4 POPULATION AND HUMAN HEALTH

4.1 INTRODUCTION

4.1.1 Background and Objectives

This Chapter of the EIAR assesses the impacts of the Project (**Figure 1.2**) on population and human health. The Project refers to all elements of the application for the construction of Letter Wind Farm (**Chapter 2: Project Description**). Where negative effects are predicted, the chapter identifies appropriate mitigation strategies therein. The assessment considers the potential effects during the following phases of the Project:

- Construction of the Project
- Operation of the Project
- Decommissioning of the Project

This Chapter of the EIAR is supported by Figures in **Volume III** and the following Appendix document provided in **Volume IV**:

- **Appendix 4.1: Shadow Flicker Assessment**

4.1.2 Statement of Authority

This chapter has been prepared by Jennings O'Donovan & Partners Limited. It was prepared by Ms. Shauna Conlon, Ms. Aileen Byrne, and reviewed by Mr. David Kiely.

Shauna Conlon is an Environmental Scientist with JOD who holds a First-Class Honours Degree (BSc. Hons) in Environmental Science from the Institute of Technology, Sligo. Since joining JOD, she has developed experience in a range of sectors through various projects with a current focus within the environment and renewable energy sector. Shauna's key capabilities include the preparation of Appropriate Assessments, Environmental Impact Assessments, and Geographic Information Systems.

Aileen Byrne is an Environmental Scientist, who holds a Bachelor (Hons) Degree in Geography and Information Technology from the National University of Ireland, Galway, and a Higher Diploma in Environmental Science from the University of Limerick. She forms part of the Environmental team responsible for preparing the EIAR Chapters. Aileen has experience in writing EIARs, Feasibility Studies and in Shadow Flicker analysis.

David Kiely has undertaken EISs/ EIARs for wind farms throughout Ireland. He has 41 years' experience in the civil engineering and environmental sector and has obtained a Bachelor of Engineering Degree in Civil Engineering and a Master of Science degree in Environmental Protection. David has overseen the development of over 60 wind farms from feasibility,

planning and environmental assessment through to construction, including the preparation of population and human health chapters for other wind farms.

4.1.3 Relevant Legislation and Guidance

The population and human health section of this EIAR is carried out in accordance with legislation and guidance contained in **Chapter 1: Introduction** and **Planning Statement**. The design and construction of the Project including the installation of associated equipment such as switchgear and substations is governed by the 2005 Safety, Health and Welfare at Work Act, The Safety, Health and Welfare at Work (General Application) Regulations 2021 and also by S.I. 291 The Safety, Health and Welfare at Work (Construction) Regulations, 2013 as amended.

The Revised EIA Directive Consultation (revised EIA Directive 2014/52/EU) (Section 1.2.2) states that:

"*It is intended that the consideration of the effects on populations and on human health should focus on health issues and environmental hazards arising from the other environmental factors, for example water contamination, air pollution, noise, accidents, disasters, and not requiring a wider consideration of human health effects which do not relate to the factors identified in the Directive*".

4.1.4 Assessment Structure

In line with the EIA Directive as amended and current EPA guidelines the structure of this chapter is as follows:

- Assessment Methodology and Significance Criteria – a description of the methods used in desktop surveys and in the assessment of the significance of effects;
- Baseline Description – a description of the socio-economic profile of the local area of the Development, i.e., of local electoral areas and of County Leitrim and based on a desk-based study using Central Statistics Office (CSO) data;
- Assessment of Potential Effects – including the "Do Nothing" scenario and identifying the ways in which the population and human health of the area could be affected by the Development during the construction, operational and decommissioning stages;
- Mitigation Measures and Residual Effects – a description of measures recommended to avoid, prevent, reduce or, if necessary, offset any potential significant adverse effects and a summary of the significance of any residual effects of the Development after mitigation measures have been implemented;

- Cumulative Effects – identifying the potential for effects of the Development to combine with those from other existing, permitted and/or proposed projects as listed in **Chapter 2: Project Description** of this EIAR, to affect the population and human health;
- Summary of Significant Effects, and
- Statement of Significance.

With respect to the EIA Directive as amended, Section 1.2.2 (outlined in Section 4.1.3), amalgamates the findings of other assessments undertaken as part of the EIA process. Limited interactions with Human Health are possible and consideration has been given to the findings of the following assessments:

- Chapter 8: Soils and Geology
- Chapter 9: Hydrology and Hydrogeology
- Chapter 10: Air and Climate
- Chapter 11: Noise and Vibration
- Chapter 15: Traffic and Transportation
- Chapter 16: Major Accidents and Natural Disasters

Where appropriate, mitigation measures have been proposed to avoid, prevent, reduce or, if necessary, offset any identified significant adverse effects.

All activities carried out by the appointed Contractor of the Development will be in accordance with the requirements of the Safety, Health and Welfare at Work Act 2005 as amended and Regulations made under this Act.

4.1.5 Scope of the Assessment

The effect of a development on population and human health includes the following broad areas of investigation:

- Population and Settlement Patterns
- Economic Activity and Tourism
- Employment
- Topography and Land Use
- Health Impacts of Wind Farms
- Property Value
- Natural Disaster and Major Accidents

Where a significant negative impact can be foreseen, it is prevented, reduced, avoided or, if necessary, offset by way of practical mitigation measures.

This assessment considers the following criteria:

- Sensitive receptors in the area
- Existing land use in the area
- General amenities in the area
- Potential effects from water, noise, shadow flicker, air quality and traffic

4.2 ASSESSMENT METHODOLOGY

In line with the EIA Directive as amended and current EPA guidelines, this Chapter includes the following elements:

- Details of Methodologies utilised in the context of legal and planning frameworks
- Baseline Descriptions
- Assessment of Potential Effects (construction, operational and decommissioning stages)
- Detailed Mitigation Measures
- Assessment of Cumulative Impacts
- Summary of Significant Effects and Statement of Significance

A desk study was undertaken using the Central Statistics Office (CSO) data along with a review of the Leitrim County Development Plan 2023-2029. Consideration was also given to the 2015[1] report produced by the EPA entitled 'Investigation into the Assessment of Health Impacts within National Environmental Regulation Processes' that outlines how human health impacts are dealt with, throughout the European Union (EU) by environmental regulators with an emphasis on the role at the planning / environment interface.

4.2.1 Definition of Study Areas

Two geographical Study Areas have been outlined for this assessment. While the greater geographical Study Area (2) provides a baseline of statistical data for this chapter, it is not considered for local impacts of this assessment. The two Study Areas as shown in **Figures 4.1 and 4.2** are outlined below:

Study Area 1: The Site and Environs – District Electoral Divisions (DEDs) Arigna/Drumkeeran/Killarga, and Belhavel.

The extent of the Study Area 1 can be seen in **Figure 4.1**. In order to make inferences about the population and other statistics in the vicinity of the Site, DEDs were analysed. The entire wind farm Site comes under one Municipal Division (MD), Manorhamilton and electoral

[1] Golder Associates (2015) *Investigation into the Assessment of Health Impacts within National Environmental Regulation Processes*. Available online at: http://www.epa.ie/pubs/reports/research/health/assessmentofhealthimpactsreport.html, [Accessed on 02/11/22]

division (ED) Arigna/Drumkeeran/Killarga that can be separated into distinct townlands, Letter, Boleybaun and Stangaun. The grid connection route also extends into the ED of Belhavel which can be separated into the distinct townlands of Letter, Greaghnadarragh, Stangaun, Corralustia, Turpaun, Gortnasillagh West, Lugmeeltan, Leckaun, Lisgaveen, Treannadullagh, Drumcashlagh and Corderry. The surrounding area is largely rural, with a mixture of agricultural grassland, commercial forestry plantations, private and public roads. Isolated residences and homesteads are also scattered throughout the area.

Study Area 2: **Leitrim** (1,589km^2). The entirety of the Development is located within Study Area 2.

Descriptive terminology for impact assessment follows the systematic method of description of the EPA Guidelines (2022), as outlined in **Chapter 1: Introduction**, **Table 1.4**.

4.2.2 Consultation

Consultation with relevant organisations was initiated during the initial stage of the EIA to identify any effects that could be initiated by the Development. A summary of the findings is detailed in **Table 4.1**.

Table 4.1: Summary of Consultation Response on Human Health

Consultation response on Human Health		
Fáilte Ireland	Email in Response to Scoping Report received on 19th April 2023.	The topics for consideration of impact are prescribed in the EIA Directive and transcribed into Irish law by the European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 (S.I. No. 296 of 2018). Impact assessment should contain the likely significant effects of a development arising from both construction and operation of a development. Advice on describing the effects is contained within the Draft Guidelines and includes the quality, significance, extent, probability, type and duration of the effect, with particular descriptors for each. In describing effects upon tourism receptors these descriptors should take account of the particular aspects and sensitivities of tourism, for example a temporary annual effect from a development may have different impacts upon tourism if it falls at peak season rather than off-peak.

Consultation response on Human Health		
		Impact assessment should be carried out as per EPA guidelines and the best practice for that prescribed topic. Population and Human Health The consideration of tourism projects within the Population and Human Health is extensive, with impacts ranging from rural employment population impacts of seasonal tourism, to the health impact of air pollution from increased traffic in urban areas. The impact upon tourism can be considered within this section through the sensitivities of Hospitality, Safety and Pace of Life. Changes in population can impact the perception of pace of life or safety in a particular location. Impacts upon these issues in areas which rely heavily on tourism or have a particular sensitive tourism generator should be considered in this section.
Leitrim County Council	Scoping response received on 22nd May 2023.	The following in relation to population and human health was noted: **Section 4 – Economic Development –** sets out the policy framework for the economic development of the county across a number of sectors including tourism, rural-based enterprise and employment, infrastructural and renewable energy. **Section 5 – Tourism** contains a number of policies and objectives targeting tourism development within the county including the development of amenity and recreational assets/facilities and harnessing the county's natural and heritage resources in a sustainable manner for tourism activities. The views of prescribed bodies such as Fáilte Ireland are also recommended to be solicited in the preparation of any forthcoming EIAR on this proposed development. **Population and Human Health –** the EIAR shall include an assessment of the likely significant effects of the proposed development on issues such as population, human health,

Consultation response on Human Health		
		employment and economic activity, residential amenity, community facilities and services, tourism, property values, shadow flicker, noise and health and safety. Suitable mitigation measures shall also be identified in any submitted EIAR.

4.3 BASELINE DESCRIPTION

4.3.1 Population and Settlement Patterns

Study Area 1: The Site and Environs (DEDs Arigna/Drumkeeran/Killarga and Belhavel)

The extent of Study Area 1 can be seen in **Figure 4.1**. There are no defined community settlements with a population greater than 2,500 within the 10km radius of the Development. Carrick-on-Shannon which has a population of 4,743[2] persons is approximately 23km south-east of the Development. The nearest centres of population to the Site are Sligo Town, Co. Sligo, 21km distant to the northwest which has a population of 20,608 and Cavan Town, Co. Cavan, 56km distant south-east which has a population of 11,741 persons. The surrounding area is largely rural, with a mixture of agricultural grassland, commercial forestry plantations, private roads and public roads. Isolated residences and farmsteads are also scattered throughout the area. Nearby settlements include the villages of Drumkeeran 2.9km east, Dromahair 9km north-west, and Ballintogher 11km north-west.

Over the last five years, Leitrim County Council have granted planning permissions in the Arigna/Drumkeeran/Killarga and Belhavel electoral division areas which include one off housing, alterations to existing dwelling houses, agricultural buildings, GAA dressing rooms extension[3]. The 2022 Census statistics note a total population of 915 in the two electoral division areas.

All inhabited dwellings are located at a distance of over 700m from any of the proposed turbines. There are 17 properties within 1.5km of the turbines. In 2022, the total population in the Arigna/Drumkeeran/Killarga ED was 618, of which Males numbered 317 and Females were 301, while the total population in Belhavel was 297, of which Males numbered 154 and females were 143. In 2022 the total number of private households was recorded as 391 across the two ED's. The Site and its wider environs are classified as '*Valley Farmland'* and '*Moorland Hills*' (Landscape Character Types) in the Leitrim County Development Plan 2023-

[2] Central Statistics Office (CSO). Data. Available online at https://data.cso.ie/. [Accessed on 12/10/23].
[3] Leitrim County Council. *Planning Map Search* Available online at: http://www.leitrimcoco.ie/eng/services_a-z/planning-and-development/online-planning-search/ [Accessed 02nd November 2022]

2029[4]. Although population concentrations are lower in these areas, there is a more stable population base and less evidence of population decline than other parts of the County.

