Knockastanna hill which has a peak elevation of 444mOD.

Ground elevations within the site range from approximately 444mOD along the southern boundary to 230mOD in the north eastern corner of the site.

Historical rainfall data, obtained from Met Éireann (www.met.ie), indicates that the average annual rainfall (AAR) for the Cooga (Lower Doon) rainfall station, located c. 7km south west of the site, is 1,072mm/yr for the period between 1984 to 2021. The average monthly rainfall values for the period 1984 to 2021 are shown in **Table 7.4** below.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AAR
108	89	81	67	69	77	81	98	78	105	106	111	1,072

Table 7.4: Monthly Rainfall Averages (mm) 1984 to 2021 for Cooga (Lower Doon)

7.3.2 Designated Sites

A review of the Environmental Protection Agency (EPA) and the National Parks and Wildlife Services (NPWS) maps highlights that the site is located within the Slievefelim to Silvermines Mountains Special Protected Area (SPA). Details of this SPA and other nearby statutory designated sites within the 2km study area are summarised below:

- Slievefelim to Silvermines Mountains SPA covers an area of 20,913ha and is located across c. 95% of the proposed development site. The SPA covers much of the upland areas within County Tipperary and Limerick and is designated for conservation interest of the Hen Harrier. As it is not designated for its hydrological or hydrogeological characteristics, it is not assessed further in this chapter; and
- The Lower River Shannon Special Area of Conservation (SAC) is located approximately 400m north of the site, along the banks of the River Bilboa. The SAC covers much of the River Shannon, the Feale and Mulkear catchments and extends to a total area of 68,300ha. The designating features include; freshwater pearl mussel, sea lamprey, brook lamprey, river lamprey, Atlantic salmon, bottle-nosed dolphin, otter and several freshwater and coastal habitats (including sandbanks, estuaries, tidal mudflats and sandflats, coastal lagoons, large shallow inlets and bays, reefs, perennial vegetation of stony banks, vegetated sea cliffs, *Salicornia* mud, Atlantic salt meadows, Mediterranean salt meadows, floating river vegetation, Molinia meadows and alluvial forests). The SAC is hydrologically connected to the site via surface water features and therefore it is assessed further in this chapter.

The Bilboa River is also designated as a proposed National Heritage Area (pNHA) further downstream, c. 1.2km south west of the site, as part of the Bilboa and Gortnageragh River Valleys pNHA (ID: 001851).

7.3.3 Soils and Geology

A description of the soils and geology which underlie the site is provided at **Chapter 6**. A summary of the soils and geology environment is included in the sections below.

7.3.3.1 Soils and Subsoils

The soil association at the site is classified as the Ballylanders soil association group (1100e) within the northern extent of the site and the Knockastanna soil association group (0843b) within the southern extent of the site.

The Ballylanders soil association group is described as well drained fine loamy soils over shale or slate bedrock, whilst the Knockastanna soil association group is described as poorly drained loamy soils over shale bedrock.

The subsoil mapping shows areas of blanket peat within the southern extent of the site whilst the northern areas are shown to be absent of any subsoils with bedrock at or close to the surface.

7.3.3.2 Local Bedrock Geology

The Geological Survey of Ireland (GSI) digital bedrock geology map of Ireland shows the site is underlain by greywacke, siltstone and grit of the Hollyford Formation.

7.3.4 Hydrogeology

7.3.4.1 Aquifer Characteristics

The bedrock deposit beneath the site is classified by the GSI as a Poor Aquifer which are generally unproductive except for local zones (Pl), see **Error! Reference source not found.** (**Annex 7.2**). Poor aquifers are considered to have 'moderate' to 'low' yields of groundwater, less than 100m^3/day.

The soils and subsoils which overlie the bedrock are not considered to be a locally or regionally important aquifer.

7.3.4.2 Groundwater Vulnerability

The GSI have developed a groundwater vulnerability classification for Ireland. The groundwater vulnerability at a particular point can be determined based on natural geological and hydrogeological characteristics at that point. The vulnerability therefore depends on the nature of the subsoils (permeability), the type of recharge (point or diffuse) and the thickness of the unsaturated zone (depth to groundwater).

Groundwater vulnerability maps published on the GSI website indicate that the groundwater vulnerability beneath the site ranges from 'Rock near the Surface (X)' within the northern extent of site to 'Extreme (E)' within the southern extent of the site(see **Error! Reference source not found.**) suggesting less than 3m of soil and subsoil cover over the bedrock.

7.3.4.3 Groundwater Levels and Quality

The GSI mapping indicates that the site is located within the Slieve Phelim Groundwater Body (GWB).

A *Summary of Initial Characterisation* report has been produced for the Slieve Phelim aquifer by the GSI, a summary of which is provided below:-

- The GWB covers a total area of 545km^2 and lies within the Devonian Old Red Sandstones and Silurian Strata (which includes the Hollyford Formation);
- Groundwater flow predominately occurs in fractures and faults, due to low permeability of the bedrock; and
- Diffuse recharge will occur over the groundwater body, via rainfall soaking through the subsoil. A large percentage of the rainfall will not recharge the aquifer but will runoff to surface water channels particularly in those areas underlain by Silurian bedrock and areas with steeper topography.

It is therefore assessed that groundwater recharge is limited at the site due to low permeability bedrock (where it is not weathered or fractured) and the steep topographic gradients encouraging the formation of surface water runoff.

It is understood that little groundwater was intercepted during construction of the existing wind farm and no permanent groundwater management measures are

required or implemented at the site. This confirms the absence of notable groundwater beneath the site.

The EPA do not maintain a routine groundwater level monitoring station within the Slieve Phelim GWB. In the absence of any site-specific groundwater data, groundwater is expected within the upper weathered surface and fractures within the bedrock deposits. The direction of groundwater flow is likely to be similar to local topographic gradients.

Under Ireland's obligations for the Water Framework Directive, the status of groundwater bodies has been assessed. The Slieve Phelim GWB has been assessed as **having 'Good' status for 2013 to 2018 (last reporting cycle).**

7.3.4.4 GSI Wells

The GSI has a database of recorded groundwater wells in the vicinity of the site, see **Error! Reference source not found.** (**Annex 7.2**). The database indicates a number of wells in the local area which are within 2km of the proposed development site; however, none of the wells are located within the site boundary.

Given the nature of the underlying unproductive poor aquifer (Pl) any groundwater pathways are likely to be local, shallow and to the closest surface watercourse only. It is therefore considered unlikely that there would be any hydrogeological pathways between the site and the identified local wells given the nature of the bedrock aquifer.

7.3.4.5 Groundwater Abstraction

There is a public water supply (Cappamore-Faileen-Bilboa PWS) abstraction located approximately 3.5km to the west of the proposed development site on the other side of the Bilboa River. The proposed development site is not located in the PWS scheme source protection area as indicated on the GSI database.

There are no groundwater abstractions at the proposed development site, recorded on the GSI website, and the site is not located within a local public water supply designated source protection zone.

7.3.5 Hydrology

7.3.5.1 Local Hydrology

The site is located within the surface water catchment of the Bilboa River as illustrated at **Error! Reference source not found.** (**Annex 7.2**). The river flows generally westwards approximately 500m north of the site, before turning southwards approximately 1km west of the site. It continues to flow generally south westwards before discharging into the Mulkear River c. 9.5km south west of the site. The Bilboa River extends to a total catchment area of 55.8km^2.

Several minor tributaries of the Bilboa River are located within or proximate to the site; three minor watercourses which flow generally northwards towards the Bilboa River are located along the north western boundary, north eastern boundary and 200m north east of the site and another minor tributary that rises approximately 80m west of the site, flowing generally south westwards to the Bilboa River, see **Error! Reference source not found.** and **Error! Reference source not found.**.

Available Ordnance Survey of Ireland historical mapping was reviewed on the GeoHive National Geospatial Data Hub (www.geohive.ie) and indicates that these watercourses have not been altered by the existing wind farm either during its

construction or operation, and continue to follow the same routes, flowing away from the proposed development site towards the Bilboa River. No surface water bodies, or watercourse crossings are noted across the site.

7.3.5.2 Surface Water Quality

Under the Water Framework Directive (WFD), rivers are assigned a status/quality. The latest WFD assessment period reported is 2013-2018.

The site is located within the Bilboa_SC_010 WFD sub catchment (ID: 25D_5). The status of the Bilboa River and its tributaries in proximity to the site, for the latest WFD assessment period, is classified as 'Moderate'. The Moderate status reflects invertebrate status or potential and failing to achieve good chemical surface water status.

It is understood during construction of the site an Environmental Manager was employed to oversee the construction activities and ensure measures required to protect the water environment. During construction activities, no environmental incidents or pollution events were recorded.

Routine site inspections are completed by the site operator, which includes regular inspection of the site drainage infrastructure. An inspection of on-site drainage infrastructure was also undertaken as part of the field study, which confirmed that there is no evidence that the existing development has, or is, resulting in a deterioration of water quality within or adjacent to the site.

7.3.5.3 Flood Risk

A site-specific Flood Risk Assessment has been completed for the site and is presented in Error! Reference source not found. (**Volume II**). The assessment confirms that the site is not at flood risk from river flooding or due to rainfall.

Local minor drains at the site which are around the turbines, hardstand areas and along the access track drain to the surrounding lands where storm runoff goes to existing surface water channels and then to the headwaters of the local stream network.

7.3.6 Identified Sensitive Receptors

A summary of the receptors identified as being sensitive to the continued operation of the Knockastanna Wind Farm include:-

- Groundwater quality which has been classified as Good and has an Extreme vulnerability. This is considered a receptor with a High sensitivity; and
- The surface waters of the Bilboa River and its tributaries have been classified as being of 'Moderate' status in the vicinity of the site. The Bilboa River is in turn in hydraulic continuity with the Lower River Shannon SAC; therefore, the local surface waters are considered to be a receptor with a 'High' sensitivity.

7.4 Description of Likely Effects

7.4.1 Construction Phase

All construction activities associated with the proposed development have been completed and no additional infrastructure is proposed. Activities associated with the reinstatement of turbine T05 are standard maintenance works which are regularly undertaken at operational wind farms and are assessed, in full, below. Therefore, no construction phase effects will occur.

