FEHILY TIMONEY

CONSULTANTS IN ENGINEERING, ENVIRONMENTAL SCIENCE & PLANNING

ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR) FOR THE PROPOSED FAHY BEG WIND FARM, CO. CLARE

VOLUME 2 – MAIN EIAR

CHAPTER 9 – LAND, SOILS AND GEOLOGY

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9. LAND, SOILS AND GEOLOGY

9.1 Introduction

This chapter has been prepared to examine the potential impacts of the proposed Fahy Beg Wind Farm, associated grid connection and turbine delivery route on existing geological conditions within the study area. The effects of the proposed project are considered, taking account of mitigation measures to reduce or eliminate any residual impacts on land, soils and geology. The assessment also considers the cumulative impacts associated with other nearby developments.

A detailed description of the project assessed in this EIAR is provided in Chapter 3 and is comprised of three main elements:

- The wind farm (hereinafter referred to as the **'site'**);
- Turbine delivery route (hereinafter referred to as the **'turbine delivery route'** or **'TDR'**);
- Grid connection route (hereinafter referred to as the **'grid connection'** or **'GCR'**).

The site includes the wind turbines, internal access tracks, hard standings, the permanent meteorological mast, onsite substation, internal electrical and communications cabling, temporary construction compound, drainage infrastructure and all associated works related to the construction of the site. The GCR will consist entirely of underground 38kV cable and will connect the on-site substation to the existing 110kV substation at Ardnacrusha. The turbine delivery route includes all aspects of the route from the M7/R494 junction to the site entrance including proposed temporary accommodation works to facilitate the delivery of wind turbine components.

9.2 Assessment Methodology

In summary the methodology adopted for this assessment includes:

- Review of appropriate guidance and legislation;
- Characterisation of the receiving environment;
- Review of the proposed project;
- Assessment of potential effects;
- Identification of mitigation measures; and
- Assessment of residual impacts.

The assessment methodology and criteria are outlined in Section 9.2.4.

9.2.1 Relevant Guidance

The general EIA guidelines are listed in Chapter 1, other topic specific reference documents used in the preparation of this section include the following:

- NRA (2009), Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes
- IGI (2013), Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements
- Scottish Executive (2017) Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments, 2nd Edition.
- European Union (2000/60/EC) Water Framework Directive
- European Union (2006/188/EC) Groundwater Directive
- Government of Ireland (2010) European Communities Environmental Objectives (Groundwater) Regulations (S.I. No. 9 of 2010)
- Government of Ireland (2003) European Communities (Water Policy) Regulations (S.I. No. 722 of 2003)
- EPA (2003), Towards Setting Guideline Values for the Protection of Groundwater in Ireland.
- EPA (2017), Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (Draft).

9.2.2 Water Framework and Groundwater Directives, Status and Risk Assessment

The Water Framework Directive (WFD) provides for the protection, improvement and sustainable use of waters, including rivers, lakes, coastal waters, estuaries and groundwater within the EU Member States. It aims to prevent deterioration of these water bodies and enhance the status of aquatic ecosystems; promote sustainable water use; reduce pollution; and contribute to the mitigation of floods and droughts.

Under the Water Framework Directive large geographical areas of aquifer have been subdivided into smaller groundwater bodies (GWB) for them to be effectively managed.

The overriding purpose of the WFD is to achieve at least “good status” in all European waters and ensure that no further deterioration occurs in these waters. European waters are classified as groundwaters, rivers, lakes, transitional and coastal waters. The first cycle of river basin management planning, which covered the period 2009-2015, developed plans and associated programmes of measures based on eight River Basin Districts (RBDs) within the island of Ireland. These plans set ambitious targets that envisaged that most water bodies would achieve good status by 2015.

The Groundwater Directive establishes a regime which sets groundwater quality standards and introduces measures to prevent or limit inputs of pollutants into groundwater. The directive establishes quality criteria that take account of local characteristics and allows for further improvements to be made based on monitoring data and new scientific knowledge. The directive thus represents a proportionate and scientifically sound response to the requirements of the Water Framework Directive (WFD) as it relates to assessments on chemical status of groundwater and the identification and reversal of significant and sustained upward trends in pollutant concentrations in groundwater.

9.2.3 Consultation

The scope for this assessment has been informed by consultation with statutory consultees, bodies with environmental responsibility and other interested parties as summarised in Chapter 5 – Scoping, Consultation and Key Issues. Responses from the consultees identified a range of observations which have been taken into consideration in the preparation of the respective chapters of this EIAR. Specific issues raised during the scoping process with respect to Land, Soils and Geology were as follows:

- Geological Survey Ireland (GSI) – geology and material assets;
- Irish Water – water quality.

9.2.4 Impact Appraisal Methodology

As outlined in Section 9.1, the aim of this is to identify the impacts of the construction, operation and decommissioning of the proposed project and associated works on the existing Land, Soils and Geology of the study area. The assessment also identifies appropriate mitigation measures to minimise these impacts.