Study Area 2: Leitrim County

County Leitrim has the lowest population of any county in Ireland. The total population in the 2022 CSO for County Leitrim was 35,199, of which Males numbered 17,553 and Females were 17,646. Leitrim showed a higher percentage increase in population (10%) (since 2016) than the national rate (8%). The population density is 22 persons per km^2. The total number of private households was 13,630 in 2022, a 9.5% increase since 2016.

County Leitrim is predominantly a rural county with a low population density and a relatively high dependency rate, meaning that the proportion of its population of non-working age (young and old) is comparatively high. This has resulted in a narrow base of economic activities but a relatively high proportion of jobs within knowledge sectors and a high proportion of entrepreneurial activity.

The extent of County Leitrim can be seen in **Figure 4.1**. There are a number of towns and villages geographically spread throughout County Leitrim. These settlements number 14 and provide essential services for the local communities and the rural hinterlands. The different settlement tiers perform differing roles with the result that no area in the county is significantly peripheral or isolated. Within the county, 89.3% of the population reside in rural areas and outside of defined urban areas (i.e. towns with population in excess of 1,500). The largest town within the county is Carrick-on-Shannon and is the only defined urban centre in the county having recorded a population of 4,743 in the 2022 Census of Population.

Carrick-on-Shannon is the predominant driver of employment within the county and as such has a significant employment base. The strategic location of the town on the N4 Dublin to Sligo National Primary Road and on the Dublin to Sligo rail line plays a key role in the strong economic performance of the town. According to the Census 2016 there are 1,740 people residing in Carrick-on-Shannon who are classed as being 'At Work'. The town of Carrick-on-Shannon is considered a Key Town. This is a key destination, along transportation corridors and is economically active in the surrounding area.

[4] Leitrim County Development Plan 2023-2029 Available online: https://www.leitrimcoco.ie/eng/services_a-z/planning-and-development/development-plans/1-volume-i-written-statement-copy-final.pdf [Accessed 18/04/23]

4.3.2 Economic Activity

4.3.2.1 Primary Sectors

Study Area 1: The Site and Environs (DEDs Arigna/Drumkeeran/Killarga and Belhavel)

The main sectors in this Study Area are professional services, commerce and trade, and manufacturing industries. These ED areas also exhibit characteristics of a weaker economic structure.

Study Area 2: Leitrim County

County Leitrim has a narrow base of economic activities but a relatively high proportion of jobs within knowledge sectors and a high proportion of entrepreneurial activity. Migration to nearby centres for work and study has also been a feature, and the county has seen appreciably large inward migration for work in foreign direct investment activities. The number of persons 'At work' in Leitrim increased by 2,088 no. between 2016-2022 (16.4%).

The CSO analysis has also shown the relative strength of indigenous employers. The largest employer within County Leitrim is medical device manufacturer Vista Med in Carrick-on-Shannon who have expanded their operations over the past 5 years. The Carrick Business Campus is a regional asset with significant further employment potential. This asset features prominently in the Strategic Economic Development Objectives, Appendix III of the Leitrim County Council Development Plan 2023-2029 as a resource that can be promoted to achieve large-scale high value employment for the county and within the wider region.

4.3.3 Employment

4.3.3.1 Study Area 1: The Site and Environs (DEDs Arigna/Drumkeeran/Killarga and Belhavel)

Although population concentrations are lower in these areas, there is a more stable population base and less evidence of population decline than other parts of the County. Detailed information on employment for such a small area is unavailable. It is assumed that the majority of those residing within this area would travel outside of it for employment. Please see Section 4.3.3.2 for more information on employment within the county.

4.3.3.2 Study Area 2: Leitrim County

According to the CSO 2022, there was 14,816 persons over the age of 15 in the labour force in County Leitrim. The three largest employers were Professional Services, Commerce and Trade, and Manufacturing Industries which employed 8,558 persons. **Table 4.2** sets out employment by Industry in Leitrim County in 2022.

Table 4.2: Leitrim County Employment by Industry (2022)

Industry	No. Persons
Agriculture, forestry and fishing	1,008
Building and construction	925
Manufacturing industries	1,860
Commerce and trade	2,859
Transport and communications	744
Public administration	1,440
Professional services	3,839
Other	2,141

4.3.4 Land Use

4.3.4.1 Study Area 1: The Site and Environs (DEDs Arigna/Drumkeeran/Killarga,and Belhavel)

County Leitrim is located in the Northern and Western Regional Assembly and is bordered by counties Sligo, Donegal, Fermanagh, Cavan, Longford, and Roscommon. The Site is located within the electoral area of Arigna/Drumkeeran/Killarga which which supports 85 farm holdings; with the average size of holding 27ha. The main livestock farmed are sheep[5]. The grid connection also extends into the ED of Belhavel which supports 48 farm holdings; with the average size of the holding 23.7ha.

Arc GIS Pro was used to calculate an area of 19.8ha of forestry within Study Area 1. The majority of the forestry within Study Area 1 was classed as 'Coniferous forest' according to CORINE Land Cover (Copernicus)[6].

4.3.5 Tourism

4.3.5.1 Tourist Attractions

Study Area 1: Development Site and Environs (10km)

The Miners Way and Historical Trail which passes through the settlement of Drumkeeran located 2.9km east of the Site is a popular network of way-marked routes through the picturesque hills and valleys of counties Leitrim, Sligo and Roscommon. The route follows many of the paths used by the miners going to work in the Arigna Coal Mines in County Roscommon. The Miners Way is a part of the Beara to Breifne Way, Ireland's longest national

[5] AgriMap 2020, CSO, https://visual.cso.ie/?body=entity/ima/coa, Accessed 02/11/2022.
[6] Environmental Protection Agency Maps https://gis.epa.ie/EPAMaps/ [Accessed Online 02/11/2022]

waymarked walking/cycling trail. The Way runs almost the length of the country and takes walkers and cyclists to some of Irelands most beautiful and least explored areas; including the coast of the Beara Peninsula, across six mountain ranges, along the banks of the River Shannon, and through the lake regions of Roscommon and Leitrim.

Study Area 2: Leitrim County

Tourism in County Leitrim is an important industry based on its rich natural and built heritage. Many areas that are important to the tourist industry of County Leitrim owe their attraction to the county's natural assets which are characterised by an abundance of tourist attractions, cultural and built heritage, village life, water-based benefits, visitor amenities and vitality with a charming sense of identity[7]. There are a number of policies and objectives in the Development Plan 2023-2029 which seek to promote tourism in the county. These include: Tour Pol 1 '*To support the development of new strategic tourism attractions that can create 'experiences' as motivational 'must do' signature experiences to draw visitors to the county, in a manner consistent with Leitrim's own brand identity*' and Tour Obj 4 '*To utilise the county's natural and heritage resources to foster the development of tourism as a viable sustainable sector of the economy, in a sustainable manner, which complements the scale, quality and unique features of the county.'*

4.3.5.2 Tourism: Numbers and Revenue

Study Area 2: Leitrim County

The Border Region includes the Counties of Leitrim, Sligo, Donegal, Cavan, and Monaghan. Regional Performance figures for the 2019 Border Region show overseas tourist numbers for this region totalled 768,000 in 2019 and tourist revenue accounted for €259,000,000 from overseas tourists. Domestics visitors from the island of Ireland accounted for 1,786,000 visits to the region in 2019, with €352,000,000 in revenue generated from domestic visitors[8].

County Leitrim is home to a number of nationally renowned visitor attractions including; Arigna Mining Experience, Drumshanbo Distillery, Moon River Cruises, the Miners Way and Historical Trail, and the Leitrim Way. Leitrim is also included in 'Ireland's Hidden Heartlands'. Fáilte Ireland has developed a clearly-defined programme for Ireland's Hidden Heartlands which is centred around rural communities and their lifestyles, as well as the many spaces

[7] County Development Plan 2023, Section 5, http://www.leitrimcoco.ie/eng/services_a-z/planning-and-development/development-plans/leitrim-county-development-plan-2023-%E2%80%93-2029/volume-i-written-statement.pdf [Accessed Online 02/11/2022]
[8] Key Tourism Facts 2019, Failte Ireland, March 2021, https://www.failteireland.ie/FailteIreland/media/WebsiteStructure/Documents/3_Research_Insights/4_Visitor_Insights/KeyTourismFacts_2019.pdf?ext=.pdf , accessed 02/11/2022

for adventure and relaxation in this region. This agenda will assist in attracting visitors 'off the beaten track' and create an internationally compelling visitor experience[9].

4.3.5.3 Visitors Attitudes to Wind Farms

The first wind farm in Ireland was completed in 1992 at Bellacorrick, Co. Mayo and since then wind farms have elicited a range of reactions from Irish people (Failte Ireland, 2012). In 2002, Sustainable Energy Ireland (SEI) now the Sustainable Energy Authority of Ireland (SEAI) commissioned a survey aimed at identifying public attitudes to renewable energy, including wind energy in Ireland[10]. The 2002 survey found that, in general, Irish people are positively disposed towards the development of wind farms. However, the survey also indicated that people will not accept wind farms everywhere and that special care should be taken so that wind farms respond to contextual landscape characteristics.

Ireland's scenery has been a cornerstone of international tourism marketing campaigns for decades. In 2012, 91% of overseas holidaymakers to Ireland rated scenery as an important part of a destination with natural/unspoilt environment also rated highly at 91%. The future sustainability of Ireland's tourism industry is therefore inextricably linked to the maintenance of the character and scenic qualities of the Irish landscape.

Fáilte Ireland, in association with the Northern Ireland Tourist Board (NITB), decided in 2007 (67 wind farms established) to survey both domestic and overseas holidaymakers to Ireland to determine their attitudes to wind farms. The survey drew on many aspects of the original SEI survey including the photomontages of wind farms, and in particular, the landscape types that were used to elicit a reaction from respondents. The purpose of the survey was to assess whether or not the development of wind farms would impact on the visitors' enjoyment of Irish scenery. In 2012, this research was updated by Millward Browne Landsdowne on behalf of Fáilte Ireland to determine if there was any change in visitor attitudes during this period.

The 2012 research indicated that 47% of visitors felt an increased positive impact on landscape, compared to 32% in 2007. Negative responses also increased, showing 30% in 2012 against 17% in 2007. However, 49% of visitors felt that wind farms had no impact on the landscape in 2007 in comparison to 23% in 2012. It was notable that those interviewed who did not see a wind farm during their trip held more negative perceptions and opinions on wind farms to those that did. Of the wind farms viewed, the majority (59%) contained less than ten turbines in 2012, which was quite similar to 2007 (63%).