7.4.2 Operation Phase

The existing site benefits from a routine inspection and, where required, maintenance programme. This programme will be continued throughout the proposed period of operations. Typical maintenance activities include maintaining access tracks, drains and carrying out wind turbine maintenance.

The effects resulting from the ongoing operational works may include localised and temporary pollution, erosion and sedimentation which could result in a slight adverse effect on surface water and groundwater.

7.4.2.1 Pollution Risk

Pollution may occur from surface water runoff from excavated and stockpiled material (arising from regular maintenance works) and from leakage and spills of hydrocarbons/chemicals from vehicle use, maintenance work and the day-to-day operation of the wind turbines and electrical switch room. Potential pollutants include sediment, oil, fuels, and cement. A pollution event is assessed as likely to result in a short term moderate adverse impact on surface water and/or groundwater.

The likelihood of a pollution event occurring during operation is considered very unlikely. There will be a limited number of vehicles required on the site for routine maintenance which reduces the likelihood of leakages or hydrocarbons.

Oils are brought to site as required for the maintenance and servicing of the turbines; and no fuels or oils are stored on site. A spill kit is permanently located adjacent to the 20kV transformer at the electrical switchroom in the case of an emergency.

7.4.2.2 Erosion and Sedimentation

During the proposed continued operation of the site, it is not anticipated that there will be any requirement for substantial excavation or stockpiling of material, reducing the likelihood of erosion and sedimentation effects. There will however be some groundworks required for the reinstatement of Turbine T05, although these will be relatively small in scale and localised to the site of the turbine foundation.

The continued regular maintenance of on-site drainage systems will reduce the likelihood of increased delivery of sediment to natural watercourses.

7.4.2.3 Infrastructure and man-made drainage

Continued operation of the site does not require any new infrastructure or man-made drainage. Consequently, no effects are assessed as likely.

7.4.3 Decommissioning Phase

Prior to decommissioning, it is proposed that the Applicant will engage with the Planning Authority to agree a specific Decommissioning Management Plan to ensure the appropriate decommissioning and reinstatement of the site having regard to prevailing environmental conditions and to ensure the use of best available recycling technology and techniques available at the time.

In general, all structures above ground level shall be demolished and removed from the site for reuse or recycling; however, access tracks may be retained depending on the proposed future use of the site. It is likely that, in order to minimise environmental disturbance, the majority of sub-surface elements of the wind farm shall remain in situ. For example, electrical cabling shall be removed and recycled but the ducting within which it is located would remain to avoid unnecessary excavations and ground disturbance. The methodologies likely to be implemented during decommissioning

are discussed in detail in **Chapter 3** (and **Annex 3.3**) of this EIAR; however, as described above, a site-specific approach will be agreed with the Planning Authority.

While, during decommissioning, there is a risk of sedimentation of local watercourses and accidental spillage/leakage of hydrocarbons from plant & machinery, the implementation of a Decommissioning Plan with appropriate measures will avoid significant effects. As a consequence of the proposed methodologies, the significance and magnitude of any effects will be Low.

7.4.4 Cumulative Effect

A cumulative effect is considered to be the effect on a hydrological and hydrogeological receptor arising from the proposed development in combination with other sites which are likely to affect surface water or groundwater.

It is assessed that there are no developments (see **Chapter 1**) located within the 2km study area, and located within the same surface or groundwater water catchments, which are likely to give rise to significant effects on the water environment. Consequently, and given the absence of significant effects arising from the proposed development; there is no likelihood of significant cumulative effects arising. The mitigation measures described below will serve to further reduce the magnitude of any effects which may arise from the site.

7.5 Mitigation & Monitoring Measures

Current industry standard good practice measures and monitoring/inspection will continue to be implemented during the proposed additional period of operations. Best practice measures are stated below.

7.5.1 Construction Phase

As the construction phase of the development is complete, no mitigation measures are required.

7.5.2 Operational Phase

7.5.2.1 General Measures

As a principle, preventing the release of any pollution/sediment is preferable to dealing with the consequences on any release.

The existing wind farm is operated and maintained in accordance with **Applicant's** Environmental Management System (EMS). This EMS ensures that the wind farm is managed in an appropriate manner which accords with best practice (see **Annex 7.3**) including in relation to pollution prevention and incident management.

7.5.2.2 Pollution Risk

Good practice measures adopted on site, and which will continue to be used on site in relation to pollution prevention include the following:-

- refuelling will take place at least 50m from watercourses and, where possible, it will not occur where there is risk that oil from a spill could directly enter the water environment. For example, periods of heavy rainfall or when standing water is present will be avoided;
- foul water generated at the existing control room will continue to be managed in accordance with best practice and will discharge to a sealed tank and routinely removed from site;
- drip trays will be placed under vehicles which could potentially leak fuel/oils

when parked;
- areas will be designated for washout of concrete vehicles which are a minimum distance of 50m from a watercourse;
- concrete washout water arising from general operations will be stored in the washout area before being treated and disposed of;
- if any water is contaminated with silt or chemicals, run-off will not be permitted to enter a watercourse directly or indirectly and will be passed through a comprehensive surface water treatment system prior to discharge;
- water will be prevented, as far as possible, from entering works areas; and
- procedures will be adhered to for storage of fuels and other potentially contaminative materials to minimise the likelihood of accidental spillage.

7.5.2.3 Erosion & Sedimentation

During the routine maintenance of the site, best practice measures for the management of erosion and sedimentation will include the following:-

- all stockpiled materials (temporary) will be located out with a 50m buffer from watercourses, including on up gradient sides of tracks and battered to limit instability and erosion;
- stockpiled material (temporary) will either be seeded or appropriately covered, minimising the area of exposed bare ground;
- monitoring of stockpiles / works areas during rainfall events;
- water will be prevented as far as possible, from entering works areas through the use of appropriate measures such as silt fences or temporary silt traps (e.g. straw bales);
- if material is temporarily stockpiled on a slope, silt fences will be located at the toe of the slope to reduce sediment transport;
- the amount of ground exposed, and time period during which it is exposed, will be kept to a minimum and appropriate drainage will be in place to prevent surface water entering excavations;
- activities involving the movement or use of fine sediment will avoid periods of heavy rainfall where possible; and
- personnel and the Principal Contractor will carry out regular visual inspections of watercourses to check for suspended solids where required during particular maintenance works.

7.5.3 Decommissioning Phase

Prior to the commencement of decommissioning works; a Decommissioning Plan will be prepared to detail the control of surface water for the duration of the decommissioning works. The Decommissioning Plan (to be developed from **Annex 3.3** prior to decommissioning) will detail the precise implementation of surface water controls and is likely to include may include silt fences, silt traps, silt bags, check dams and buffered outfalls together with the implementation of clean and dirty water drains to direct surface water away from the works area. The Decommissioning Plan will also provide for the appropriate management of hydrocarbons and procedures for refuelling of plant & machinery.

7.6 Residual Effects

Given the controls above the following residual effects are assessed:

7.6.1 Construction Phase

As all construction activities associated with the Knockastanna Wind Farm have been completed, no residual effects will occur.

7.6.2 Operational Phase

7.6.2.1 Pollution Risk

The magnitude of impact associated with a pollution event during the operational phase of the site life on groundwater and surface water receptors is considered negligible. Therefore, the significance of effect of a pollution event during the operational phase is predicted to be minor (not significant) for all receptors, including the Lower River Shannon SAC. No further mitigation is required.

7.6.2.2 Erosion and Sedimentation

The magnitude of impact associated with potential erosion and sedimentation occurring is considered negligible following adherence to good practice measures. Therefore, the significance of effect on the identified receptors, including the River Shannon SAC, is minor (not significant). No further mitigation is required.

7.6.3 Decommissioning Phase

It has been assessed that the existing development has not impaired groundwater or surface water resources nor increased flood risk.

Prior to any decommissioning, a decommissioning plan, including a comprehensive SWMP, will be prepared and will include the measures required to safeguard the water environment during and following decommissioning works.

Following adherence to good practice measures, the magnitude of impact with respect to pollution risk, erosion and sedimentation, and drainage, is assessed to be negligible. Therefore, the likely significance of effect on the identified receptors is minor (not significant). No further mitigation is required.

7.7 Summary

This chapter presents an assessment of the water (hydrological and hydrogeological) setting of the proposed development site and its environs.

It has been confirmed that the hydrogeological environment beneath the proposed development site is a Poor Aquifer which is generally unproductive except for local zones, and that it does not form an important resource locally. Groundwater, where present, may be relatively shallow, and therefore is vulnerable to pollution. It has, therefore, be considered a sensitive receptor in this assessment.

The site drains to the Bilboa River which, with its tributaries is considered a sensitive receptor as they drain to the Lower River Shannon SAC, which is c. 400m to the north of the site.

A site walkover survey was completed and has been used to confirm the baseline study completed as part of this assessment. The walkover survey also confirmed that there is no indication that the existing wind farm, or its associated water management measures, has impaired groundwater or surface water resources; has not increased flood risk; and has not resulted, and is not resulting, resulted in any downstream pollution of surface waters.

The continued operation and future decommissioning of the site, including cumulative effects, have been assessed. The assessment has concluded that, subject

to the continued implementation of best practice operation and maintenance techniques, continued use of the existing site does not and would not result in any significant effect on the hydrology, hydrogeology or flood risk.

It is proposed that, prior to decommissioning, a decommissioning plan (incorporating a SWMP) is prepared to detail method statements and safeguards to be adopted during this process. With adoption and adherence to a decommissioning plan, it is expected that there will be no significant decommissioning effects with respect to hydrology, hydrogeology or flood risk.

Knockastanna Wind Farm

Chapter 8: Air Quality & Climate

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8.1 Introduction

This chapter comprises an assessment of the likely effect on air quality and climate associated with the proposed development. This report provides a baseline assessment of the setting of the proposed development in terms of air quality and climate and discusses the likely and significant effects that the construction, operation and decommissioning of the proposed development will have on them. Where required, appropriate mitigation measures to limit any identified likely significant adverse impacts to air quality and climate are recommended. A cumulative impacts assessment is also carried out.