The following elements were examined to determine the potential impacts of the proposed project on the Land, Soils and Geology within the study area:

- characterisation of the land, soils and geology underlying the proposed project;
- evaluation of the potential impacts of the proposed project.

The baseline geological and hydrogeological conditions within the study area were determined following a desktop review of publicly available information including aerial photography and EPA and GSI online databases. Site walkovers and intrusive investigations were also carried out. The study area is defined as the area that could potentially experience impacts from any element of the project.

Following the assessment of the existing environment, the unmitigated impacts of the proposed project during the construction, operational and decommissioning phases on sensitive receptors identified were determined. The evaluation of the significance of the impacts was undertaken in accordance with the IGI guidance (2013).

Where potential impacts were identified, mitigation measures were recommended to minimise impacts on the environment to acceptable levels of significance. The residual impact from the proposed project was then re-appraised taking into account the recommended measures. The residual impacts from the proposed project are presented in Section 9.7 of this chapter.

9.2.5 Evaluation Criteria

During each phase (construction, operation, maintenance and decommissioning) of the proposed project, several activities will take place on site, some of which will have the potential to cause impacts on the geological regime at the proposed site and the associated Land, Soil and Geology. These potential impacts are discussed throughout this chapter. Mitigation measures where required are presented in Section 9.6.

9.2.5.1 Assessment of Magnitude and Significance of Impact on Land, Soils and Geology

An impact rating has been developed for each of the phases of the proposed project based on the Institute for Geologists Ireland (IGI) "Guidance for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements". In line with the IGI Guidance, the receiving environment (Geological Features) was first identified.

Using the NRA rating criteria in Appendix C of the IGI Guidance, the importance of the geological and hydrogeological features are rated (Tables Table 9-1 and
Table 9-2) followed by an estimation of the magnitude of the impacts on geological and hydrogeological features (Tables

The assessment of the magnitude of an impact incorporates the timing, scale, size and duration of the potential impact. The magnitude criteria for impact on Geological and Hydrogeological features are outlined in Tables 9.3 and 9.4 respectively.

Table 9-3 and
Table 9-4).

This determines the significance of the impact prior to application of mitigation measures as set out in Table 9-5.

Table 9-1: Criteria rating Site Importance of Geological Features (NRA, 2009)

Magnitude	Criteria	Typical Example
Very High	Attribute has a high quality, significance or value on a regional or national scale. Degree or extent of soil contamination is significant on a national or regional scale. Volume of peat and/or soft organic soil underlying the site is significant on a national or regional scale	• Geological feature on a regional or national scale (NHA). • Large existing quarry or pit. • Proven economically extractable mineral resource
High	Attribute has a high quality, significance or value on a local scale. Degree or extent of soil contamination is significant on a local scale. Volume of peat and/or soft organic soil underlying the site is significant on a local scale	• Contaminated soil on site with previous heavy industrial usage • Large recent landfill site for mixed wastes • Geological feature of high value on a local scale (County Geological Site) • Well drained and/or high fertility soils • Moderately sized existing quarry or pit • Marginally economic extractable mineral resource
Medium	Attribute has a medium quality, significance or value on a local scale. Degree or extent of soil contamination is moderate on a local scale. Volume of peat and/or soft organic soil underlying the site is moderate on a local scale	• Contaminated soil on site with previous light industrial usage • Small recent landfill site for mixed wastes • Moderately drained and/or moderate fertility soils • Small existing quarry or pit • Sub- economic extractable mineral resource
Low	Attribute has a low quality, significance or value on a local scale. Degree or extent of soil contamination is minor on a local scale. Volume of peat and/or soft organic soil underlying the site is small on a local scale	• Large historical and/or recent site for construction and demolition wastes • Small historical and/or recent landfill site for construction and demolition wastes • Poorly drained and/or low fertility soils • Uneconomic extractable mineral resource.

Table 9-2: Criteria rating Site Importance of Hydrogeological Features (NRA, 2009)

Importance	Criteria	Typical Example
Extremely High	Attribute has a high quality or value on an international scale	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation e.g. SAC or SPA status
Very High	Attribute has a high quality or value on a regional or national scale	Regionally Important Aquifer with multiple wellfields. Groundwater supports river, wetland or surface water body ecosystem protected by national legislation – e.g. NHA status. Regionally important potable water source supplying >2500 homes Inner source protection area for regionally important water source.
High	Attribute has a high quality or value on a local scale	Regionally Important Aquifer. Groundwater provides large proportion of baseflow to local rivers. Locally important potable water source supplying >1000 homes. Outer source protection area for regionally important water source. Inner source protection area for locally important water source.
Medium	Attribute has a medium quality or value on a local scale	Locally Important Aquifer Potable water source supplying >50 homes. Outer source protection area for locally important water source.
Low	Attribute has a low quality or value on a local scale	Poor Bedrock Aquifer. Potable water source supplying <50 homes.

The assessment of the magnitude of an impact incorporates the timing, scale, size and duration of the potential impact. The magnitude criteria for impact on Geological and Hydrogeological features are outlined in Tables 9.3 and 9.4 respectively.