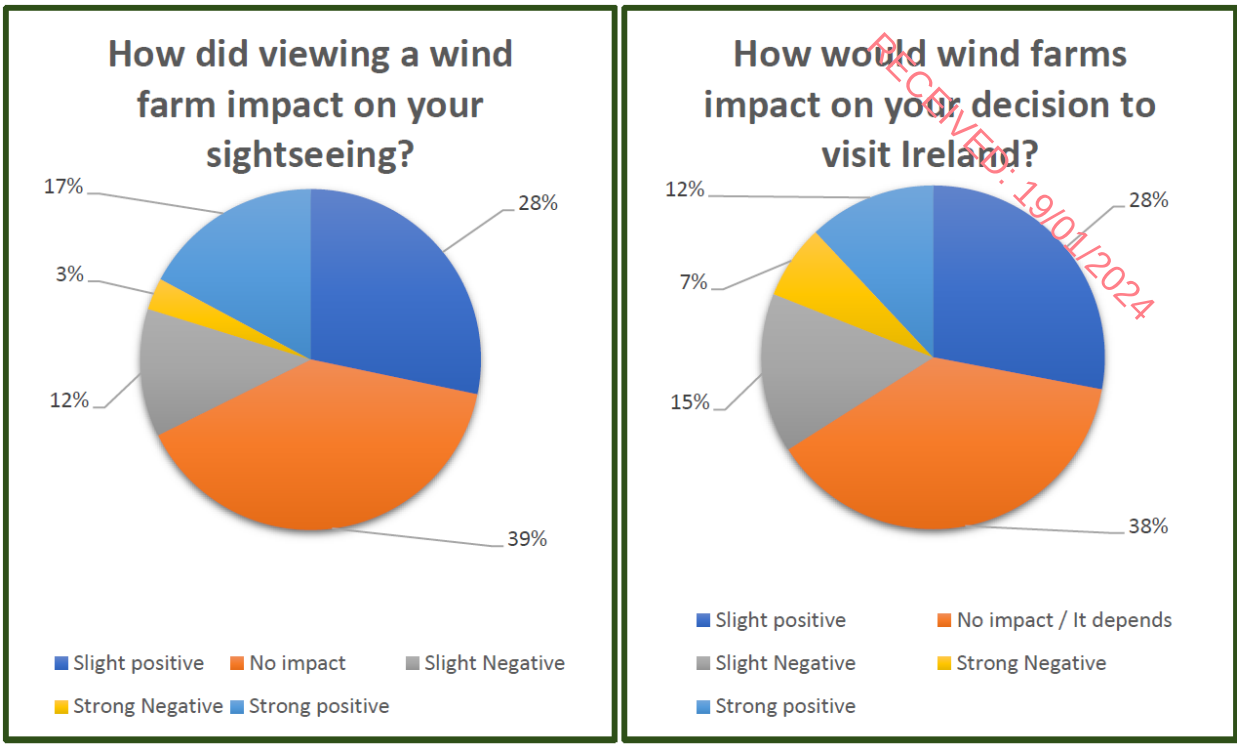
[9] Ireland's Hidden Heartlands, Failte Ireland, Available online at https://www.failteireland.ie/IrelandsHiddenHeartlands.aspx [Accessed on 02/11/2022]
[10] Sustainable Energy Ireland (2003), Attitudes towards the Development of Wind Farms in Ireland, Dublin

Despite the fact that there has been an increase in the number of visitors who have seen at least one wind farm on their holiday, there was also a slight increase (from 45% in 2007 to 48%) in the number of visitors who felt that this had no impact on their sight-seeing experience. Importantly, and as has been seen in the previous research, the type of landscape in which a wind farm is sited can have a significant impact on attitudes. Although 21% feel that wind farms have a fairly or very negative impact on sight-seeing, this figure increases substantially for wind farms in coastal areas (36%).

Visitors were again asked to rate the beauty of five different yet typical Irish landscapes: coastal, mountain, farmland, bogland and urban industrial land, and then rate the scenic beauty of each landscape and the potential impact of siting a wind farm in each landscape. As in 2012, the results indicate that each potential wind farm and site must be assessed on its own merits, due to the scenic value placed on certain landscapes by the visitor and the preferred scale/ number of wind turbines within a wind farm. Looking across all landscapes, wind farms are seen to have an enhancing effect on the landscapes seen as less beautiful, particularly urban/ industrial and bogland.

Coastal areas (91%) followed by mountain moorland (83%) and fertile farmland (81%) continue to be rated as the most scenic, and unsurprisingly resistance is greatest to wind farms in these areas. For instance, there was a greater relative negativity expressed about potential wind farms on coastal landscapes (40%), followed by fertile farmland (37%) and mountain moorland (35%). On the other hand, less than one in four were negatively disposed to the construction on bogland (24%) or urban industrial land (21%). The majority of visitors also still favour large turbines (47%) over small turbines (28%), and in smaller numbers, with the option of five turbines proving the most popular, followed by two clusters of ten and finally wind farms of 25 turbines.

Seven out of ten (or 71%) visitors claim that potentially greater numbers of wind farms in Ireland over the next few years would have either no impact or a positive impact on their likelihood to visit Ireland (**Graph 4.1**). Of those who feel that the potentially greater number of wind farms would impact positively on future visits, the key driver is support for renewable energy, followed by potential decreased carbon emissions. Given the scenario where more wind farms will be built in Ireland in the future, the most widely held view is that this will not impact their likelihood to visit the area again, with a slightly greater majority saying that this would have a positive rather than a negative impact.



Graph 4.1 Visitors Attitudes on the Environment – Wind Farms. Source: Fáilte Ireland (2008)

Fáilte Ireland carried out research on Overseas Holidaymakers Attitudes to Ireland in 2018. It noted holiday makers choice is based largely on *beautiful scenery* (93%), followed closely by *plenty to do and see* (91%) and *friendly people* and *natural attractions* (88%). BiGGAR Economics carried out research in Scotland on 28 wind farms and tourism trends (2017)[11]. No pattern emerged that would suggest that onshore wind farm development has had a detrimental impact on the tourism sector, even at a very local level. No relationship was identified between the development of onshore wind farms and tourism employment at the level of the Scottish economy, at local authority level nor in the areas immediately surrounding wind farm development.

4.3.6 Human Health

Common concerns around wind farms in terms of human health are generally associated with electromagnetic fields, shadow flicker and noise. These topics are considered in this assessment in addition to air quality and water contamination, and traffic.

[11] BiGGAR (2017) Wind Farms and Tourism Trends in Scotland. Available online at: https://biggareconomics.co.uk/wp-content/uploads/2020/01/Wind-farms-and-tourism-trends-in-Scotland.pdf [Accessed on 02/11/2022]

4.3.6.1 General Health of Population

Human health of communities can vary greatly owing to a number of factors including susceptibility to disease, location, income inequality, access to health care etc. In 2022 the Department of Health published "Health in Ireland – Key Trends 2022" which shows population health at the national level presents a picture of decreasing mortality rates and high self-perceived health over the past ten years. Ireland has the highest self-perceived health status in the EU, with 82.1% of people rating their health as good or very good.

The 2022 census data for the general health of the population as shown in **Table 4.4** indicates the health status across all three study areas is "Very Good" to "Good". The 'Very Good' health status for both the Site and Environs (46%), and County Leitrim (52%) is below the national average of 53%.

Table 4.4: Population by General Health (2016)

General Health	The Site and Environs	County Leitrim	Ireland
	Percentage (%)		
Very good	46	52	53
Good	33	31	29
Fair	17	10	9
Bad	2	2	1
Very bad	0	0	0.3
Not stated	2	4	7

4.3.6.2 Electromagnetic Interference

Electromagnetic fields ("EMF") are invisible lines of force that surround electrical equipment, power cords, wires that carry electricity and outdoor power lines. Electric and magnetic fields can occur together or separately and are a function of voltage and current. When an electrical appliance is plugged into the wall, an electric field is present (there is voltage but no current); when that appliance is turned on, electric and magnetic fields are present (there is both voltage and current). Both electric and magnetic fields decrease with distance. Electric fields are also dissipated by objects such as building materials. On a daily basis, people are exposed to extremely low frequency ("ELF") EMF as a result of using electricity.

National and international health and scientific agencies have reviewed more than 35 years of research including thousands of studies. None of these agencies has concluded that exposure to ELF-EMF from power lines or other electrical sources is a cause of any long-term adverse effects on human, plant, or animal health. The International Commission on Non-Ionising Radiation Protection (ICNIRP) Guidelines give a limit of 100µT for sources of AC magnetic fields. This compares to 0.13µT that arises from a 110kV underground cable when directly above it; 1.29µT that arises from a 220kV underground cable when directly above it and 11.4µT that arises from a 400kV AC underground cable that is one metre deep and measured directly above it. This is detailed in information booklet published by ESB in 2017 called "EMF & You" which provides information about Electric & Magnetic Fields and the electricity network in Ireland[12]. It is noted that the "EMF & You" guidance document does not provide electric field values for 20kV power lines. However, the document does note 'the higher the voltage, the stronger the electric field'. Based on this assertion, it can be predicted that the 20kV grid connection for the Development will produce an electromagnetic field of less than 0.13µT (arises from a 110kV underground cable).

In 2014 a study was undertaken in Canada[13], measuring electromagnetic fields around wind farms and the impact on human health. The study found that:

> *"there is nothing unique to wind farms with respect to EMF exposure; in fact, magnetic field levels in the vicinity of wind turbines were lower than those produced by many common household electrical devices and were well below any existing regulatory guidelines with respect to human health"*.

From the limit of 100µT for sources of AC magnetic fields given by the ICNIRP, a comparison of between 0.02µT and 0.41µT arises when turbines operate under "high wind" scenarios.

4.3.6.3 Shadow Flicker

The Department of Energy and Climate Change for England stated in its report Update of UK Shadow Flicker Evidence Base (2011) that it is considered that the frequency of the flickering caused by the wind turbine rotation is such that it should not cause a significant risk to health.

Section 4.6 provides the full assessment of shadow flicker for this EIAR.

[12] EMF & You, ESB, 2017 -Available online at https://esb.ie/docs/default-source/default-document-library/emf-public-information_booklet_v9.pdf?sfvrsn=0. [Accessed 02/11/2022].
[13] Lindsay C McCallum, *et al*. (2014) *Measuring electromagnetic fields (EMF) around wind turbines in Canada: is there a human health concern?*

4.3.6.4 Noise

A study by the EPA in South Australia on low frequency noise near wind farms and in other environments found that *'Overall, the study demonstrates that low frequency noise levels near the wind farms in the study are no greater than levels in urban areas at comparable rural residences away from wind farms'.*

The turbine rotor blades will be fitted with a serrated extension of the trailing edge which will mitigate noise emission by design by effectively breaking up turbulence. Baseline noise measurements were carried out from 24th June and 22nd July 2021. A number of predictions were prepared for layout of the 4 turbine Development. Based on layout, potential noise-sensitive receptors including occupied and un-occupied were identified from maps. Receptor locations were verified through visits to the area. **Chapter 11: Noise** provides an assessment of noise in relation to the Development.

4.3.6.5 Air Quality

Environmental Protection Agency (EPA, 2016), EU and World Health Organisation (WHO, 2014) reports estimate that poor air quality accounted for premature deaths of approximately 600,000 people in Europe in 2012, with 1,200 Irish deaths attributable to fine particulate matter (PM2.5) and 30 Irish deaths attributable to Ozone (O3)[14] [15]. These emissions, along with others including nitrogen oxides (NO_x) and sulphur oxides (SO_x) are produced during the burning of fossil fuels for energy generation, transport or home heating. There are no such emissions associated with the operation of wind turbines.

Traffic disruption to the public during the construction and decommissioning phases of the Project is likely. Transport accounts for a significant portion of pollutants in the atmosphere. Potential impacts are discussed in Section 4.4.6.

Chapter 10: Air and Climate provides an assessment of air quality in relation to the Project.

4.3.6.6 Water Contamination

Contaminants such as sediments arising from the Project have the potential to contaminate water bodies designated for drinking water purposes and may cause ecological damage as well. Mitigations as set out in **Chapter 9: Hydrology and Hydrogeology** will prevent and reduce risk of contamination of waterbodies. The drainage design and surface water network are considered in terms of assimilative capacity, that is to dilute contaminants in receiving

[14] www.euro.who.int/en/health-topics/environment-and-health/air-quality/news/news/2014/03/almost-600-000-deaths-due-to-air-pollution-in-europe- new-who-global-report. [Accessed 02/11/2022].
[15] Irelands Environment 2016 – An Assessment', EPA, 2016. [Accessed on 02/11/22].

waterbodies as a 'last line of defence'. Any contaminants will be treated when water is abstracted for drinking water purposes.

Consultation with GSI well database indicates there are no mapped wells within the Site boundary. Governing industry guidelines stipulate a buffer zone of 250m is required of from boreholes used for drinking water abstraction. The closest mapped wells are more than 5.4km from the boundary of the Site. All houses are over 700m from the Site, therefore can be considered outside the 250m buffer.

Chapter 9: Hydrology and Hydrogeology provides an assessment of the hydrological impacts in relation to the Project, including the potential for water contamination.

4.3.6.7 Traffic

It is proposed that the turbine nacelles, tower hubs and rotor blades will be landed at Killybegs Harbour, County Donegal and will be transported via the N56, N15, N4, R285, R280, and L482 to the site entrance.

Receptors considered as having 'high' sensitivity are primarily premises which are directly on the N56, N15, and R280 which have significant potential to generate traffic.

The sensitive receptors are assessed in **Chapter 15: Traffic and Transportation**.

4.3.6.8 Health Impact Studies

While there are anecdotal reports of negative health effects on people who live near operational wind farms there is no peer reviewed scientific research in support of these views. Several peer reviewed scientific research publications are outlined below.