8.1.1 Summary of the Proposed Development

In summary, the proposed development comprises the continued operations of the existing wind farm for a further period of 15-years. The existing development, including secondary ancillary developments, consists of the following main components:-

- 4 no. wind turbines;
- Associated turbine foundations and crane hard standings;
- 1 no. electrical control building with a total footprint of 66 square metres (m^2), including welfare facilities and associated electrical equipment enclosure;
- Underground electrical cabling between each of the existing wind turbines and the electrical control building;
- 1 no. site entrance and 2km of site access tracks; and
- Site drainage infrastructure.

A full description of the proposed development is presented in **Chapter 3**.

8.1.2 Statement of Authority

This chapter of the EIAR was completed by Crystal Leiker. Crystal is an associate planner with SLR with 6-years of experience. Crystal holds an M.A. (Hons) in Planning and Sustainable Development from UCC, Cork.

8.2 Relevant Legislation & Guidance

8.2.1 Air Quality

The following Environmental Protection Agency (EPA) guidelines were considered in this assessment:-

- *Guidelines on the Information to be contained in Environmental Impact Statements* (EPA 2002);
- *Advice Notes on Current Practice (in the preparation of Environmental Impact Statements* (EPA 2003);
- *Guidelines on the Information to be contained in Environmental Impact Assessment Reports* (EPA 2022)
- *Draft Guidelines on the Information to be contained in Environmental Impact Assessment Reports* (EPA 2017); and
- *Draft EPA Advice Notes for Preparing Environmental Impact Statements* (EPA 2015).

In order to protect our health, vegetation and ecosystems, EU Directives have set out air quality standards for Ireland and the other member states for a wide variety of pollutants. These Directives include how we should monitor, assess and manage ambient air quality. The European Commission set down the principles to this approach in 1996 with its Air Quality Framework Directive (96/62/EC). Four "daughter" directives lay down limits for specific pollutants:

- 1st Daughter Directive (99/30/EC): Sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead;
- 2nd Daughter Directive (2000/69/EC): Carbon monoxide and benzene;
- 3rd Daughter Directive (2002/69/EC): Ozone; and
- 4th Daughter Directive (2001/107/EC): Polyaromatic hydrocarbons, arsenic, nickel, cadmium and mercury in ambient air.

The Ambient Air Quality and Cleaner Air for Europe (CAFE) Directive (2008/50/EC) was published in May 2008. It replaced the Framework Directive and the first, second and third Daughter Directives.

The fourth Daughter Directive (2004/107/EC) will be included in CAFE at a later stage. The limit and target values for both Directives are outlined below.

The CAFE Directive was transposed into Irish legislation by the Air Quality Standards Regulations 2011 (S.I. No. 180 of 2011). It replaces the Air Quality Standards Regulations 2002 (S.I. No. 271 of 2002), the Ozone in Ambient Air Regulations 2004 (S.I. No. 53 of 2004) and the Environmental Protection Agency Act, 1992 (Ambient Air Quality Assessment and Management) Regulations, 1999 (S.I. No. 33 of 1999). The fourth Daughter Directive was transposed into Irish legislation by the Arsenic, Cadmium, Mercury, Nickel and Polycyclic Aromatic Hydrocarbons in Ambient Air Regulations 2009 (S.I. No. 58 of 2009). **Table 8.1** details the limit values for pollutants as per the CAFÉ Directive.

Pollutant	Limit Value Objective	Averaging Period	Limit Value ug/m3	Limit Value ppb	Basis of Application of the Limit Value
SO_2	Protection of human health	1 hour	350	132	Not to be exceeded more than 24 times in a calendar year
SO_2	Protection of human health	24 hours	125	47	Not to be exceeded more than 3 times in a calendar year
SO_2	Protection of vegetation	calendar year	20	7.5	Annual mean
SO_2	Protection of vegetation	1 Oct to 31 Mar	20	7.5	Winter mean
NO_2	Protection of human health	1 hour	200	105	Not to be exceeded more than 18 times in a calendar year
NO_2	Protection of human health	calendar year	40	21	Annual mean

$NO + NO_2$	Protection of ecosystems	calendar year	30	16	Annual mean
PM_{10}	Protection of human health	24 hours	50	Not to be exceeded more than 35 times in a calendar year	PM_{10}
$PM_{2.5}$	Protection of human health	calendar year	40	Annual mean	$PM_{2.5}$
$PM_{2.5}$ - stage 1	Protection of human health	calendar year	25	Annual mean	$PM_{2.5}$ - stage 1
$PM_{2.5}$ - stage 2	Protection of human health	calendar year	20	Annual mean	$PM_{2.5}$ - stage 2
Lead	Protection of human health	calendar year	0.5	Annual mean	Lead
Monoxide	Protection of human health	8 hours	10,000	8620	Not to be exceeded
Benzene	Protection of human health	calendar year	5	1.5	Annual mean

Table 8.1: Limit Values of CAFE Directive 2008/50/EC

There are no statutory limits for dust deposition, however, the TA Luft (German Government 'Technical Instructions on Air Quality') state a guideline value of 350 mg/m2/day.

There are no limit values in relation to ozone, however, the Ozone Daughter Directive sets target values. These are detailed in **Table 8.2** along with information threshold and alert threshold values.

Objective	Calculation	Target Value for 2021
Protection of Human Health	Maximum daily 8-hour mean	120 µg/m^3
Protection of vegetation	AOT40*, calculated from 1-hour values from May to July	6000 µg/m^3-h
Information threshold	1-hour average	180 µg/m^3
Alert Threshold	1-hour average	240 µg/m^3
*The sum of the differences between hourly ozone concentration and 40 ppb for each hour when the concentration exceeds 40 ppb during a relevant growing season, e.g. for forest and crops.		

Table 8.2: Target Values for Ozone

8.2.1.1 Air Quality and Health

The World Health Organisation (WHO) in 2016 estimated that ambient air pollution caused 4.2 million deaths worldwide (WHO, 2018). According to the EPA (Air Quality in Ireland 2018 – Indicators of Air Quality (EPA 2018), in Ireland the number of deaths directly linked to air pollution is estimated at 1,180 premature deaths in Ireland in 2016 due to poor air quality (predominantly due to $PM_{2.5}$), with a figure of 538,014 premature deaths across the wider EU[1].

Generally, air quality in Ireland is acceptable. However, in the short term, when compared with WHO guideline values and EEA reference level values; ozone, particulate matter and PHAs are of concern and NO_2 is expected to increase as traffic on our roads increase.

The use of fossil fuel-based electricity generation leads to NOx and SOx emissions; however, wind generation does not produce any NOx or SOx emissions.

8.2.2 Climate

Carbon dioxide (CO_2) is a greenhouse gas which, if released in excessive amounts, **can lead to increases in global temperatures known as 'global warming' or the 'greenhouse effect' which can influence climate change.** As the proposed wind farm has been constructed there will be no negative impacts on climate change and in fact it will have a long-term positive impact by providing a sustainable energy source.

Should the proposed extension of time on the existing wind farm not continue, fossil fuel power stations will be the primary alternative at the expiration of the current planning permission to provide the required quantities of electricity. This will further contribute to greenhouse gas and other emissions, and hinder Ireland in its commitment to meet its target to increase electricity production from renewable sources and to reduce greenhouse gas emissions.

At the Paris climate conference (COP21) in December 2015, 195 countries adopted the first-ever universal, legally binding global climate deal. The agreement sets out a global action plan to put the world on track to avoid dangerous climate change by limiting global warming to well below 2°C above pre-industrial levels and to limit the increase to 1.5°C. Under the agreement, Governments also agreed on the need for global emissions to peak as soon as possible, recognising that this will take longer for developing countries, and to undertake rapid reductions thereafter in accordance with the best available science.

The International Panel on Climate Change (IPCC) has put forward its clear assessment that the window for action on climate change is rapidly closing and that renewable energy sources such as wind will have to grow from 30% of global electricity at present to 80% by 2050 if we are to limit global warming. In this regard, the Government enacted the *Climate Action and Low Carbon Development (Amendment) Bill 2020*[2] which provides for a series of actions to be undertaken by Government to ensure that our 2050 targets are met. These include annual updates to the Climate Action Plan 2019, the preparation of a long-term climate action strategy, the provision of a carbon budget programme, and sets out a roadmap of actions and other measures.

[1] EEA, 2019, cited in 'Air Quality in Ireland 2018 – Indicators of Air Quality, EPA 2019, p. 25.

[2] Climate Action and Low Carbon Development (Amendment) Bill 2020, Section 4.

Under the Kyoto Protocol and the Doha Amendment, during the first commitment period, 37 industrialized countries and the European Community committed to reduce GHG emissions to an average of five percent below 1990 levels. During the second commitment period, Parties committed to reduce GHG emissions by at least 18 percent below 1990 levels in the eight-year period from 2013 to 2020.

In December 2018, the revised Energy Efficiency Directive, the revised Renewable Energy Directive and the new Governance Regulation were formally adopted. The new regulatory framework includes a binding renewable energy target for the EU for 2030 of 32% with an upwards revision clause by 2023. This agreement will help the EU meet the Paris Agreement goals. The commission has also indicated an intention to **adopt the increased target of 55% at the EU's Nationally Determined Contribution** (NDC) under the Paris Agreement by the end of 2020. As well as the target being given legislative force in the EU through the proposed EU Climate Law, it will oblige all EU institutions across all areas of competence, and the Member States, to work collectively to achieve the target of 55%[3].

The main achievements of this agreement in terms of renewable energy production are:

- Sets a new, binding renewable energy target for the EU for 2030 of 32%, including a review clause by 2023 for an upward revision of the EU level target
- A financial framework for investors is to be established to facilitate investment in renewable energy projects
- Increases competition and market integration of renewable electricity
- Will reduce dependence on energy imports and increase energy security
- Improves the design and stability of support schemes for renewables.

8.2.2.1 Climate Action Plan

The Irish government has published the Climate Action Plan 2021 (CAP) which sets out a plan of action to address climate change and sets decarbonisation targets. In terms of renewable energy, an increase in electricity generated from renewable sources is to increase to 80% by 2030, with up to 8GW of increased onshore wind capacity.

Chapter 1 of the CAP sets out the nature of the challenge which Ireland faces over the coming years. The CAP notes that the evidence for warming of our climate system is beyond dispute with observations showing that global average temperatures have increased by more than 1°C since preindustrial times. These changes will cause extensive direct and indirect harm to Ireland and its people, as well as to other countries more exposed and less able than we are to withstand the associated environmental impacts such as extremes in weather, flooding, displacement of population by the creation of climate refugees poorer water quality and poorer air quality. In order to help reduce CO_2 emissions and reach our 2030 and 2050 emissions targets, CAP has set out a list of renewable energy goals which includes implementing up to 8GW total of increased onshore wind capacity on the island.

Achieving the 80% renewable electricity target by 2030 will involve phasing out coal and peat-fired electricity generation plants, increasing our renewable electricity generation, reinforcing our grid (including greater interconnection to allow electricity to flow between Ireland and other countries), and putting systems in place to manage intermittent sources of power, especially from wind.

[3] European Commission. (2020). State of the Union: Commission raises climate ambition and proposes 55% cut in emissions by 2030

8.2.2.2 Climate Change Performance Index

The Climate Change Performance Index (CCPI) is an independent monitoring tool which tracks countries climate protection performance. It assesses individual countries based on climate policies, energy usage per capita, renewable energy implementation and Greenhouse Gas Emissions (GHG) and ranks their performance in each category and overall. The 2020 CCPI was published in December 2019 and presented at the COP25. While the CCPI 2020 indicated signs of potential reductions in global emissions, no country achieved its Paris Climate targets and therefore the first three places of the ranking system remain unoccupied.

Ireland has ranked as the worst EU performer in the CCPI 2019. However, Ireland has climbed 7 places from 48th out of 60 globally ranked countries to 41st place and has **moved from a "very low" to "low" in international performance. Despite these gains however, it remains at "very low" at a national performance level. The CCPI report** states that while some improvements have been made, GHG per capita emissions **are at a high level and "significant challenges lie ahead in closing Ireland's emission gap, meeting the current (2030) target and aligning Ireland's emission trajectory with** a net zero goal for 2050. Therefore, the country still ranks among the bottom ten **performers in this indicator."**

Recognising Ireland's Climate Action Plan 2019, the CCPI states:-

> *"The government must go much further in implementing policies across all sectors that drive sustained emissions reductions over the next decade. Near-term ambition needs to be ratcheted up quickly by specifying deep cuts in fossil fuel and reactive nitrogen usage to put Ireland on a net zero emissions pathway aligned with the Paris temperature goals".*

8.2.2.3 Carbon Emissions

CO_2 emissions occur naturally in addition to being released with the burning of fossil fuels. All organic material is composed of carbon, which is released as CO_2 when the material decomposes. Organic material acts as a store of carbon. Peatland habitats are significant stores of organic carbon. The vegetation on a peat bog slowly absorbs CO_2 from the atmosphere when it is alive and converts it to organic carbon. When the vegetation dies, in the acidic waterlogged conditions of bogs and peatlands, the organic material does not decompose fully, and the organic carbon is retained in the ground.

The carbon balance of proposed wind farm developments in peatland habitats has attracted significant attention in recent years. When developments such as wind farms are proposed for peatland areas, there will be direct impacts and loss of peat in the area of the development footprint. There may also be indirect impacts where it is necessary to install drainage in certain areas to facilitate construction. The works can either directly or indirectly allow the peat to dry out, locally, which permits the full decomposition of the stored organic material with the associated release of the stored carbon as CO_2. It is essential therefore that any wind farm development in a peatland area displaces more CO_2 produced from fossil fuel sources than it releases during the construction, operation and restoration of the wind farm site.

The proposed development is situated in an area which has limited peat habitats. The site is not located on active bog or fen habitats. Peat is present at limited depths (0.5-1.5m) throughout most of the site The proposed development has been sensitively situated within an upland environment of limited habitat value.

The Scottish Carbon Calculator Tool was used to calculate carbon emissions and carbon savings as a result of the proposed wind farm extension of operation - www.gov.scot. Input data used in the calculations is presented in **Annex 8.1**.

Ireland's Carbon Emissions

Ireland's greenhouse gas (GHG) emissions are tracked and projected by the EPA for submission to the EU UNFCCC annually. Carbon dioxide emissions are reported alongside methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF6), and nitrogen trifluoride (NF3).

The EPA's latest projections report, 'Ireland's Greenhouse Gas Emissions Projections 2019-2040' (July 2020) projected Ireland's greenhouse gas emissions under two scenarios:

- With Existing Measures scenario (WEM) and
- With Additional Measures (WAM) scenario.

The WEM scenario incorporates the anticipated impact of policies and measures that were in place (and legislatively provided for) by the end of 2018. The WAM scenario is primarily based on SEAI's Advanced Energy Projection (which includes existing and planned policies and measures) and anticipated progress in the implementation of Government renewable and energy efficiency policies and measures including those set out in the National Renewable Energy Action Plan (NREAP), the National Energy Efficiency Action Plan (NEEAP) and Ireland's National Development Plan 2018 - 2027. **Figure 8.1** illustrates the WEM and WAM projected emissions in relation to Energy Industries.

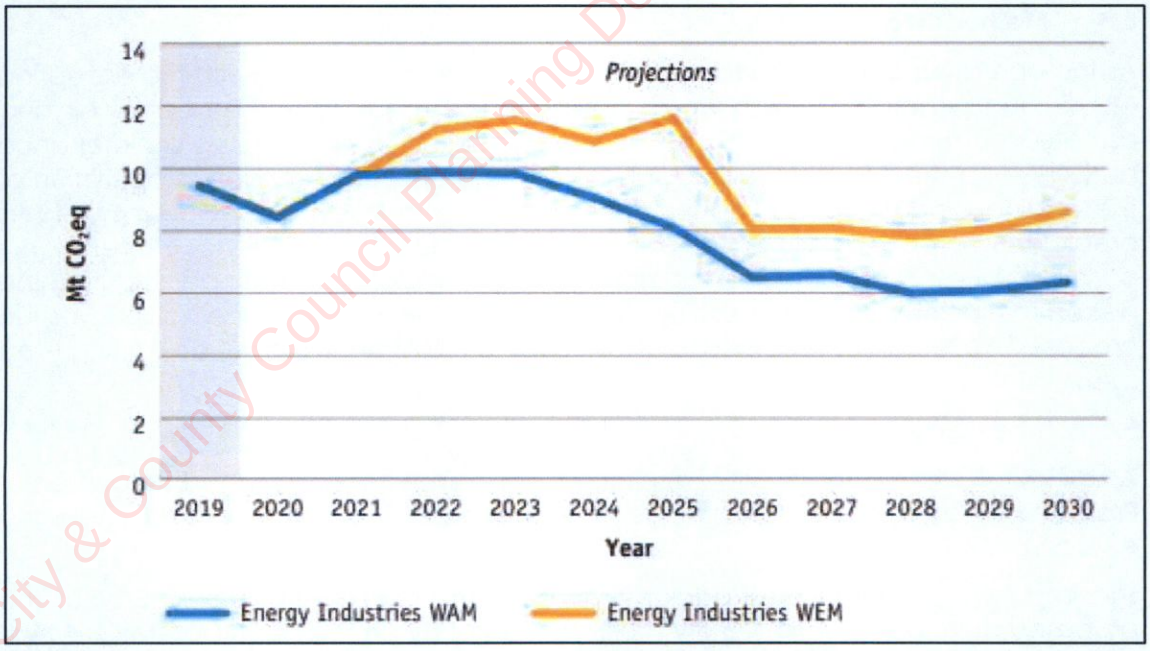

Figure 8.1: Greenhouse Gas Emissions Projections from the Energy Industries Sector under the WEM and WAM Scenarios to 2030

Over the period 2020-2030, Ireland's overall emissions are projected to decrease from the latest Inventory (2019) levels by 3% by 2030 under the With Existing Measures scenario and by 20% under the With Additional Measures scenario.

Emissions in the Energy Industries sector showed that energy emissions contributed **14.8% of Ireland's total emissions in 2019. This number is expected to reduce to 13.3%** by 2030 under the With Existing Measures scenario. However, under the With Additional Measures scenario, emissions produced by the renewable energy sector are projected to decrease by 24.8% to 6.3 Mt CO_2 over the period 2020-2030.

In 2017, electricity generated from wind and hydro increased by 21.1% and 1.6% respectively, reflected in a 9.1% decrease in the emissions intensity of power generation in 2017 (437g CO_2/kWh) compared with 2016 (480 g CO_2/kWh). Renewables are projected to account for 55% of electricity consumption in 2030, up from 29.6% of electricity generated in 2017 under the With Existing Measures scenario. Under the With Additional Measures scenario, it is assumed that 40% of electricity generation will be from renewable sources, and that this number will increase to 70% by 2030.

Sustainable Energy Authority of Ireland (SEAI) estimate that the use of renewables in electricity generation in 2018 reduced CO_2 emissions by 4.9 Mt. Renewable energy accounts for 82% of the CO_2 emissions avoided. A total of 358 MW of wind capacity (both on and offshore) was installed in 2018 and wind generation now accounts for 28% of the electricity generated.

According to 'Ireland's Greenhouse Gas Emissions Projections 2018-2040' (EPA, 2019), 2018 greenhouse gas emissions projections show total emissions increasing from current levels by 1% and 6% by 2020 and 2030 respectively, under the With Existing Measures scenario. Under the With Additional Measures, emissions are estimated to decrease by 0.4% by 2020 and decrease by 10% by 2030.

8.3 Methodology

As the operation of the wind farm does not give rise to emissions (with the exception of back-up generators which would not be in use regularly), in respect of air and climate, this chapter focusses on the emissions likely to arise during maintenance activities and the decommissioning phase of the proposed extension of operation of the existing wind farm. The Scottish Windfarm Carbon Assessment Tool was used to predict the carbon savings for the existing development for an extended operational period of 15 years and includes all activities and associated likely impacts during the decommissioning phase. It does not however cover the maintenance activities as the proposed development seeks to reinstate turbine T05 of operation of an existing wind farm.

8.3.1 Air Quality

A review of existing air quality monitoring data undertaken by the Environmental Protection Agency (EPA) was reviewed and used to characterise the existing environment.