Frontiers in Public Health published a study[16] in 2014 on wind turbines and human health. This review summarised and analysed the science in relation to this issue specifically in terms of noise (including audible noise, low-frequency noise, and infrasound), EMF, and shadow flicker. The study noted that:

"*Based on the findings and scientific merit of the research conducted to date, it is our opinion that the weight of evidence suggests that when sited properly, wind turbines are not related to adverse health effects. This claim is supported (and made) by findings from a number of government health and medical agencies and legal decisions*".

[16] L. D. Knopper, *et al*. (2014) *Wind turbines and human health*.

The National Health and Medical Research Council, Australia's leading medical research body, concluded that there is no reliable or consistent evidence that wind farms directly cause human health problems as part of their Systematic Review of the Human Health Effects of Wind Farms published in December 2013. The review was commissioned to determine whether there is a direct association between exposure to wind farms and negative effects on human health or whether the association is casual, by chance or bias.

Objectors to wind farms often refer to wind turbine syndrome as a condition that can be caused by living in close proximity to wind farms. The symptoms allegedly include sleep deprivation, anxiety, nausea and vertigo. It has been rejected by the wind industry as there is no scientific backing to these claims. This review began in late 2012 and included a literature and background review of all available evidence on the exposure to the physical emissions produced by wind turbines. These emissions were noise, shadow flicker and electromagnetic radiation produced by wind turbines. The review concludes that the evidence considered does not support any direct association between wind farms and human health problems and that confounding bias could be possible explanations for any reported association.

In general, there are no specific health considerations in relation to the operation of a wind turbine. The area surrounding the turbine base will still be available for use. Noise and Shadow Flicker are operational Health and Safety issues, which have been addressed in **Chapter 11: Noise** and **Section 4.6**.

4.3.6.9 Turbine Safety

Turbines pose no threat to the health and safety of the general public. The Department of the Environment, Heritage and Local Government (DoEHLG)'s '*Wind Energy Development Guidelines for Planning Authorities 2006*' state that there are no specific safety considerations in relation to the operation of wind turbines. Fencing or other restrictions are not necessary for safety considerations. People or animals can safely walk up to the base of the turbines. The DoEHLG Guidelines state that there is a very remote possibility of injury to people from flying fragments of ice or material from a damaged blade. However, most blades are composite structures with no bolts or separate components and the danger is therefore minimised. The build-up of ice on turbines is unlikely to present problems. The wind turbines will be fitted with anti-vibration sensors, which will detect any imbalance caused by icing of the blades. The sensors will prevent the turbine from operating until the blades have been de-iced.

Turbine blades are made of fibre-reinforced polymer or unsaturated polyester, a non-conducting material which will prevent lightning strikes. Lightning protection conduits will be integral to the construction of the turbines. Lightning conduction cables, encased in protection conduits, will follow the electrical cable, from the nacelle to the base of the turbine. The conduction cables will be earthed adjacent to the turbine base. In extremely high wind speed conditions, (usually at Beaufort Storm Force 10 or greater) the turbines will shut down to prevent excessive wear and tear, and to avoid any potential damage to the turbine components.

4.3.7 Property Value

There are currently no Irish studies undertaken to assess the impact of wind farms on property prices. However, a number of studies have been undertaken in the UK, with findings set out in **Table 4.5**.

A study on 'the effect of wind farms on house prices' was undertaken in 2014 by the Centre of Economic Research. The study found that house prices were driven by the property market and not the presence or absence of wind farms [17]. Another study on 'Valuing the Visual Impacts of Wind turbines through House Prices' was undertaken in 2014 by the London School of Economics and it found the presence of wind farms negatively impacted property values within 2km of very large wind farms[18]. However, in 2016, following on from the contrasting results of the two 2014 studies, ClimateXChange carried out their own research in Scotland. The ClimateXChange study found no significant effect on the change in price of properties within 2km or 3km and found the effect to be positive[19]. This study also found that some wind farms can provide economic and amenity benefits to an area.

[17] https://cdn.ymaws.com/www.renewableuk.com/resource/resmgr/publications/reports/ruk-cebr-study.pdf [Accessed 03/11/2022]

[18] http://eprints.lse.ac.uk/58422/1/__lse.ac.uk_storage_LIBRARY_Secondary_libfile_shared_repository_Content_SERC%20discussion%20papers_2014_sercdp0159.pdf [Accessed 03/11/2022]

[19] Heblich, D. S., Olner, D. D., Pryce, P. G. & Timmins, P. C., 2016. *Impact of wind turbines on house prices in Scotland,* Scotland: ClimateXChange. [Accessed 3/11/2022]

Table 4.5: Summary of Research findings between Wind Farms and Property Values

Year	Country	Research Group	Finding
2014	UK	Centre of Economic Research	In summary the analysis found that country-wide property market drives local house prices, not the presence or absence of wind farms; and The econometric analysis established that construction of wind farms at the sites examined across England and Wales has not had a detectable negative impact on house price growth within a 5km radius of the sites.
2014	UK	London School of Economics	There was an average reduction in the value of houses (based on 125,000 house sales between 2000 and 2012) of between 5% and 6% within 2km of very large wind farms.
2016	UK (Scotland)	ClimateXChange	Following a wide range of analyses, including results that replicate and improve on the approach used in the 2014 study by London School of Economics, the study did not find a consistent negative effect of wind turbines or wind farms when averaging across the entire sample of Scottish wind turbines and their surrounding houses. Most results either show no significant effect on the change in price of properties within 2km or 3km, or find the effect to be positive. Some wind farms provide economic or leisure benefits (e.g. community funds or increasing access to rural landscapes through providing tracks for cycling, walking or horse riding)

4.3.8 Natural Disasters and Major Accidents

A wind farm is not a recognised source of chemical pollution. Should a major accident or natural disaster occur, the potential sources of pollution onsite during both the construction and operational phases are limited. Sources of chemical pollution with the potential to cause

significant environmental pollution and associated negative effects on health include bulk storage of hydrocarbons or chemicals and storage of wastes. Spills and leaks can occur if they are not mitigated against which may cause negative effects to human health, if contamination of food or water occurs. The occurrence of such spills and leaks is unlikely as bunding and safe storage practices will be complied with. **Chapter 16: Major Accidents and Natural Disasters** and **Appendix 2.1: Construction Environmental Management Plan** discusses this in more detail. The Site is not regulated under the Control of Major Accident Hazards Involving Dangerous Substances Regulations i.e. SEVESO sites and so there is no potential effect from this source. All SEVESO sites are located approximately 45km or more from the Site.

There is limited potential for significant natural disasters to occur at the Site. Ireland is a geologically stable country with a mild temperate climate. The potential natural disasters that may occur are therefore limited to peat-slide, flooding and fire.

With reference to **Chapter 8: Soils and Geology, Section 8.3.3,** land in the vicinity of the proposed Letter Wind Farm site is predominantly underlain by the Dergvone Shale Formation. The Peat Stability Assessment Risk Ranking has indicated '*Low to Negligible risk of instability in relation to the proposed turbine locations and other infrastructure, should all mitigation measures and recommendations be adhered to*'. The risk of peat-slide is further addressed in **Chapter 8: Soils and Geology**. A Peat and Spoil Management Plan has been prepared in **Appendix 2.1**.

There are no recorded localised flood events within the immediate area of the Site. A Surface Water Management Plan has been put in place and can be found in **Appendix 2.1**. The risk of flooding is addressed in **Appendix 9.1: Strategic Flood Risk Assessment**.

A 2020 article in Wind Power Engineering Magazine estimated that 1 in 2,000 wind turbines catch fire each year[20]. Fires are the second most common cause of wind turbine accidents after blade failure. A 2014 report notes turbine accidents caused by fire accounted for 15% of all reported accidents from 1995-2012[21]. This represents an average of 11.7 fires per year (approx. 200,000 wind turbines in 2011). Overall, the data shows that wind turbine fires are relatively rare[22]. It is therefore considered that the risk of significant fire occurring, affecting the wind farm and causing the wind farm to have significant environmental effects is limited.

[20] https://www.windpowerengineering.com/is-rope-based-descent-emergency-evacuation-at-the-end-of-its-tether/ [Accessed 27/01/2022]
[21] Solomon Uadiale , Évi Urbán , Ricky Carvel , David Lange , and Guillermo Rein (2014). 'Overview of Problems and Solutions in Fire Protection Engineering of Wind Turbines' *Fire Safety Science.*11:983-995.
[22] https://www.firetrace.com/fire-protection-blog/wind-turbine-fire-statistics [Accessed 27/01/2022]

As described earlier, there are no significant sources of pollution in the wind farm with the potential to cause environmental or health effects. Also, the spacing of the turbines and distance of turbines from any properties limits the potential for impacts on human health. The issue of turbine safety is addressed in **Section 4.3.6.9**.

In the unlikely event that the stability of peat is compromised, an Emergency Response Plan has been prepared and can be found in **Appendix 2.1: Construction Environmental Management Plan, Management Plan 1**. Accidents and disasters are fully assessed in **Chapter 16: Major Accidents and Natural Disasters**.

4.4 ASSESSMENT OF POTENTIAL IMPACTS

4.4.1 'Do-Nothing' Scenario

If the Project was not to proceed, the existing uses of the site for agriculture and commercial forestry would continue. The opportunity to capture a renewable green energy supply would be lost, as would the opportunity to contribute to Ireland's 2050 target of net-zero emissions. The opportunity to generate local employment and tourism would also be lost.

4.4.2 Population and Settlement Patterns

The Project does not contain a housing or services element and is not considered to have any direct, long term, positive or negative impact on the local or regional population levels. However, construction workers who are not based locally may temporarily relocate to the region, this is more likely for the initial construction and decommissioning phase than for the operational phase. The overall impact is considered to be imperceptible in terms of population.

The predicted effect on the immediate settlement patterns and social patterns is also slight to non-existent. There is however, the benefit which will accrue to the region in terms of the ability to provide electricity to industry and business via a high-quality supply. This will lead to the region becoming more attractive to business with the subsequent benefit of increased employment opportunities in the region. A renewable, green energy supply could potentially be attractive for companies looking to develop in County Leitrim.

During the construction phase there is the potential for limited impacts on the residential amenity of the local population. These will be short-term impacts relating primarily to an increase in construction traffic causing noise, dust, and an increase in traffic volume. The

impacts of each on nearby properties have been found to be slight negative in the construction and decommissioning phases and imperceptible in the operational phase.

While the Project is not likely to result in a marked increase in settlement in the area, or a change in social patterns in the area, it will provide a renewable energy source which will prove attractive to certain types of industry depending on national and global economic conditions.

The overall impact of the construction and decommissioning phases on population and settlement patterns is predicted to be slight positive and short-term in nature should construction workers relocate to the area for the duration of these phases. The overall impact during the operational phase is predicted to be slight positive at the local level in terms of settlement patterns where increased business is attracted to the region.

4.4.3 Economic Activity

During the construction phase, there will be economic effects resulting from the expenditure on items such as Site preparation, Site Access Roads, purchase and delivery of materials, plant, equipment and components. Information provided by the Developer on experience at other wind farms indicates that there is expected to be a peak onsite workforce of maximum 25-workers. Some of these workers will be sourced from the local labour market where possible in Study Area 2, but professional and skilled personnel may be required to be sourced from areas inclusive of Ireland or even further afield.

During the initial decommissioning and construction phase, jobs are likely to be created. Local employment will be provided, as well as employment on local, national and international levels both directly and indirectly. Throughout the project lifetime, employment will be both created and maintained on local, regional, national and international levels.

It is envisaged that labour and materials will be sourced from the local area during construction where possible. Ready-mix concrete will also be sourced from a local supplier, again subject to authorisation, and to quality and quantity being available.

Employees involved in the construction of the Project will most likely use local shops, restaurants and hotels/accommodation. Therefore, overall, there will be a slight, positive impact on employment in the locality. Employees also involved in the subsequent operation and decommissioning of the Project will use local shops, restaurants and hotels/accommodation.

BVG Associates carried out extensive assessments on the economic benefits from eight onshore wind farms in Southwest Scotland[23]. Each contract value was assigned to one or more relevant elements of a supply chain. Capital expenditure (CAPEX) was found to relate to turbine, civil works and electrical works supply chains, whereas the operational expenditure (OPEX) relates to transmission operations, maintenance and service (OMS) supply chain, the wind farm OMS and also the decommissioning supply chain.