The impact assessment methodology involved the review and assessment of the proposed development to identify the likelihood of air emissions. The activities which were assessed are:

- The existing wind farm and associated infrastructure (Electrical Control Building, cabling, site entrance and overhead lines); and
- Continued operation of the above components for 15 additional years.

To assess the impacts of construction dust emissions, the NRA's Assessment Criteria for the impact of dust emissions from construction activities with standard mitigation in

place was used. This table is provided in Appendix 8 of the National Roads Authority (NRA) Guidelines for the Treatment of Air Quality during the Planning and Construction of National Road Schemes (NRA, 2011) and reproduced below in **Table 8.3**.

Table 8.4 details the definitions of impact magnitude for changes in ambient pollutant concentrations and **Table 8.5** details the descriptors for changes in annual mean nitrogen dioxide, PM_{10} and $PM_{2.5}$ at receptors.

Source		Potential Distance for Significant Effects (Distance from Source)		
Scale	Description	Soiling	PM_{10}	Vegetation Effects
Major	Large construction sites, with high use of haul routes	100m	25m	25m
Moderate	Moderate sized construction sites, with moderate use of haul routes	50m	15m	15m
Minor	Minor construction sites, with limited use of haul routes	25m	10m	10m

Table 8.3: Assessment Criteria for the Impact of Dust Emissions from Construction Activities, with Standard Mitigation in Place

Magnitude of Change	Annual Mean NO_2/PM_{10}	No. Days with PM_{10} conc. >50µg/m³	Annual Mean PM_{10}
Large	Increase/Decrease ≥4µg/m³	Increase/Decrease > 4 days	Increase/Decrease ≥2.5 µg/m³
Medium	Increase/Decrease 2- < 4µg/m³	Increase/Decrease 3 or 4 days	Increase/Decrease 1.25 - <2.5 µg/m³
Small	Increase/Decrease 0.4 - <2 µg/m³	Increase/Decrease 1 or 2 days	Increase/Decrease 0.25 - <1.25 µg/m³
Imperceptible	Increase/Decrease <0.4 µg/m³	Increase/Decrease <1 day	Increase/Decrease <0.25 µg/m³

Table 8.4: Definition of Impact Magnitude

Absolute Concentration In relation to Objective/Limit Value	Change in Concentration		
	Small	Medium	Large
Increase with Scheme			
Above Objective/Limit Value with Scheme (≥40µg/m³ of NO_2 or MP_{10}) (≥25µg/m³ of $PM_{2.5}$)	Slight adverse	Moderate adverse	Substantial adverse
Just below objective /limit value with scheme (36- <40 µg/m³ of NO_2 or PM_{10}) (22.5 - <25 µg/m³ of $PM_{2.5}$)	Slight adverse	Moderate adverse	Moderate adverse
Below objective / limit value with scheme (30- <36 µg/m³ of NO_2 or PM_{10}) (18.75 - < 22.5 µg/m³ of $PM_{2.5}$)	Negligible	Slight adverse	Slight adverse

Well below objective /limit value (<30 µg/m³ of NO_2 or PM_{10}) (<18.75 µg/m³ of $PM_{2.5}$)	Negligible	Negligible	Slight adverse
Decrease with Scheme			
Above objective/limit value without scheme (≥40 µg/m³ of NO_2 or PM_{10}) (≥25 µg/m³ of $PM_{2.5}$)	Slight beneficial	Moderate beneficial	Substantial beneficial
Just below objective / limit value without scheme (36 - <40 µg/m³ of NO_2 or PM_{10}) (22.5 - <25 µg/m³ of $PM_{2.5}$)	Slight beneficial	Moderate beneficial	Moderate beneficial
Below objective/limit value without scheme (30 - <36 µg/m³ of NO_2 or PM_{10}) (18.75 - <22.5 µg/m³ of $PM_{2.5}$)	Negligible	Slight beneficial	Slight beneficial
Well below objective/limit value without scheme (<30 µg/m³ of NO_2 or PM_{10}) (<18.75 µg/m³ of $PM_{2.5}$)	Negligible	Negligible	Slight beneficial

Table 8.5: Air Quality Impact Descriptors for Changes to Annual Mean Nitrogen Dioxide and PM_{10} and $PM_{2.5}$ Concentrations at a Receptor

8.3.2 Climate

A desk-top study assessment was undertaken of available climatic information to characterise the existing environment. In terms of climatic impact, the appraisal considered the net impact that operating the existing wind farm will have in terms of CO_2 and its displacement of CO_2 from other energy sources over the carbon losses caused by its construction using the Scottish Carbon Calculator tool.

The impact assessment considered the positive impacts the continued operation of the existing wind farm will have on contributing to national targets for the reduction of greenhouse gas emissions. The proposed development will result in the production of energy from a renewable source which, once fed into the National Grid, has the potential to avoid several thousand tonnes of carbon dioxide (CO_2) annually that would have been released had the energy been generated by the average Irish power generation mix.

The Intergovernmental Panel on Climate Change (IPCC) in '*Renewable Energy Sources and Climate Change Mitigation*' (2014) state that 50 estimates from 20 studies indicate that emissions "*are small compared to the energy generated and emissions avoided over the lifetime of wind power plants [farms]: the GHG [greenhouse gas] emissions intensity of wind energy is estimated to range from 8 to 20g CO_2/kWh in most instances*". The IPCC (2010) report that the energy payback time, based on lifecycle assessment procedures, per turbine vary between 0.25 years and 0.65 years for onshore developments.

The amount of CO_2 that could potentially be avoided on an annual basis due to the continued operation of the existing wind farm is estimated based on the expected output of the wind farm. The net displacement value may increase or decrease somewhat, as the generation mix in Ireland develops, under different fuel price scenarios and as demand changes over time, and as more storage, interconnection and demand side management (smart meters) come online. Refer to **Section 8.5.2.3** for details of the calculations for carbon saving as a result of the continued operation of the existing wind farm.

8.3.2.1 Carbon Calculation

Previously, guidance produced by Scottish Natural Heritage in 2003 had been widely employed to determine carbon payback in the absence of any more detailed methods.

Concerns were raised about the existing methods of calculating carbon savings for large scale wind farms being developed in Scotland as many of the developments were located on peatlands and forestry which can contain large carbon stocks and which are poorly protected. The methodology for calculating carbon losses was created in 2008 by scientists at the University of Aberdeen and the Macauley Institute with support from the Rural and Environment Research and Analysis Directorate of the Scottish Government, Science Policy and Co-ordination Division. The document, **'Calculating Carbon Savings from Wind Farms on Scottish Peat Lands', was** developed to calculate the impact of wind farm developments on the soil carbon stocks held in peat. This methodology was refined and updated in 2011 based on feedback from users of the initial methodology and further research in the area. The web-based version of the carbon calculator, which supersedes the excel based versions of the tool, was released in 2016.

The tool provides a straightforward method for estimating the impacts of wind farms on the carbon dynamics of peatlands. The tool also provides guidance when figure inputs are unknown. The carbon calculator, whilst designed for Scottish wind farm developments is used for assessing Irish wind farm developments due to the similarity in development sites, i.e. high ground on peatlands which contain forestry in a similar climate.

The calculator was created to calculate the loss of carbon from acidic bog or fen habitat and defines peat soils as soils with a surface horizon greater than 50cm deep. The calculator takes into account the carbon fixing potential from peatland plants (which is small) and calculates the total area of peat excavation and the total area of peat affected by drainage, using the annual gains due to carbon fixing potential and the time required for any habitat restoration. Carbon stored within the peat itself represents a large potential source of carbon which can be lost during excavation and drainage. Forestry on proposed wind farm sites can affect wind energy yields and therefore clear felling is generally required (tree felling is limited to the minimum required for infrastructure construction and bat mitigation in this project), However, in this instance, the wind farm is established and therefore carbon losses as a result of felling do not apply. The calculator also takes into account the carbon emissions from the life cycle analysis of the wind turbines and the back-up source in order to calculate carbon savings and carbon payback times of a wind farm. Site specific capacity factor is also required to provide a realistic payback time for a site. The calculator also takes into account a grid mix emission factor. The calculator uses default values from the Intergovernmental Panel on Climate Change (IPPCC, 1997) as well as site specific equations from scientific literature to calculate carbon loss.

In keeping with guidance specific figures have been inputted wherever possible and where this information was not available the guidance provided by the calculator was used[4]. The assumption to use the fossil fuel generation emission factor was made based on the reality that additional wind generation will displace fossil fuel generation (Scot. Gov., 2018). With regards to the wind farm characteristics the following

[4] Scottish Government. Calculating potential carbon losses and savings from wind farms on Scottish peatlands Technical Note Version 2.10.0

presumptions for the existing 4 turbine wind farm were made: the lifetime of the windfarm is 29 years, the capacity factor is 33% and the fraction of output to back up is 5.28% (i.e. 5% of capacity factor[5]). With regards to the characteristics of the 'peatland' before development, the peat on the site does not meet the standards for peatland in that it is less than 0.5m in depth. The site has been cultivated and is dominated by forestry meaning that the carbon content of the peat is much lower than that of an actual peatland habitat, with carbon having been released during the drainage and cultivation of the site.

8.4 Description of Existing Environment

8.4.1 Air Quality

European air quality legislation requires that each member state be defined in terms of Zones and Agglomerations for air quality, with Ireland divided into four zones.

- Zone A: Dublin City and its environs;
- Zone B: Cork City and its environs;
- Zone C: 24 cities and towns (such as Galway, Limerick and Waterford cities and towns such as Naas, Newbridge, Celbridge, Leixlip) with a population of greater than 15,000; and
- Zone D covers the remainder of the country.

These zones were defined to meet the criteria for air quality monitoring, assessment and management described in the Framework Directive and Daughter Directives. The proposed development is located in Zone D.

The air quality in each zone is monitored by the EPA and classified with respect to upper and lower assessment thresholds based on measurements over the previous five years. The number of monitoring locations required is dependent on population size and whether ambient air quality concentrations exceed the upper assessment threshold, are between the upper and lower assessment thresholds, or are below the lower assessment threshold. The Air Quality In Ireland 2017 – Indicators of Air Quality (EPA 2018) noted that Ireland's overall air quality was good and compares favourably with other member states and all the parameters were below the EU limit and target values. However, when compared to the tighter WHO Air Quality Guideline values, Ireland exceeded the WHO Guideline values in 2017 for PM_{10}, O_3 and PAH. $PM_{2.5}$ has been highlighted by the EPA as being predominantly responsible for most of the 1,180 estimated premature deaths. The Air Quality Index for Health map on the EPA website, shows that the current air quality within the existing wind farm site is classed as 1 – Good.