Based on this research and the largest 17MW capacity proposed, the CAPEX for the Project is estimated to be approximately €25 million. This expenditure will result in economic benefit at a national, regional and local level. The OPEX in nominal terms is estimated to be €34 million. The BVG report found, for the eight projects studied, that 66% of the total project spend (CAPEX & OPEX) was retained within the National economy, 17% of the total was retained in the local region hosting the project.

Leitrim County Council will benefit from payments under both the Project Contribution Scheme and from the annual rate payments. The Applicant is also committed to a 'Community Benefit' package. This package will be advertised annually and managed by the local community or an independent body on behalf of the local community. The purpose of the community fund is to enable the local community to share in the benefits of the Project The community benefits funds typically support local projects, with funds allocated to projects from all aspects of the community.

The overall impact on economic activity is predicted to be a moderate, positive, short-term impact during the construction phase of the Project and moderate, positive and long-term during the operational phase. There will be similar effects to the construction phase during decommissioning.

4.4.4 Employment

The employment effects that are attributable to the Project can be outlined as direct, indirect and induced.

Direct: Employment and other economic outputs that are directly attributable to the delivery of the Project. These include any new jobs that are created to manage and supervise the construction phase, operational and decommissioning phases of the Project and that are

[23] Economic Benefits from onshore wind farms, September 2017, BVG Associates, [Accessed 03/11/22]

filled by employees of the Developer or the appointed Contractor (or sub-contracted employees).

Indirect: Employment and other outputs created in other companies and organisations that provide services to the Project, (i.e. procurement and other supply chain effects). Most manufactured materials like towers, blades and subcomponents are assumed to be imported (import intensity of 66%) with major infrastructure delivery through Killybegs Harbour; fewer indirect manufacturing jobs will be generated domestically in Ireland.

Induced: Additional jobs and other economic outputs that are created in the wider economy, as a result of the spreading of employee incomes and other ripple effects that occur as a result of the direct and indirect effects of the Project.

Sustainable Energy Authority of Ireland (SEAI) researched the flow of investment and sales revenue from onshore wind and the transmission grid through the different industrial sectors in the supply chain required for input–output macro-analysis (**Table 4.6**).

Table 4.6: Capital Investment breakdown for onshore wind supply (Source SEAI, 2015 [24])

	Industrial Sectors
€192 million average annual capital investment to reach 2020 NREAP/NEEAP targets	Manufacturing (70%): turbines, blades, towers, gearbox, generator, electrical equipment, transformer etc.
	Construction (12%)
	Electricity Supply Services (10%)
	Transport (2.5%)
	Finance (2.5%)
	Professional Services (3%)

In terms of its capacity to capture capital investment domestically, Ireland has strong indigenous feasibility, planning, foundations and engineering expertise, with the skills and knowledge base to potentially supply niche markets in controls and instrumentation, albeit the bulk of heavy manufacturing (blades, towers) is imported. Similarly, the Irish supply chain is very well positioned in all of the preliminary design and operational aspects of the electricity grid, providing a significant boost to national employment. However, some manufactured

[24] A Macroeconomic Analysis of Onshore Wind Deployment to 2020 An analysis using the Sustainable Energy Economy Model, SEAI, 2015. [Accessed Online 03/11/2022] Available at: https://www.seai.ie/publications/A-Macroeconomic-Analysis-of-Onshore-Wind-Deployment-to-2020.pdf

materials such as cables, underground pipes, insulators and conductors are sourced from abroad.

According to SEAI, there are approximately 0.34 new long-term jobs per MW, which falls in line with European Wind Energy Association (EWEA) estimates for direct employment in Europe. In the case of the Development, this translates to 6 new long-term jobs for a 16.8MW powered installation.

According to Institute for Sustainable Futures document (2015)[25], 3.2 jobs are created per MW of wind energy development during the construction and installation phase, the report assumes a 2-year construction period. Based on this employment estimate and an approximate two-year construction phase, 54 jobs could be created during the construction phase (for an installed capacity of 16.8MW).

According to the European Wind Energy Association's (EWEA) Report 'Wind at Work' (2009)[26], 1.2 jobs per MW are created during installation of wind energy projects based on 1 year construction period. Using this figure, a projection of 20 jobs could be created as a result of the construction of the Development (for an installed capacity of 16.8MW and a construction period of 2 years).

The Sustainable Energy Authority of Ireland' 2015 report 'A Macroeconomic Analysis of Onshore Wind Deployment to 2020'[27] puts direct construction jobs from wind farm developments at 1.07 jobs per MW based on 1 year of construction. Using this figure, a projection of 36 jobs could be created as a result of the construction of the Development (for an installed capacity of 16.8MW and a construction period of 2 years). Therefore, considering the minimum and maximum figures, it is estimated that between 6 and 54 direct and indirect jobs could be created during the construction phase of the proposed project. It is not expected that all of these jobs will be based at the wind farm Site, however, the employment of tradespeople, labourers, and specialised contractors for the construction phase will have a direct, short-term significant, positive impact on employment in the study area.

[25] Institute for Sustainable Futures, Calculating Global Energy Sector Jobs – 2015 Methodology Update, 2015. [Accessed Online 03/11/2022]
Available:https://opus.lib.uts.edu.au/bitstream/10453/43718/1/Rutovitzetal2015Calculatingglobalenergysectorjobsmethodology.pdf

[26] European Wind Energy Association (EWEA) (2009), Wind at Work, - Wind Energy and Job Creation in the EU [Accessed Online: 03/11/2022] available at: http://www.ewea.org/fileadmin/files/library/publications/reports/Wind_at_work.pdf

[27] Sustainable Energy Authority Ireland (SEAI) (2015), A Macroeconomic Analysis of Onshore Wind Deployment to 2020. [Accessed Online: 03/11/2022]. Available at: https://www.seai.ie/publications/A-Macroeconomic-Analysis-of-Onshore-Wind-Deployment-to-2020.pdf

An estimated breakdown of the potential construction employment is as follows:

Table 4.7: Estimated Employment breakdown during the construction phase of the Development

Occupation/Task	No. of People	Employment Period
Foundation team	eight	20 weeks
Roads (truck drivers)	eight	40 weeks
Plant drivers	four	60 weeks
Foreman	one	64 weeks
Engineer	one	64 weeks
Engineer	two	15 weeks
Substation Civils	ten	10 weeks
Substation electrical	fourteen	16 weeks
Foreman	two	15 weeks
General operatives	two	64 weeks

Approximately 25 persons will be employed on site during the peak of the construction phase of civil engineering of access Roads, crane hardstand, turbine foundation, and substation construction. These numbers will be somewhat less for the turbine delivery, assembly and commissioning activities. A mixture of skills will be required, including unskilled/semi-skilled/skilled manual (construction labour and machine operators), non-manual (administration roles), managerial and technical (civil, electrical, mechanical technical and engineering) and professional roles (scientific, engineering, legal, business and accounting). The manual roles will be Site-based with the other roles being predominately office-based, with Site visits as and when required. During construction, personnel will be at the Site over a number of months and during these times will likely use local accommodation and restaurants and other facilities.

There will be 10 workers required for the decommissioning phase including engineer/ supervisor, crane drivers, plant drivers, banksman, HGV drivers, safety officer, wind turbine technician and general operatives.

Anecdotal evidence received by the Developer on other wind farm construction projects shows that local businesses such as accommodation providers welcome the enhanced level of occupancy that is achieved due to the construction contractors using their accommodation

on a year-round basis, including periods of the year that are traditionally considered 'low season'. This is supported by the Edf-re.uk study which found that:

"*using local contractors, developing businesses to build wind farm technology, and supporting the workforce with food, accommodation and amenities*"[28]

The benefits of increased business, although temporary, can allow businesses to invest in improvements that would not otherwise be affordable, leading to a long-term enhancement.

Whilst overall effects on the tourism economy are considered in **Section 4.4.6** to be negligible and not significant, the benefits to individual businesses will be substantial and significant.

The Development will create approximately two full-time jobs during the operational phase. In addition to these jobs, various personnel will be required for the successful and continued operation of the wind farm. During the operation phase of the wind farm, the operation and reliability, maintenance (turbines, civil works and electrical infrastructure) finance, ongoing compliance with permissions and permits, safety, security, community relations and benefits and land-owner agreements must be continually managed. These requirements are widely distributed over various employment sectors and are an integral part of the ongoing operation of the Development and will provide continuous employment for the lifetime of the wind farm. A general outline of the employment associated with the operational phase of the wind farm is outlined in **Table 4.8.**

Table 4.8: Parties involved during the operational phase[29]

Maintenance Contracts	Financial and Services Contracts	Other Stakeholders
Project Manager	Lenders	Local Community
Asset Management	Power Purchase Agreement (PPA) Provider	Local Authority (incl. rates payments)
Turbine Contractor • Transport Companies • Crane Hire • Plant and Vehicle Hire • Site Facilities	Landowner Agreements	Construction and Maintenance material suppliers: • Local shops • Food providers • Accommodation providers
	Insurance	Plant Hire companies
	Accountancy	Telecom provider
	Safety Consultants	
	Community Liaison Officer	
Electrical Works Contractor	Environmental Monitoring • Noise	

[28] Edf-re.uk. Available at: https://www.edf-re.uk/local-community/community-benefits#economy [Accessed 03/11/2022]
[29] Irish Wind Energy Association (2019) *Life-cycle of an Onshore Wind Farm.* Ionic Consulting. Available online at: https://www.iwea.com/images/files/iwea-onshore-wind-farm-report.pdf [Accessed 03/11/2022]

Maintenance Contracts	Financial and Services Contracts	Other Stakeholders
	• Ornithology • Habitat Management	
Civil Works Contractor		
Utility		

The persons fulfilling these roles may live and work anywhere in Ireland, visiting the Site as and when required, to operate and maintain the plant and equipment. During major service operations, personnel may be at the Site over several days and during these times may use local accommodation and restaurants.

Overall, there will be a slight positive short-term impact on employment in the area during construction and decommissioning and a long-term positive impact on employment in the area during the operation phase.

4.4.4.1 Embedded measures

The Developer has a long track record of developing wind farms in Ireland and experience from previous wind farm construction projects is that expenditure in local goods and services is widely spread and makes a difference to existing businesses. The Developer is committed to employing good practice measures with regard to maximising local procurement and will adopt measures such as those set out in the Renewable UK Good Practice Guide, 2014: 'Local Supply Chain Opportunities in Onshore Wind' (Renewable UK, 2014).

The Developer will work with a variety of contractors who will be actively encouraged to develop local supply chains throughout the local area, and work with subcontractors to invest in training and skills development.

At this stage in the development process, it is not possible however, to quantify economic benefits in respect of individual supply chain companies, as contracts would not be let until consent is granted. However, it is evident from the Developer's recent experience that local and regional suppliers of a wide range of goods and services will benefit from such a Project (in this case, Leitrim and Ireland as a whole).

4.4.5 Land Use

Prior to the grid connection installation works within public roads, it is proposed that all access points (domestic, business, farm) are considered when finalising the temporary road closures

and diversions to maintain local access as much as possible and avoid impacts on various land uses.

With reference to **Chapter 8: Soils and Geology,** the average peat depth across the Site is 1.98m. Pockets of deep peat are present within the Site. As far as possible, the footprint of the Development avoids these areas. The Risk Ranking at Site infrastructure peat probe locations is Negligible to Low Risk. There is a relatively extensive area of deep peat due west of the site access track to be upgraded in the Northern portion of the Site. The risk ranking here is Negligible. An Emergency Response Plan has been included in **Appendix 2.1: Construction Environmental Management Plan**.

4.4.6 Tourism

Fáilte Ireland published guidelines in 2011 for the treatment of tourism in an EIS, which describes the effects of wind farm projects on tourism. Many of the issues covered in the report are similar to those covered in this EIAR, for example, scenery is assessed in **Chapter 12: Landscape and Visual Amenity**.

Fáilte Ireland published a study on 'Visitor Attitudes on the Environment' in 2012[30] to assess the perceived impacts of wind farms on potential future visits to an area. The study found that 12% of those surveyed, responded that wind farms would have 'a strong positive impact' on their decision to visit Ireland, with 27% responding it would have a 'slight positive impact', whilst 38% said it would have 'no impact'. 7% of respondents stated it would have a 'strong negative impact' and 15% stated it would have a 'slight negative impact'. The survey also found that wind farms were noted as more favourable than other forms of development such as housing, mobile phone masts or electricity pylons.

Based on historical examples and findings of the BiGGAR Economics report (mentioned in **Section 4.3.5.3**) there is not expected to be any direct relationship between the tourism sector growth and this Development.

Due to the distance and the intervening landscape, there will be no impact from the Development to tourists.

Based on the findings of the collective assessments, it was considered that the Development will not give rise to any significant effects on tourism. Overall effects of the Development with

[30] Fáilte Ireland (2012) Visitors Attitudes on the Environment – Wind Farms - https://www.failteireland.ie/FailteIreland/media/WebsiteStructure/Documents/3_Research_Insights/4_Visitor_Insights/WindFarm-VAS-(FINAL)-(2).pdf?ext=.pdf [Accessed on 03/11/2022]

regards to tourism are considered to be imperceptible during both the construction and operation with a slight positive impact during operation.

4.4.7 Human Health

4.4.7.1 Electromagnetic fields

Electromagnetic fields from wind farm infrastructure, including the grid connection and substation, are very localised and are considered to be an imperceptible, long-term impact.

4.4.7.2 Shadow flicker

Section 4.6 provides an impact assessment of shadow flicker from the Development.

4.4.7.3 Noise

The construction process associated with wind farms is not considered intensive and is temporary works, most of which is carried out a considerable distance from receptors. The main noise sources will be associated with the construction of the turbine foundations, turbine hardstands, grid connection, extraction and processing in the borrow pit location, with lesser sources being site access roads, construction of a 20kV substation and compound. Accessing stone material from the borrow pit will significantly reduce road traffic flow on local roads. The main construction traffic to Site will be due to a very short period where trucks will deliver stone around the Site and ready-mix trucks deliver concrete for the turbine bases. The delivery of turbines by large trucks travelling at very low speed will generate very low levels of noise.

The effects of noise and vibration from onsite construction activities are not considered significant. The effects for Decommissioning will be similar to construction but of shorter duration (See **Chapter 11: Noise**, Section 11.4.1).

Predicted operational noise limits from the Development are within the noise limits set out in the Wind Energy Development Guidelines 2006 and are imperceptible. (see **Chapter 11: Noise and Vibration**, Section 11.4.4).

Noise effects during decommissioning of the Development are likely to be of a similar nature to that during construction but of shorter duration. Existing roadways and turbine bases (excluding plinths) will be left in place and naturally vegetated over. Any legislation, guidance or best practice relevant at the time of decommissioning will be complied with.

4.4.7.4 Air Quality

Chapter 10: Air and Climate provides an assessment of air quality in relation to the Project. The impact assessment concludes that:

The effect of the Project on air quality will be imperceptible over the short-term period in which there will be an increase in traffic movements during construction and decommissioning. There will be slight, long term, positive effects on air quality because of the wind farm during operation.

Overall, the air quality impacts of the Project on Human Health will be a long term, positive effect on human health.

4.4.7.5 Water Contamination

Chapter 9: Hydrology and Hydrogeology provides an assessment of the hydrological impacts of the Project, including the potential for water contamination.

Water contamination could potentially occur during the construction and the decommissioning phases from the release of suspended solids, accidental spillages of cement, or hydrocarbons. Once mitigation measures are implemented the risk of water contamination will be significantly reduced. However, there remains a level of risk and therefore both precautionary measures and emergency response protocols have been established and specified in Management Plans 1 and 3 of the CEMP, **Appendix 2.1**.

4.4.7.6 Traffic

Chapter 15: Traffic and Transportation provides an assessment of the traffic impacts in relation to the Project.

The assessment concludes that: the Project has generally been assessed as having the potential to result in a moderate, negative effect of short-term duration and high probability during the construction phase, with an imperceptible effect on traffic during the decommissioning phase. After mitigation, the residual effects have been assessed as producing a positive residual benefit during the construction phase, no residual effects during the operational phase, and slight negative, direct and short term during the decommissioning phase.

It is possible that a blade (or set of blades) could require replacement if damaged by lightning on nearby wind farms. Should this coincide with the construction period for the Project, then

there is the potential for cumulative transport affects. However, these are considered as being of low probability, slight impact and of short duration.

4.4.8 Property Value

Based on the available published studies the operation of a wind farm at the Site will not significantly impact on property values in the area as discussed in **Section 4.3.7**. The Project will have a long-term imperceptible impact on property values.

4.4.9 Natural disaster and major accidents

Chapter 16: Major Accidents & Natural Disasters provides an assessment of the vulnerability of the Project to major accidents and natural disasters. Possible risks associated with the Project during the construction, operation and decommissioning phases are outlined and assessed. The consequence ratings assigned to each potential risk assumes that all proposed mitigation measures and safety procedures have failed to prevent the major accident and/or disaster. All scenarios when assessed were considered "low risk".

4.5 MITIGATION MEASURES AND RESIDUAL EFFECTS

Although no negative potential impact of significance has been established, there are a number of measures, which may be implemented for the safety of workers and the public during the construction, operational and decommissioning phases.

4.5.1 Embedded Mitigation

The Project, as described in **Chapter 2: Project Description**, incorporates good practice measures for limiting the adverse effects of the construction works. The principal potential effects arising from works tend to relate to construction traffic affecting the use of National roads, local primary roads and access roads by the general public and drainage. Measures are set out in **Chapter 15: Traffic and Transportation** relating to how delivery of goods and services will be managed during works to minimise impacts and details of mitigations and the use of Sustainable Drainage Systems can be found in **Chapter 9: Hydrology and Hydrogeology**. The proposed mitigation measures have been further developed in the **Construction and Environmental Management Plan (CEMP)** (**Appendix 2.1**).

4.5.2 Population and Settlement Patterns

Given that no negative impacts have been identified, no mitigation measures are proposed.

4.5.3 Economic Activity

Allowing for the implementation of embedded mitigation, no significant effects have been identified in respect of socio-economic receptors arising from the construction of the Project and therefore no mitigation measures are required to reduce or remedy any adverse effect.

4.5.4 Employment

Given that potential impacts of the Project at construction, operation and decommissioning phases are predominantly positive in respect of socioeconomics, employment and economic activity, no mitigation measures are considered necessary.

4.5.5 Land Use

Mitigation measures for land use have been incorporated into the preliminary design stage. This has allowed for the prevention of unnecessary or inappropriate ground works or land use alterations to occur.

In this regard, the construction and operational footprint of the Project has been kept to the minimum necessary to avoid impact on existing land uses. Furthermore, existing forestry tracks have been incorporated into the design to minimise the construction of new Site Access Roads and minimise the removal of forested areas. New Site Access Roads have been sensitively designed to minimise impact on forestry. Electricity cables will be installed underground in or alongside Site Access Roads to avoid and minimise negative impact. The construction and decommissioning works will be planned and controlled by a Construction and Environmental Management Plan (CEMP). This provides details on day to day works and methodologies. As part of these works, the public and other stakeholders will be provided with updates on construction activities which will affect access to lands. This will be communicated to members of the public through a community liaison officer employed for the duration of the construction period.

Chapter 15: Traffic and Transportation will be referred to for all proposed works and deliveries along the turbine delivery route to avoid undue impact to adjacent land uses.

4.5.6 Tourism

Mitigation measures for recreation, amenity and tourism are primarily related to the preliminary design stage of the Project, which has allowed for the prevention of unnecessary or inappropriate development to occur that will significantly affect any recreational or tourist amenity. In designing the Development, careful consideration was given to the potential impact on landscape amenity.

4.5.7 Human Health and Safety

4.5.7.1 *Construction and Decommissioning*

To maintain safety and avoid health impacts on construction workers and the general public, best practice site safety and environmental management will be maintained. The proposed development will be designed, constructed, operated and decommissioned in accordance with the following:

- Safety, Health & Welfare at Work (Construction) Regulations 2013 Safety
- Health & Welfare at Work Act 2005 Safety
- Health & Welfare at Work (General Applications) Regulations 2007

All construction staff will be adequately trained in health and safety and will be informed and aware of potential hazards.

All hazards will be identified, and risks assessed. Where elimination of the risk is not feasible, appropriate mitigation and/or control measures will be followed. The contractor will be obliged under the construction contract and current health and safety legislation to adequately provide for all hazards and risks associated with the construction phase of the project.

Safe Pass registration cards are required for all construction, delivery and security staff. Construction operatives will hold a valid Construction Skills Certificate Scheme card where required. The Developer is required to ensure a competent contractor is appointed to carry out the construction works. The Contractor will be responsible for the implementation of procedures outlined in the Safety & Health Management Plan.

In relation to COVID-19, up to date Health Service Executive guidance will be consulted regularly in line with Health and Safety Authority recommendations and all reasonable on-site precautions will be taken to reduce the spread of COVID-19 on construction sites, should the virus be prevalent at the time of construction.

Once mitigation measures and health and safety measures are followed, the potential for impact on human health on the construction site during construction and decommissioning is expected to be not significant and temporary to short-term.

Public safety will be addressed by restricting access to the public in the vicinity of the site works during the construction and decommissioning stage. This measure aims to avoid potential injury to members of the public as a result of construction activities.

Appropriate warning signage will be posted at the construction site entrance, directing all visitors to the site manager. Appropriate signage will be provided on public roads approaching site entrances and along haul routes.

In relation to the turbine delivery route, extra safety measures will be employed when large loads are being transported, for instance, Garda escort will be requested for turbine delivery and a comprehensive turbine delivery plan will be utilised to avoid potential impact to human safety for road users and pedestrians.

For the installation of the grid connection cable in the public road, a traffic management plan has been developed (**Appendix 2.1**) in discussion with locals who will be directly impacted by the works, and in agreement with the Local Authority. Public consultation will be conducted along the grid cable route to inform local residents ahead of construction and decommissioning works.

Once mitigation measures and health and safety measures are implemented and followed, the potential for impact on human health for members of the public during construction and decommissioning of the proposed project is expected to be not significant and temporary to short-term.

4.5.7.2 Operation

For operation and maintenance staff working at the proposed wind farm, appropriate site safety measures will be utilised during the operational phase by all permitted employees. All personnel undertaking works in or around the turbines will be fully trained and will use appropriate Personal Protective Equipment (PPE) to prevent injury.

Equipment within high voltage substations presents a potential hazard to health and safety. The proposed substation will be enclosed by palisade fencing and equipped with intruder and fire alarms in line with ESB and EirGrid standards.

All electrical elements of the proposed development are designed to ensure compliance with electro-magnetic fields (EMF) standards for human safety.

All on-site electrical connections are carried by underground cable and will be marked out above ground where they extend beyond the track or hardstanding surface. Details of cables installed in the public road will be available from ESBN.

Lightning conductors will be installed on each turbine as all structures standing tall in the sky require this protection. Turbines specifically require this to prevent power surges to electrical components. Turbines will be fitted with ice detection systems which will stop the turbine from rotating if ice is forming on a turbine blade. This aims to prevent ice throw.

Rigorous statutory and engineering safety checks imposed on the turbines during design, construction, commissioning and operation will ensure the risk posed to humans is negligible. 24-hour remote monitoring and fault notifications are included as standard in the Turbine Operations and Maintenance Contracts. A Supervisory Control and Data Acquisition ("SCADA") system will monitor the Development's performance. If a fault occurs, then a message is automatically sent to the operations personnel preventing emergency situations.

In addition to scheduled maintenance, the maintenance contracts will allow for call out of local engineers to resolve any issues as soon as they are picked up on the remote monitoring system.

Access to the turbines inner structure will be locked at all times and only accessed by licenced employees for maintenance.

In line with the Health Service Executive's Emergency Planning recommendations, any incident which may occur at the site which requires emergency services, incident information will be provided in the 'ETHANE' format:

- Exact location
- Type of incident
- Hazards Access and egress
- Number of casualties (if any) and condition
- Emergency services present and required

4.5.8 Major Accidents and Natural Disasters

The design of the Project has considered the susceptibility to natural disasters. The proposed site drainage will mitigate against any potential flooding risk due to run off with the use of Sustainable Drainage Systems (SuDS). Construction drainage will be left in-situ for the lifespan of the project through to decommissioning.