An assessment of air quality was carried out in Shannon from 15th March 2011 – 18th July 2012[6].the monitoring assessment at Shannon is the closest site to the application site and provides an environmental baseline of air quality conditions in the region. A summary of findings for sulphur dioxide, Particulate Matter (PM_{10}), Nitrogen Dioxide (NO_2) and Carbon Monoxide (CO) is found in the following sections.

[5] The capacity factor, ppcap (%), is calculated from the ratio of calculated annual power output from the turbine, Pact (MWh turbine-1 yr-1), and the theoretical power output of the turbine, Pmax (MW turbine-1 yr-1), removing the specified value for estimated downtime for maintenance, tdown (%) (Source: Calculating potential carbon losses and savings from wind farms on Scottish peatlands Technical Note Version 2.10.0.

[6] https://www.epa.ie/publications/monitoring--assessment/air/ambient-air-monitoring/ambient-air-monitoring-in-shannon.php

8.4.1.1 Sulphur Dioxide

Sulphur Dioxide for the period of March 2011 – July 2012 recorded at the Shannon air monitoring station is presented in **Table 8.6**. The hourly limit value was not exceeded during the measurement period. There were no exceedances of the 50 µg.m-3 lower assessment threshold. The directive stipulates that the lower assessment threshold should not be exceeded more than three times in a calendar year.

Parameter	Measurement
Number of Hours	11,407
No. of Measured Values	10,588
Percentage Coverage	92.8%
Maximum hourly value	22.9µg.m^{-3}
98 percentile for hourly values	6.1 µg.m^{-3}
Mean hourly value	1.7 µg.m^{-3}
Maximum 24 hour mean	6.1 µg.m^{-3}
98 percentile for 24 hour mean	4.1 µg.m^{-3}

Table 8.6: Sulphur Dioxide Data for Shannon 2011-2012

8.4.1.2 Particulate Matter (PM_{10})

Particulate matter are very small particles which can be either solid or liquid. Some of these particles occur naturally, while many are man-made. Particulate matter is referred to as PM. The number following the PM is used to show how small the PM is. The EPA monitors two types of PM and compare levels to limit values in the CAFE (Clean Air for Europe) Directive and WHO guidelines. These are PM_{10} and $PM_{2.5}$.

Particulate matter (PM_{10}) data for the March 2011 – July 2012 period recorded at the Shannon air monitoring station is presented in **Table 8.7**. The daily limit value for the protection of human health (50 µg.m-^{3}) was exceeded twice during the measurement period. The directive stipulates that the limit value should not be exceeded more than 35 times in a calendar year. The upper assessment threshold (35 µg.m -^{3}) with regard to the daily average PM_{10} concentration was exceeded on 10 days while the lower assessment threshold (25 µg.m-^{3}) with regard to daily average PM_{10} concentration was exceeded on 28 days. The Directive stipulates that each of the assessment thresholds should not be exceeded more than 35 times in a calendar year. The 90.4 percentile value (22.5 µg.m-^{3}) is below the lower assessment threshold value of 25 µg.m-^{3}.

The mean of the daily values during the measurement period (11.1 µg.m-3) is below the lower assessment threshold with regard to annual average PM_{10}. The annual limit value for the protection of human health is 40 µg.m-3.

Parameter	Measurement
Number of Days	457
No of measure values	421
Percentage Coverage	92.1%
Maximum daily value	57.2 µg.m^{-3}
Mean daily value	11.1 µg.m^{-3}

Table 8.7: Particulate Matter (PM_{10}) data Shannon

8.4.1.3 Nitrogen Dioxide (NO_2)

Nitrogen dioxide and oxides of nitrogen data for the March 2011 – July 2012 period recorded at the Shannon air monitoring station is presented in **Table 8.8**. There were no exceedances of the lower threshold value concerning the protection of human health. No more than 18 exceedances each of the lower assessment threshold, upper assessment threshold and limit value are allowed per year. The mean hourly NO_2 concentration was 7.6 µg.m-3. This was below the lower assessment threshold value of 26 µg.m-3 for the protection of human health. The mean annual NOx concentration was 10.1 µg.m-3. This is below the lower assessment threshold concentration concerning protection of vegetation and natural ecosystem; however, this assessment criterion is not applicable to the Shannon site (Zone D) as the monitoring location was within the boundaries of Shannon town. The criteria for the assessment of NOx with regard to the protection of vegetation are as follows (2005/EC/50, Annex II B.2):

- Sampling points targeted at the protection of vegetation and natural ecosystems shall be sited more than 20km away from agglomerations or more than 5 km away from other built-up areas, industrial installations or motorways or major roads with traffic counts of more than 50,000 vehicles per day, which means that a sampling point must be sited in such a way that the air sampled is representative of air quality in a surrounding area of at least 1,000 km2.

Parameter	Measurement
Number of Hours	11,400
No. of Measured Values	11198
Percentage Coverage	98.2%
Maximum hourly value	76.6µg.m^{-3}
99.7 percentile for hourly values	55.2 µg.m^{-3}
Mean hourly value (NO_2)	7.6 µg.m^{-3}
Mean hourly value (NO_x)	10.1 µg.m^{-3}

Table 8.8: Nitrogen Dioxide and Oxides of Nitrogen Shannon

8.4.1.4 Carbon Monoxide (CO)

Carbon Monoxide data for the March 2011 – July 2012 period recorded at the Shannon air monitoring station is presented in **Table 8.9**. The mean hourly concentration of carbon monoxide recorded was 0.2 mg/m3. The CO limit value for the protection of human health is 10 mg/m3. No exceedances of the Limit Value or Thresholds occurred.

Parameter	Measurement
Number of Hours	11,417
No. of Measured Values	10,714
Percentage Coverage	93.8%
Maximum hourly value	2.5 µg.m^{-3}
98 percentile for hourly values	0.5 µg.m^{-3}

Mean hourly value	0.2 µg.m^{-3}
Maximum 8 hour mean	1.29 µg.m^{-3}

Table 8.9: Carbon Monoxide Data for Shannon 2011-2012

8.4.1.5 Dust

There are no statutory limits for dust deposition in Ireland. However, EPA guidance suggests that a deposition of 10 mg/m2/hour can generally be considered as posing a soiling nuisance. This equates to 240 mg/m2/day. The EPA recommends a maximum daily deposition level of 350 mg/m2/day when measured according to the TA Luft Standard 2002.

Construction dust has the potential to be generated from on-site activities such as excavation and backfilling. The extent of dust generation at any site depends on the type of activity undertaken, the location, the nature of the dust, (i.e. soil, sand, peat) and the weather. In addition, dust dispersion is influenced by external factors such as wind speed and direction and/or, periods of dry weather. Construction traffic movements also have the potential to generate dust as they travel along the haul route. Construction related dust deposition for the proposed development will be limited only to the reconstruction of turbine T05.

8.4.2 Climate

Changing climate patterns are thought to increase the frequency of extreme weather conditions such as droughts, floods and storms. Warmer weather places pressure on flora and fauna which cannot adapt to a rapidly changing environment. The dominant influence on Ireland's climate is the Gulf Stream. Consequently, Ireland does not suffer from the extremes of temperature experienced by many other countries at similar latitudes.

The climatic conditions for the wider geographical area have been derived from historical meteorological measurements compiled by Met Éireann at Shannon Airport weather station which is approximately 28km west of the existing wind farm. These meteorological conditions are presented in **Table 8.10** for the period January 2018-January 2022 (source www.met.ie/climate).

Total rainfall in millimetres for Shannon													
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
2022	46.6	143.7	-	-	-	-	-	-	-	-	-	-	-
2021	105.5	82.6	82.6	15.4	91.6	17.3	85.3	80.5	72.0	131.7	53.6	112.3	930.4
2020	74.8	244.5	97.4	39.6	16.2	84.0	130.6	174.8	41.6	114.8	102.2	131.0	1251.5
2019	71.4	58.4	177.2	68.2	30.8	55.8	51.0	167.2	108.1	101.9	104.9	117.1	1112.0
LTA	102.3	76.2	78.7	59.2	64.8	69.8	65.9	82.0	75.6	104.9	94.1	104.0	977.5
Mean temperature in degrees Celsius for Shannon													
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
2022	6.8	7.7	-	-	-	-	-	-	-	-	-	-	-
2021	4.5	6.7	8.0	8.7	10.4	14.2	17.8	16.3	15.7	12.4	9.0	7.8	11.0
2020	6.7	6.7	6.9	10.4	13.0	14.2	14.9	16.3	14.1	10.3	8.7	5.8	10.7
2019	6.8	8.4	7.8	10.1	11.8	13.6	16.8	15.9	13.8	10.0	6.7	6.6	10.7
LTA	6.0	6.2	7.7	9.4	12.0	14.5	16.3	16.0	14.1	11.1	8.3	6.3	10.7
Mean 10cm soil temperature for Shannon at 0900 UTC													
Jan	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
2022	7.3	N/A	-	-	-	-	-	-	-	-	-	-	-
2021	4.2	5.9	7.5	9.1	11.7	15.2	18.2	17.1	16.5	13.4	10.3	7.9	11.4
2020	5.9	5.7	6.1	10.0	13.0	15.0	16.0	17.0	14.6	10.8	9.0	6.2	10.8
2019	6.2	6.0	7.0	9.3	12.2	13.5	17.3	16.4	14.6	10.6	6.8	6.0	10.5
LTA	4.8	4.8	6.3	8.5	12.1	15.1	16.6	16.1	13.6	10.3	7.4	5.5	10.1
Potential Evapotranspiration (mm) for Shannon													
Jan	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
2022	13.6	21.4	-	-	-	-	-	-	-	-	-	-	-
2021	8.7	23.6	34.7	68.2	80.9	89.2	96.2	72.9	47.6	28.8	13.3	13.4	577.5
2020	15.6	24.1	40.2	65.2	101.6	81.8	80.5	71.9	49.5	29.4	14.7	11.1	585.6
2019	13.1	25.1	38.4	64.4	88.2	86.8	96.3	72.7	48.5	29.3	13.7	14.0	590.5