The Contractor's fire plans are reviewed and updated on a regular basis. A nominated competent person shall carry out checks and routine maintenance work to ensure the

reliability and safe operation of firefighting equipment and installed systems such as fire alarms and emergency lighting. A record of the work carried out on such equipment and systems will be kept on site at all times.

Shadow flicker detection systems will be installed on all turbines to manage occurrence of shadow flicker on nearby receptors.

4.5.9 Property Value

Given that potential impacts of the Project at construction, operation and decommissioning phases are a long-term imperceptible impact in respect of property value no mitigation measures are considered necessary.

4.5.10 Residual Risk

Once the above mitigations are taken into account, the residual risk on population and human health is assessed to be an imperceptible, long-term effect.

4.6 CUMULATIVE EFFECTS

For the assessment of cumulative impacts, any other existing, permitted or proposed developments (wind energy or otherwise) have been considered where they have the potential to generate a significant in combination or cumulative impact with the construction and operational phases of this Project. Further information on projects considered as part of the cumulative assessment are given **Chapter 2 Appendix 2.3**. The impacts with the potential to have cumulative impacts on population and human health, in particular noise, air and climate, traffic, material assets and visual impacts are addressed in their relevant chapters of this EIAR.

4.7 SUMMARY OF SIGNIFICANT EFFECTS

The assessment has not identified any likely significant effects from the Project on its own or in combination with other projects on population and human health.

4.8 STATEMENT OF SIGNIFICANCE

This chapter has assessed the significance of potential effects of the Project on population and human health. The Project has been assessed as having the potential to result in effects of a slight positive, long-term impact overall. Through the implementation of mitigation measures, the cumulative effects associated with the Project are predicted to be not significant.

4.9 SHADOW FLICKER

This section comprehensively assesses the potential shadow flicker effects of all scenarios within the Turbine Range of the Development. The potential impacts that could arise from the Development during the construction, operation and decommissioning phases relate to potential shadow flicker impacts during operation. No shadow flicker will occur during the construction or decommissioning phases.

A shadow flicker computer model was used to calculate the occurrence of shadow flicker at all relevant receptors to the Project. The output from the calculations is analysed to identify and assess potential shadow flicker impacts. This is further detailed in **Appendix 4.1a** and **b.** Where negative effects are predicted, this section identifies appropriate mitigation strategies.

The 2018 Review of the 2006 Guidelines confirms that:
"Shadow Flicker occurs when the sun is low in the sky and the rotating blades of a wind turbine casts a moving shadow which, if it passes over a window in a nearby house or other property results in a rapid change or flicker in the incoming sunlight. The time period in which a neighbouring property may be affected by shadow flicker is completely predictable."

Shadow flicker lasts only for a short period and happens only in certain specific combined circumstances. The circumstances require that:

- the sun is shining;
- the turbine is directly between the sun and the affected property, and
- there is enough wind energy to ensure that the turbine blades are moving.

If any one of these conditions is absent, shadow flicker cannot occur.

The 2019 Draft Revision of the Wind Energy Development Guidelines (WEDG) also added the following circumstance required for shadow flicker occurrence:

- *"there is sufficient direct sunlight to cause shadows (cloud, mist, fog or air pollution could limit solar energy levels)"*

The 2019 Draft Guidelines also note:

"Generally only properties within 130 degrees either side of north, relative to the turbines, can be affected at these latitudes in the UK and Ireland – turbines do not cast long shadows on their southern side".

Shadow flicker may have the potential to cause disturbance and annoyance to residents if it affects occupied rooms of a house. Careful site selection, design and planning, and good use of relevant software to control turbine operation can help reduce the possibility of shadow flicker. Modern wind turbines have the facility to measure sunlight levels and to reduce or stop turbine rotation if the conditions that would lead to excess shadow flicker at any neighbouring property arise.

The distance and direction between the turbine and property is of significance because:

- The duration of the shadow will be shorter, the greater the distance (i.e., it will pass by quicker)
- The shadow flicker cast by rotating wind turbine blades will be reduced, the further a dwelling is from an operating turbine

The path of the sun varies over the seasons resulting in a changing potential for a shadow to be cast throughout the year. Similarly, the sun's position in the sky over the course of a day is changing such that the shadow cast by a turbine is constantly changing. Shadow flicker is more likely to occur on sunny winter days, when the sun is lower in the sky and shadows can cast a greater distance from the turbine. Shadow flicker is more likely to occur to the west or south-west of the wind turbines with some occurrences also predicted to the north or north-east and south-east. This can be seen in **Appendix 4.1 a** and **b.**

Persons with photosensitive epilepsy can be sensitive to flickering light between 3 and 60 Hertz (Hz)[31]. This is supported by research in recent years asserting that flicker from turbines must interrupt or reflect sunlight at frequencies greater than 3 Hz to pose a potential risk of inducing photosensitive seizures. The frequencies of flicker caused by modern wind turbines are less than 1 Hz[32], and are well below the frequencies known to trigger effects in these individuals. Therefore, any potential shadow flicker effect from the wind turbines is considered an effect on residential amenity, rather than having the potential to affect the health of residents.

[31] Epilepsy Action (2012) *Other Possible Triggers of Photosensitive Epilepsy*. Available online at: http://www.epilepsy.org.uk/info/photosensitive-epilepsy. [Accessed on 11/07/23]
[32] Harding, G., Harding, P., & Wilkins, A. (2008). *Wind turbines, flicker, and photosensitive epilepsy*. *Epilepsia* (49) 6, pp. 1095-1098.

4.9.1.1 Relevant Guidance

The relevant Irish guidance for shadow flicker is derived from the 'Wind Energy Development Guidelines for Planning Authorities' (Department of the Environment, Heritage and Local Government (DoEHLG), 2006) and the 'Best Practice Guidelines for the Irish Wind Energy Industry' (Irish Wind Energy Association, 2012).

The Department of Environment, Community and Local Government in its Wind Energy Development Guidelines (2006) (the 2006 Guidelines) considers that:
"*At distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low. Where shadow flicker could be a problem, developers should provide calculations to quantify the effect and where appropriate take measures to prevent or ameliorate the potential effect, such as by turning off a particular turbine at certain times".*

The 2006 Guidelines also state that:
"It is recommended that shadow flicker at neighbouring offices and dwellings within 500m should not exceed 30 hours per year or 30 minutes per day".

A significant minimum separation distance from all occupied dwellings of 710m has been achieved with the Project design. There are 17 No. occupied dwellings within 1.5km of any proposed wind turbine location.

The DoEHLG guidelines state that shadow flicker lasts only for a short period of time and occurs only during certain specific combined circumstances, as follows:

- the sun is shining and is at a low angle in the sky, i.e., just after dawn and before sunset; and
- the turbine is located directly between the sun and the affected property; and
- there is enough wind energy to ensure that the turbine blades are moving; and
- the turbine blades are positioned so as to cast a shadow on the receptor.

Although the DoEHLG thresholds apply to dwellings located within 500 metres of a proposed turbine location, for the purposes of this assessment, the guideline thresholds of 30 hours per year or 30 minutes per day have been applied to all properties located within ten rotor diameters (i.e., assumed at 1,170 metres as the widest potential roto diameter within the range (117m) and 1,500 metres for completeness) of the proposed turbines within the Site (as per IWEA guidelines, 2012). The DoEHLG Guidelines state that at distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low.

The adopted 2006 DoEHLG guidelines are currently under review. The DoHPLG released the 'Draft Revised Wind Energy Development Guidelines' in December 2019. The revised draft of Wind Energy Development Guidelines 2019 provides for zero shadow flicker.

The Draft 2019 Guidelines are based on the recommendations set out in the 'Proposed Revisions to Wind Energy Development Guidelines 2006 – Targeted Review' (December 2013) and the 'Review of the Wind Energy Development Guidelines 2006 – Preferred Draft Approach' (June 2017).

The assessment herein is based on compliance with the current DoEHLG Guidelines limit (30 hours per year or 30 minutes per day). However, it should also be noted that the Project can be brought in line with the requirements of the 2019 draft guidelines to ensure no shadow flicker occurs at residential dwellings within the vicinity of the wind farm. Should the 2019 draft guidelines be adopted while this application is in the planning system, the Project will fully comply with their requirements through the implementation of the mitigation measures outlined herein and subject to a time allowance for the turbine to safely stop rotating.

4.9.1.2 Shadow Flicker Modelling

An industry standard wind farm assessment software package, WindPRO from EMD International Version 3.6 was used to prepare a model of the Development. The programme facilitates the analysis of a wind farm for possible shadow flicker occurrence at nearby houses. It allows for the production of maps, and shadow flicker prediction. The data output from the programme has been analysed and the receptors potentially vulnerable to shadow flicker were identified. The significance of shadow flicker effects were assessed.

Generic windows of 2m width, 2m height and 0.5m from bottom line above ground are applied in the model to each side of the house. The model assumes the receptor will not face any particular direction, but instead will face all directions. These windows represent an approximation of the existing windows on the houses facing north, south, east and west and provide an estimate of potential shadow flicker to a window on each side of the house. The software determines the times of day/year when the sun will be in line with the rotational components of the turbine and the house/receptor, thereby having the potential to cause shadow flicker. The software outputs details of potential shadow flicker, in this case by mean and maximum duration of the shadow flicker events, days per year and times of occurrence and maximum hours per year and maximum minutes per day of shadow flicker.

The following data inputs were required and used to produce an estimate of the effect of shadow flicker from the wind farm:

- Digital elevation model of the Development and areas around all properties within the model (10m resolution – OS X, Y, and Z data points)
- Turbine locations
- Turbine dimensions (rotor diameter and hub height)
- Receptor locations (i.e. property locations)
- Bottom line height above ground 'window' (0.5m above ground level)
- Wind speed and direction for the site to determine the period that the wind turbines will be in operation from the different wind directions during the year

The software creates a mathematical model of the Development and its surroundings and uses this information to calculate specific theoretical times and durations of flicker effects for the identified properties. The following 'worst-case' assumptions were initially incorporated into the shadow flicker modelling:

- there are no clouds and sunlight is always bright and direct
- the turbines are always rotating whereas this might not be the case due to maintenance works or break downs
- there is no intervening structures or vegetation (other than topography) that may restrict the visibility of a turbine, preventing or reducing the effect
- a limit to human perception of shadow flicker is not considered by the model

The model operates by simulating the path of the sun during the year. The results of the model provide a calculation of theoretical specific times and durations of flicker effects for the identified properties. As previously stated, given the assumptions incorporated into the model, the calculations overestimate the duration of effects. The worst-case assumption is considered to be sufficient for the purposes of this assessment as it assumes the sky is always clear, the turbines are always aligned face-on to each window and that there is a clear and undisturbed line of sight between the windows of the receptors and the turbines (except where this is prevented due to topography). In reality, this will not occur; the turbines will not always be orientated as described, clouds will obscure the sun and line of sight may also be obscured (for example, from leaves on trees). The flicker effects will be substantially less than this and will not meet the results of the worst-case assumption.

The model also outputs a more realistic scenario, or "expected values". In this scenario, the only change in assumptions is that the statistically likely monthly sunshine frequency and wind direction frequency data is assessed. This assessment only changes the annual hours

per year metric and is not applied to the daily data. 'This is because it could be sunny, with the wind coming from the relevant direction, on any individual day The data used in the model was the:

- Long-term sunshine probability data from the Met Éireann synoptic station in Clones
- Long-term wind rose data from the SEAI Wind Mapping System

4.9.1.3 Baseline Description

The study area is defined as ten times the widest potential rotor diameter within the range (10 x 117 m = 1,170 m). A range of turbine parameters were assessed; however, a maximum rotor diameter of 117 m was used to calculate this distance which was then rounded up to 1.5km. This dimension gives the most significant outcome as smaller rotor diameters will cast less shadow. A study area of 1,500 m is used for completeness.

In determining potential shadow flicker effects, it is the swept path of the blade that dictates the shadow. The longer the blade the greater the swept path and corresponding shadow, the shorter the blade the smaller the swept path and shadow. Two scenarios were included in the assessment in order to fully assess the range of turbine parameters discussed in **Chapter 2: Project Description**. To ensure the full extent of the moving shadow which would be created by the Turbine Range was assessed the following scenarios were modelled.