LTA	15.7	22.8	36.2	57.9	78.5	87.3	84.3	71.3	50.7	29.0	16.0	12.9	562.6
Degree Days Below 15.5 Degree Celsius for Shannon Airport													
Jan	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
2022	270	-	-	-	-	-	-	-	-	-	-	-	-
2021	340	247	232	207	162	63	18	24	33	104	196	237	1864
2020	272	256	266	162	106	64	44	28	68	161	203	300	1930
2019	269	199	240	168	124	82	22	29	67	172	264	275	1912
Mean	294	262	241	186	121	58	28	32	64	139	218	285	1929

Table 8.10: Climate Record for Shannon Weather Station 2018-2022

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Temperature (degrees Celsius)													
mean daily max	8.8	9.2	11.1	13.3	16.0	18.3	19.8	19.6	17.7	14.3	11.1	9.0	14.0
mean daily min	3.2	3.2	4.5	5.7	8.2	10.9	12.9	12.7	10.8	8.2	5.5	3.6	7.4
mean temperature	6.0	6.2	7.8	9.5	12.1	14.6	16.4	16.2	14.2	11.2	8.3	6.3	10.7
absolute max.	14.8	15.5	18.3	23.5	27.2	30.2	30.6	29.8	26.1	22.3	17.6	15.3	30.6
min. maximum	-2.4	0.9	3.5	5.4	8.0	11.8	13.8	13.0	11.1	7.0	0.8	-6.0	-6.0
max. minimum	11.8	12.3	11.7	13.0	15.3	17.8	19.4	19.3	17.8	16.3	13.4	12.9	19.4
absolute min.	-11.2	-5.5	-5.8	-2.3	0.2	3.6	6.7	4.4	1.7	-2.0	-6.6	-11.4	-11.4
mean num. of days with air frost	5.3	5.1	2.1	0.7	0.0	0.0	0.0	0.0	0.0	0.5	2.3	4.8	20.8
mean num. of days with ground frost	13.7	12.6	11.0	8.3	3.3	0.3	0.0	0.1	1.2	3.8	9.5	12.5	76.3
mean 5cm soil	4.5	4.6	6.3	8.9	12.7	15.9	17.2	16.4	13.8	10.2	7.1	5.2	10.2
mean 10cm soil	4.8	4.8	6.3	8.5	12.1	15.1	16.6	16.1	13.6	10.3	7.4	5.5	10.1
mean 20cm soil	5.5	5.6	7.0	9.2	12.3	15.1	16.8	16.6	14.5	11.4	8.4	6.3	10.7
Relative Humidity (%)													
at 0900UTC	87.1	87.0	85.0	79.8	76.3	76.8	80.0	82.1	84.7	87.0	88.9	88.4	83.6
mean at 1500UTC	80.5	74.6	70.5	64.4	63.3	65.1	68.0	68.2	69.2	75.2	80.5	83.1	71.9
Sunshine (hours)													
mean daily duration	1.6	2.3	3.2	5.1	5.8	5.2	4.5	4.5	3.9	2.9	2.0	1.4	3.5

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
greatest daily duration	8.1	10.2	11.0	13.6	15.6	15.8	15.7	14.4	12.2	10.1	8.3	7.1	15.8
mean no. of days with no sun	9.2	6.4	5.7	2.4	1.9	2.0	2.4	2.3	2.9	5.5	7.8	11.1	59.8
Rainfall (mm)													
mean monthly total	102.3	76.2	78.7	59.2	64.8	69.8	65.9	82.0	75.6	104.9	94.1	104.0	977.6
greatest daily total	38.2	29.4	28.1	40.2	25.0	40.6	39.5	51.0	52.3	36.9	26.9	41.2	52.3
mean num. of days with >= 0.2mm	20	16	19	16	16	15	16	18	16	20	20	19	211
mean num. of days with >= 1.0mm	16	12	14	11	12	11	12	13	12	16	15	15	159
mean num. of days with >= 5.0mm	8	5	5	4	4	4	4	5	4	7	6	7	63
Wind (knots)													
mean monthly speed	10.3	10.2	10.0	9.0	8.9	8.5	8.5	8.2	8.4	9.2	9.1	9.4	9.1
max. gust	75	80	65	62	59	51	52	55	62	71	66	83	83
max. mean 10-minute speed	52	46	44	40	37	37	38	35	40	47	41	57	57
mean num. of days with gales	1.7	0.9	0.8	0.3	0.2	0.1	0.0	0.1	0.1	0.6	0.7	1.2	6.7
Weather (mean no of days with...)													
snow or sleet	2.3	2.3	1.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.3	8.0
snow lying at 0900UTC	0.6	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.9
hail	3.6	3.3	3.4	2.2	1.2	0.1	0.1	0.1	0.3	0.9	1.1	2.4	18.6

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
thunder	0.9	0.5	0.4	0.3	0.5	0.5	0.8	0.4	0.2	0.4	0.4	0.5	5.7
fog	3.3	2.0	2.1	1.9	1.5	1.4	1.4	2.0	2.9	2.9	3.9	4.2	29.6

Table 8.11: Average Annual Climate and Weather conditions at Shannon Weather Station between 1981 - 2010

8.5 Description of Likely Effects

8.5.1 Air Quality

8.5.1.1 Construction Phase

As the construction of the Knockastanna Wind Farm is complete, no effects on air quality are assessed as likely. Construction-like activities will occur during the continued operational phase (re-mounting of T05 and maintenance of areas of hardstanding); however, these are assessed at **Section 8.5.1.2** below.

8.5.1.2 Operation Phase

The principal source of air emissions during the operation phase would arise from dust arising from maintenance activities (including re-mounting of T05), the movement of plant & machinery, loading and unloading of aggregates/materials, and the movement of material around the site

Dust emissions arise when particulate matter becomes airborne making it available to be carried downwind from the source. Dust emissions can lead to elevated PM_{10} and $PM_{2.5}$ concentrations and may also cause dust soiling. The amount of dust generated and emitted from a working site and the potential impact on the surrounding areas varies according to:

- The type and quantity of material and working methods;
- Distance between site activities and sensitive receptors; and
- Climate/local meteorology and topography.

Applying the NRA criteria listed in **Table 8.1**, the re-mounting of Turbine T05 as part of the proposed development would be considered a moderate construction-like activity. This would result in (dust) soiling effects which have the potential to occur up to 50m from the source, with PM_{10} deposition and vegetation effects occurring up to 15m from the source. The nearest receptor to Turbine T05 is c. 760m and therefore will not experience the soiling, deposition, or vegetation effects. Emissions from plant & machinery have the potential to increase concentrations of compounds such as NO_2, Benzene and PM_{10} in the receiving environment. Due to distance between the nearest receptor and source of emissions, the impact from these emissions would be imperceptible.

It is not assessed that an air quality impact will occur due to traffic at the proposed development site is the impacts will fall below the screening criteria are set out in the UK DMRB guidance (UK Highways Agency 2007), on which the TII guidance is based. This UK DMRB guidance states that road links meeting one or more of the following **criteria can be defined as being 'affected' by a proposed developments and should** be included in the local air quality assessment:

- Road alignment change of 5m or more;
- daily traffic flow changes by 1080 ADT or more;
- HGVs flow changes by 200m per day or more;
- daily average speed changes by 10km/h or more; or
- peak hour changes by 20km/h or more.

Plant and machinery such as generators, excavators, etc. will be required at various stages during the re-mounting of Turbine T05. These will be relatively small units which will be operated on an intermittent basis. Although there will be an emission from these units, given the scale and length of operation time, the impacts of emissions from these units will be imperceptible.

Other maintenance activities (e.g. access tracks or crane hardstandings) are assessed as requiring similar plant & machinery but are likely to be of a lesser duration. Similarly, therefore, any effects are assessed to be imperceptible.

Additionally, wind turbine & electrical control building maintenance vehicles will access the wind farm site periodically during the operational period, however, due to the low traffic movements involved, the impact will be imperceptible.

The operational phase of the wind farm will continue to result in positive impacts on air quality due to the displacement of fossil fuels as an energy source.

8.5.1.3 Decommissioning Phase

In terms of decommissioning, there will be truck movements associated with removing the wind turbines from the wind farm resulting in vehicular emissions and also dust. However, the number of truck movements would be significantly less than would have been required during the construction phase and would likely result in a slight temporary impact. There will also be emissions from plant & machinery on site including for the movement of soil to cover the foundations, however, this is not likely to result in significant impacts.

8.5.2 Climate

There is the likelihood of greenhouse gas emissions to the atmosphere during the construction phase such as those arising from vehicles, the use of on-site generators, pumps etc. The likely climatic impacts arising from these emissions are assessed hereunder with respect to micro and macro climates.

8.5.2.1 Microclimate

The proposed development comprises the extension of operation of an existing wind farm. There are no new permanent hardstanding surfaces, no new access tracks and no new physical development. There will also be no further tree felling. Consequently, there will be no direct or indirect impact on air temperature and microclimate due to the proposed development.

8.5.2.2 Macroclimate

Carbon dioxide (CO_2) is a greenhouse gas which if released in excessive amounts can **lead to increases in global temperatures known as 'global warming' or 'greenhouse effect' which can influence climate** change. **Section 8.5.2.3** details the carbon savings that have been calculated for the continued operation of the existing wind farm.

Should the existing wind farm not continue to operate, fossil fuel power stations will be the primary alternative to provide the required quantities of electricity. This will further contribute to greenhouse gas and other air pollutant emissions, as well as hindering Ireland in its commitment to meet its target to increase electricity production from renewable sources and to reduce greenhouse gas emissions.

The continued operation of the existing wind farm offers Ireland an indigenous form of sustainable electricity and will provide for security of supply, reducing our dependence on imports in addition to the positive impact on the macroclimate.

8.5.2.3 Carbon Balance

In terms of carbon losses and savings, the online Scottish Windfarm Carbon Assessment Tool (https://informatics.sepa.org.uk/CarbonCalculator/index.jsp) was used to estimate carbon savings as a result of the operation of the existing wind farm plus the

proposed additional 15-years of operations. This allows for an overall calculation of the carbon balance savings of the Knockastanna Wind Farm. **Annex 8.1** detail the inputs to the model.

Based on the Scottish Windfarm Carbon Assessment Tool, during the manufacturing of turbines, and construction and decommissioning of the turbines 5,316 tonnes of CO_2 will be lost to the atmosphere. Losses during the decommissioning phase will be due to reduced carbon fixing potential and losses from soil organic matter. Values for turbine life are presented in **Annex 8.1**.

In total, it is estimated that 5,968 no. tonnes of CO_2 will be displaced over the overall lifetime (including the proposed 15-year extension) of the wind farm i.e. 205.7 no. tonnes of CO_2 per annum, which assists in realising the ambitious goals of the Climate Action Plan 2021. From an operational perspective, the proposed development will displace the emission of CO_2 from other less clean forms of energy generation and will assist Ireland in meeting its renewable energy targets and obligations. The burning of fossil fuels for energy creates greenhouse gases, which contributes significantly to climate change. These and other emissions also create acid rain and air pollution.

For the proposed continued operation of the existing wind farm development with 4 no turbines assuming a turbine power rating of 1.5MW, the 'payback' time for the manufacture, construction and decommissioning phases (including carbon losses from soil, felling of forestry etc.) of the wind farm is estimated at approximately 1.7-years. This payback period has already been achieved with the operation of the existing wind farm.

Origin of Losses	**Total CO_2 Losses (tonnes CO_2 equivalent)**
Turbine manufacture, construction and decommissioning	5,316
Losses from soil organic matter	28
Losses due to Backup	617
Felling of Forestry	0
Other	0
Total Expected Losses	5,968
Emission Savings	**Expected CO_2 emission savings (tonnes CO_2 per Annum)**
Fossil fuel mix electricity generation	3,548
Energy Output from Wind Farm	**MWh**
Estimated Annual Output	7,253
Estimated Lifetime Output	228,636
Carbon Payback Time	**Years**
Fossil fuel mix of electricity generation	1.7

Table 8.12: Carbon Payback Time

8.5.3 Cumulative Effects

In terms of cumulative impacts, negative effects in relation to air quality would only occur if a large development was being constructed in the vicinity of the proposed

development site. There are 12 no. large developments and a number of housing and agricultural developments within 10km of the site, including:

- Rearcross Quarries, Co. Tipperary. Rearcross Quarries is currently operational and are located c. 2.5km from the site. During the operational phase of both projects, the emissions of the proposed development will be significantly less than the emissions from the quarry as there will only be operational maintenance vehicles servicing the proposed development. These effects are considered to be imperceptible in significance.
- Lackamore Quarry, Co. Limerick. Lackamore Quarry is currently operational and are located c. 2.5km from the site. During the operational phase of both projects, the emissions of the proposed development will be significantly less than the emissions from the quarry as there will only be operational maintenance vehicles servicing the proposed development. These effects are considered to be imperceptible in significance.
- Garracummer Wind Farm, Co. Tipperary. – Garracummer Wind Farm is an operational wind energy development located c. 3.6km from the proposed development site. During the operational phase of both projects, the emissions of the proposed development will be similar to the emissions from Garracummer Wind Farm as there will be only operational maintenance vehicles servicing the respective developments. These effects are considered to be imperceptible in significance.
- Mienvee Wind Turbine, Co. Tipperary. – The Mienvee Wind Turbine is a single operational wind turbine located c. 4.1km from the proposed development. During the operational phase of both projects, the emissions of the proposed development will be similar to the emissions from the singular turbine as there will be only operational maintenance vehicles servicing the respective developments. These effects are considered to be imperceptible in significance.
- Hollyford Wind Farm, Co. Tipperary. – the Hollyford wind farm is an operational wind farm located c. 9.2km from the proposed development. During the operational phase of both projects, the emissions of the proposed development will be similar to the emissions from Hollyford Wind Farm as there will be only operational maintenance vehicles servicing the respective developments. These effects are considered to be imperceptible in significance.
- Glenough Wind Farm, Co. Tipperary. – Glenough Wind Farm is an operational wind farm located c. 9.3km from the proposed development. During the operational phase of both projects, the emissions of the proposed development will be similar to the emissions from Glenough Wind Farm as there will be only operational maintenance vehicles servicing the respective developments. These effects are considered to be imperceptible in significance.
- Glencarbry Wind Farm, Co. Tipperary. – Glencarbry Wind Farm is an operational wind farm located c. 8km from the proposed development. During the operational phase of both projects, the emissions of the proposed development will be similar to the emissions from Glencarbry Wind Farm as there will be only operational maintenance vehicles servicing the respective developments. These effects are considered to be imperceptible in significance.
- Cappawhite Wind Farm A and B, Co. Tipperary. - Cappawhite Wind Farms (Cappawhite A and B) are operational wind farms located c. 6km from the proposed development. During the operational phase of both projects, the emissions of the proposed development will be similar to the emissions from Cappawhite Wind Farm as there will be only operational maintenance vehicles

servicing the respective developments. These effects are considered to be imperceptible in significance.

- Turraheen Upper Wind Turbine, Co. Tipperary. – the Turraheen Upper Wind Turbine is a single operational turbine c. 10km from the proposed development. During the operational phase of both projects, the emissions of the proposed development will be similar to the emissions from the singular turbine as there will be only operational maintenance vehicles servicing the respective developments. These effects are considered to be imperceptible in significance.
- Castlewaller Wind Farm, Co. Tipperary. – Castlewaller Wind Farm is a permitted wind farm but has not been constructed. Cumulative negative or adverse effects in terms of emissions associated with the construction of the permitted development, in combination with the existing wind farm, are considered to be short term in duration and imperceptible in significance given the significant distance between both developments. During the operational phase of both projects, the emissions of the proposed development will be similar to the emissions from Castlewaller Wind Farm as there will be only operational maintenance vehicles servicing the respective developments. These effects are considered to be imperceptible in significance.
- Upperchurch Wind Farm, Co. Tipperary. – Upperchurch Wind Farm is a permitted wind farm but has not been constructed. Cumulative negative or adverse effects in terms of emissions associated with the construction of the permitted development, in combination with the existing wind farm, are considered to be short term in duration and imperceptible in significance given the significant distance between both developments. During the operational phase of both projects, the emissions of the proposed development will be similar to the emissions from Upperchurch Wind Farm as there will be only operational maintenance vehicles servicing the respective developments. These effects are considered to be imperceptible in significance.

Following a review of these developments, it is considered that the proposed development is not likely to act cumulatively in terms of dust, due to the separation distances to other projects as any dust is likely to settle within c. 50m of the source and PM_{10} and vegetation effects are only likely within 15m.

8.6 Mitigation & Monitoring Measures

8.6.1 Air Quality

The following mitigation measures have been prescribed for the proposed wind farm operational extension of life:

8.6.1.1 Construction Phase

As the construction of the Knockastanna Wind Farm is complete, no construction phase effects will occur.

8.6.1.2 Operational Phase

As the operation of the existing wind farm for an additional 15-years will have an overall positive impact on air quality, additional mitigation measures are considered unnecessary. However, during construction-like activities associated with the re-mounting of turbine T05, the following mitigation measures will be implemented:-

- A water bowser will be available to spray work areas and haul roads, especially during periods of dry weather, in order to suppress dust migration from the site;
- All loads which could cause a dust nuisance will be covered to minimise the

potential for fugitive emissions during transport;
- Any exposed areas will be vegetated to stabilise surfaces as soon as practicable.
- The access and egress of plant, machinery and vehicles will be controlled to designated locations, along defined routes, with all vehicles required to comply with onsite speed limits;
- Plant and machinery will be serviced and in good working order;
- All vehicles will be required to switch off engines when stationary (no idling); and
- Exhaust emissions from plant & machinery operating within the site will be controlled by the contractor by ensuring that emissions are minimised through regular servicing of machinery.

8.6.1.3 Decommissioning Phase

Mitigation measures similar to the construction phase of the original wind farm. Industry standard decommissioning mitigation measures include:-

- A water bowser will be available to spray work areas and haul roads, especially during periods of dry weather, in order to suppress dust migration from the site;
- All loads which could cause a dust nuisance will be covered to minimise the potential for fugitive emissions during transport;
- Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.
- The access and egress of vehicles will be controlled to designated locations, along defined routes, with all vehicles required to comply with onsite speed limits;
- Plant and machinery will be serviced and in good working order;
- Wheel washing facilities will be provided at the entrance/exit point of the proposed wind farm site; and
- The developer in association with the contractor will be required to implement a dust control plan as part of the Decommissioning Plan.

8.6.2 Climate

It is considered that the proposed extension of operation of the existing wind farm will have an overall positive impact in terms of carbon reduction and climate change. It will assist Ireland in meeting the new binding renewable energy target for the EU of 32% by 2030. Also, it will aid in increasing the onshore wind capacity, as per the Climate Action Plan 2021. In terms of renewable energy, an increase in electricity generated from renewable sources is to increase to 70% by 2030, with up to 8.2GW of increased onshore wind capacity. This will be achieved by:

- Phasing out fossil fuels;
- Harnessing renewable energy;
- Micro-generation; and
- Other measures.

In terms of the operational phase, the continued operation of the existing wind farm will have a positive effect on climate due to the displacement of fossil fuels.

8.7 Residual Effects

8.7.1 Air Quality

Following the implementation of the above mitigation measures, the proposed continued operation of the existing wind farm, the only impacts envisaged during the operational period are related to vehicle emissions from maintenance vehicles and no significant impacts are anticipated.

During operations, the proposed extension of operation to the existing wind farm will result in the avoidance of emissions from fossil fuel generators which is a positive effect on air quality.

8.7.2 Climate

There will be residual positive impacts from the continued operation of the existing wind farm in terms of the displacement of fossil fuel energy generation with renewable energy.

8.8 Summary

It is assessed that the proposed development will result in an imperceptible adverse effect upon air and climate during the proposed additional 15-years of operations; while the continued operation will result in a positive effect in terms of renewable energy generation and continued contribution to reduced fossil fuel reliance.