- Scenario 1 – 91.5m hub (lowest hub), 117 m rotor diameter (longest rotor), 150m tip height
- Scenario 2 – 92m hub (tallest hub), 115m rotor diameter (shortest rotor), 149.85m tip height

A shadow flicker computer model was used to calculate the occurrence of shadow flicker at relevant receptors (houses located within 1,500 m of the proposed turbines). The output from the calculations is analysed to identify and assess potential shadow flicker impacts. Wind turbines, like other tall structures, can cast long shadows when the sun is low in the sky.

The properties were identified using a combination of Ordnance Survey of Ireland (OSI) Maps, AutoCAD planning drawings and from internet mapping resources including *Eircode Finder, Google Street View*, *Google Earth*, *Bing Maps,* a planning permission search using the Leitrim County Council web resources and visits to the Study Area. There are 17 properties within the shadow flicker study area radius. The majority of houses are located to the east of the Development. The coordinates of each dwelling and its distance to the closest proposed turbine are listed in **Table 4.9** and are shown in **Figure 1.3**.

Table 4.9: Properties within the shadow flicker study area

Current House ID	East_ITM	North_ITM	Elevation (AOD m)	Closest Turbine	Closest Distance to Turbine (m)
H1	587495	823063	232.6	T4	728
H2	587972	822926	199.4	T4	777
H3	588550	823532	184.9	T4	710
H4	588584	823583	187.5	T4	735
H5	588599	823681	192	T4	742
H6	588756	823642	162.1	T4	901
H7	588841	823710	155.2	T4	984
H8	588125	825399	165.5	T1	925
H9	588700	824266	179	T3	1,024
H10	588587	824530	177.5	T3	1,028
H11	588452	825457	144.6	T1	1,190
H12	588261	825511	150.3	T1	1,097
H13	588687	825627	135.8	T1	1,480
H14	587934	825595	169.7	T1	1,001
H15	587946	825648	170.5	T1	1,055
H16	588675	823501	170.5	T4	843
H17	588841	823893	169.7	T4	1,006

4.9.1.4 Assessment of Potential Effects

This assessment considers the potential shadow flicker impact of the Development on the remaining surrounding properties in terms of:

- Predicting and assessing the extent of shadow flicker experienced by all properties within the shadow flicker study area
- Specifying mitigation measures, where deemed necessary

A detailed assessment of each of the following scenarios is included in **Appendix 4.1a** and **b:**

- Scenario 1 – 91.5m hub, 117m rotor diameter, 150m tip height
- Scenario 2 – 92m hub, 115.7m rotor diameter, 149.85m tip height

Table 4.10: Summary of Potential Cumulative Shadow Flicker Listing for All Properties

Receptor ID	Scenario 1			Scenario 2		
	Max Shadow [h/day]	Worst Case Shadow [h/year]	Expected Shadow [h/year]	Max Shadow [h/day]	Worst Case Shadow [h/year]	Expected Shadow [h/year]
H1	*0:50*	*61:51:00*	10:28	0:50	*61:51:00*	10:28
H2	*0:30*	*16:36:00*	02:59	0:30	*16:36:00*	02:59
H3	*0:44*	*69:18:00*	13:51	0:44	*67:52:00*	13:34
H4	*0:47*	*78:31:00*	15:31	0:46	*77:10:00*	15:15
H5	*0:37*	*47:38:00*	09:42	0:37	*46:32:00*	09:28
H6	*0:30*	*33:21:00*	06:48	0:30	*32:34:00*	06:38
H7	*0:28*	*25:45:00*	05:05	0:28	*25:06:00*	04:58
H8	*0:33*	*41:04:00*	03:59	0:32	*40:24:00*	03:55
H9	*0:27*	*46:01:00*	07:42	0:27	*45:20:00*	07:35
H10	*0:27*	*52:51:00*	07:24	0:27	*51:25:00*	07:13
H11	*0:25*	*20:42:00*	02:17	0:24	*20:12:00*	02:14
H12	*0:30*	*31:18:00*	03:05	0:29	*30:43:00*	03:02
H13	*0:19*	*7:18:00*	00:50	0:20	*16:32:00*	01:43
H14	*0:30*	*24:36:00*	02:14	0:29	*24:15:00*	02:12
H15	*0:27*	*19:12:00*	01:41	0:27	*18:53:00*	01:39
H16	0:44	62:54:00	12:28	0:43	61:46:00	12:15
H17	0:27	46:52:00	08:42	0:27	46:01:00	08:33

Annual Impacts - Worst-Case Shadow Flicker

The calculated worst-case shadow flicker occurrences in the **Table 4.10** assumes the sun is always shining, that there is no cloud cover, and the dwelling is always occupied and orientated towards the sun and has a window orientated towards the proposed turbines. As previously stated, this calculation is based on topography alone and excludes vegetation, buildings and other man-made structures in the intervening distance. It does not account for weather conditions, which have a significant impact upon the amount of shadow flicker that may actually occur.

It can be seen from **Table 4.10**, that in the case of Scenario 1 where a hub height of 91.5m and a rotor diameter of 117 m are used for the proposed turbines, all turbines will experience some degree of shadow flicker. There will be eleven (11 No.) receptors that exceed the WEDG (2006) 30 hours per year shadow flicker using the worst-case assumptions of the model.

In Scenario 2, where a hub height of 92m and a rotor diameter of 115.7m are proposed, all receptors will also experience some degree of shadow flicker. There will be eleven (11 No.) receptors that exceed the WEDG (2006) 30 hours per year shadow flicker using the worst-case assumptions of the model.

It is possible for wind turbines to flicker at 2 or more receptors simultaneously and/or receptors may receive flicker from 2 or more turbine simultaneously. As can be seen in the shadow flicker assessment attached as **Appendix 4.1** all of the proposed turbines give rise to some degree of cumulative shadow flicker, if unmitigated.

Annual Impacts – Expected Shadow Flicker

To calculate more realistic and 'real world' occurrences of shadow flicker for the receptors that are identified as potentially vulnerable to shadow flicker (**Table 4.10**), it is necessary to identify the likely meteorological conditions which are expected to be experienced at the Site. To estimate the likely duration of sunshine occurrence at the Site, historical meteorological data from the Met Éireann is automatically uploaded by the software. Data from Clones Meteorological Observatory was used as this Met Éireann observatory is the closest to the Site. This gives a good representation of data for the Development. This data was utilised to consider the probability of sunshine occurrence, and thus allow the determination of 'projected' values for shadow flicker occurrence.

The worst-case predicted hours for shadow flicker are reduced by the average time the weather is cloudy annually. As discussed above, to estimate the impact of sunshine occurrence, historical meteorological data is utilised to consider the likelihood of sunshine (the sunshine probability) at different times of the year. This allows the determination of 'expected' values for shadow flicker occurrence as can be seen in the 'Expected' columns in **Table 4.10**. This is achieved by applying a reductive factor to the worst-case total hours per year of shadow flicker. **Table 4.10** shows the worst-case and the expected shadow flicker values per year which are likely to be experienced by each receptor. Although the expected duration of shadow flicker is reduced substantially for each dwelling when data from Clones Meteorological Observatory is incorporated into the assessment, it is not eliminated entirely.

For both Scenario 1 and 2 there are no exceedances of the WEDG (2006) shadow flicker 30hrs/year threshold at any receptor using the expected shadow flicker data. H4 has the greatest shadow flicker impact at 15 hours and 31 minutes, and 15 hours and 15 minutes respectively.

Daily Shadow Flicker Potential Impacts

It is not appropriate to apply the annual average sunshine hours correction to the predicted daily totals as the data is based upon monthly averages, which cannot be applied to daily levels with sufficient accuracy. Furthermore, the infrequency of clear skies is more likely to reduce the overall number of instances of shadow flicker over the year, rather than reduce the length of each individual instance. As such, the assessment of daily impacts considers the maximum theoretical amount of shadow flicker only and is inherently conservative.

It can be seen from **Table 4.10**, that in the case of both Scenario 1 and 2, six receptors will exceed the WEDG (2006) 30 mins per day shadow flicker threshold.

4.9.1.5 Cumulative Effects

Cumulative shadow flicker impacts could arise if dwellings are at risk from potential shadow flicker impacts as a result of more than one wind farm. While separate wind farms are not likely to cause effects simultaneously, they could increase the cumulative total hours where a receptor is impacted. In this instance, there is one consented wind farm (Garvagh Glebe Wind Farm) within a 1.5km range of the turbines that may cause cumulative effects.

4.9.1.6 Mitigation Measures & Residual Effects

Due to the potential for shadow flicker to affect receptors within the shadow flicker study area, it is proposed that a shadow control system will be installed on each of the wind turbines. The control system will calculate, in real-time:

- Whether shadow flicker has the potential to affect nearby properties, based on pre-programmed co-ordinates for the properties and turbines
- Wind speed (can effect how fast the turbine will turn and how quickly the flicker will occur)
- Wind direction
- The intensity of the sunlight
- The turbine will automatically shut down safely during periods when shadow flicker exceeds the thresholds as set out in the WEDG (2006); and will restart when the potential for shadow flicker ceases at the affected properties.

The WEDG (2006) recommends a 30 hours per year threshold for shadow flicker. The Draft Revised Wind Energy Development Guidelines, December 2019, recommend that shadow flicker should not impact any dwelling, meaning the relevant turbine or turbines must be shut down on a temporary basis until the potential for shadow flicker ceases.

It is intended that the measures outlined above, subject to safe shut down time of approximately 60 seconds, will ensure the WEDG (2006) shadow flicker thresholds are not exceeded at any of the properties within the study area, this will be the case regardless of which turbine is selected within the turbine range.

The control system can be adjusted to automatically shut-down the turbine when the control systems detects the sunlight is strong enough to cast a shadow thereby complying with the 2019 Draft WEDG if/when they come into effect.

In the event that complaints of shadow flicker are received by the Developer / Site Operator or by Leitrim County Council during operation, an investigation will take place and the complaints frequency, duration and time of complaints will be considered and specialist modelling software will be used to confirm the occurrence(s). If the effects are confirmed in the modelling, a shadow flicker survey involving the collection of light data will also be carried out at the property in which the complaint was made. Further refinement of the blade shadow control system will be conducted to eliminate the shadow flicker occurrence. This could result in the shutting off turbines at specific times of day.

4.9.1.7 Summary of Significant Effects

This assessment has identified the potential for shadow flicker to affect all 17 No. receptors within the shadow flicker study area for all two scenarios assessed. The expected shadow flicker results show there are no exceedances of the WEDG (2006) 30 hrs/year shadow flicker threshold at all receptors. However, the WEDG (2006) 30 mins/day shadow flicker threshold is exceeded at 6 No. receptors. A shadow control system will be installed to ensure shadow flicker levels do not exceed the WEDG (2006) thresholds and can be adjusted to eliminate shadow flicker, ensuring compliance with the 2019 Draft WEDG if they come into effect. Such systems are common in many wind farm developments and the technology has been well established.

4.9.1.8 Statement of Significance

This assessment has identified that the Project will comply with the WEDG (2006) shadow flicker guidelines. The assessment also determined that the Project will comply with the 2019 Draft WEDG by installing a blade shadow control system on the proposed turbines. Therefore, the Project will not result in significant impacts in relation to shadow flicker. Given that only effects of significant impact or greater are considered "significant" in terms of the EIA Regulations, the potential effects of the Development as a result of shadow flicker, when mitigated, are considered to be not significant.

4.10 CUMULATIVE EFFECTS

As per **Appendix 2.2**, the nearest operational wind farm to the Site is Garvagh Glebe, comprising 13 turbines located <1km to the South-West of the Site Boundary. The Development along with other Irish renewables generation is considered to be a fundamental change in the climate effects of Ireland's energy supply, which is an important, positive effect that is significant under the EIA regulations and will contribute to Ireland's legally binding reduction targets.

The Project will contribute to the offset of burning of fossil fuels which has the potential to positively impact human health. The cumulative impact of the Project can be predicted to be a small, short-term negative impact on tourism and amenity during construction. There is predicted to be a short-term, moderate positive impact in terms of employment from the Development.

4.11 SUMMARY OF SIGNIFICANT EFFECTS

The assessment has not identified any likely significant effects from the Project on population and human health.

4.12 STATEMENT OF SIGNIFICANCE

This chapter has assessed the significance of potential effects of the Project on population and human health. The Project has been assessed as having the potential to result in effects of a slight positive, long-term impact overall. Through the implementation of mitigation measures, the cumulative effects associated with the Project are predicted to be not significant.