Table 9-3: Estimation of Magnitude of Impact on Geological Features (NRA, 2009)

Magnitude	Criteria	Typical Example
Large Adverse	Results in loss of attribute	• Loss of high proportion of future quarry or pit reserves • Irreversible loss of high proportion of local high fertility soils • Removal of entirety of geological heritage feature • Requirement to excavate / remediate entire waste site • Requirement to excavate and replace high proportion of peat, organic soils and/or soft mineral soils beneath alignment
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	• Loss of moderate proportion of future quarry or pit reserves • Removal of part of geological heritage feature • Irreversible loss of moderate proportion of local high fertility soils • Requirement to excavate / remediate significant proportion of waste site • Requirement to excavate and replace moderate proportion of peat, organic soils and/or soft mineral soils beneath alignment
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	• Loss of small proportion of future quarry or pit reserves • Removal of small part of geological heritage feature • Irreversible loss of small proportion of local high fertility soils and/or • high proportion of local low fertility soils • Requirement to excavate / remediate small proportion of waste site • Requirement to excavate and replace small proportion of peat, organic soils and/or soft mineral soils beneath alignment
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	No measurable changes in attributes
Minor Beneficial	Results in minor improvement of attribute quality	Minor enhancement of geological heritage feature
Moderate Beneficial	Results in moderate improvement of attribute quality	Moderate enhancement of geological heritage feature
Major Beneficial	Results in major improvement of attribute quality	Major enhancement of geological heritage feature

Table 9-4: Estimation of Magnitude of Impact on Hydrogeological Features (NRA, 2009)

Magnitude	Criteria	Typical Example
Large Adverse	Results in loss of attribute and /or quality and integrity of attribute	Removal of large proportion of aquifer. Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems. Potential high risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >2% annually.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Removal of moderate proportion of aquifer. Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or ecosystems. Potential medium risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >1% annually.
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Removal of small proportion of aquifer. Changes to aquifer or unsaturated zone resulting in minor change to water supply springs and wells, river baseflow or ecosystems. Potential low risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >0.5% annually.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Calculated risk of serious pollution incident <0.5% annually.

The matrix in Table 9-5 determines the significance of the impacts based on the importance and magnitude of the impacts as determined by Tables Table 9-1 to
Table 9-4.

Table 9-5: Ratings of Significance of Impacts for Geology/Hydrogeology (NRA, 2009)

Importance of Attribute	Magnitude of Impact			
	Negligible	Small Adverse	Moderate Adverse	Large Adverse
Very High	Imperceptible	Significant/Moderate	Profound/Significant	Profound
High	Imperceptible	Moderate/Slight	Significant/Moderate	Profound/Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight/Moderate

The determination of the significance of each impact for the proposed project is discussed in Section 9.5.

9.2.6 Desk Study - Methodology

Prior to undertaking the site walkovers and intrusive site investigations, a desk study was undertaken to determine the baseline conditions within the study area and planning boundary to provide relevant background information. The desk top study involved an examination of the following sources of information:

- Geology of Tipperary [i]
- Groundwater Protection Scheme for County Clare [ii]
- Aerial imagery from Google and Bing accessed in 2020
- Current and historical (6 inch and 25 inch) Ordnance Survey maps [iii]
- Clare Wind Energy Strategy 2017 – 2023 [iv]
- DoEHLG Wind Farm Planning Guidelines [v]
- IWEA Best Practice Guidelines [vi]
- Flood Risk Data [vii]
- Ecological Designations [viii]
- Mapping data of the area produced by the Geological Survey of Ireland (GSI) [ix]
    - *Quaternary subsoil geology*
    - *100k bedrock geology*
    - *Karst features*
    - *Geological heritage features*
    - *Aggregate potential*
    - *Landslide susceptibility*
- Datasets from the EPA [x]
- European Union open datasets [xi]
- Peat Landslide Hazard and Risk Assessments, Best Practice Guide for Proposed Electricity Generation Developments [xii]

9.2.7 Site Investigations and Field Assessments – Methodology

As part of the geotechnical assessment site walkovers were undertaken by Fehily Timoney and Company (FT) in August 2021 (undertaken by Alison Delahunty BEng, MSc, CEng – Senior Geotechnical Engineer with 10 years' experience) and June 2022 (undertaken by Aaron Clarke BSc, MSc, PGeo, EurGeol – Principal Geologist with 18 years' experience) to determine the baseline characteristics of the proposed site.

The site assessment works undertaken comprised the following:

- Walk over inspections of the main site with recording of salient geomorphological features at proposed infrastructure locations;
- Peat depth probing and slope stability assessment at proposed turbine and access road locations;

- Recording of GPS co-ordinates of site investigation locations using a hand-held GPS.

Intrusive site investigations were undertaken by Irish Drilling Ltd (IDL) under the supervision of FT during February and May 2022. An addition round of trial pitting was undertaken by FT in July 2022.

The scope of the site investigations is summarised below with the information obtained referenced in this chapter:

3rd to 7th February 2022

- Advancement of 10 No. trial pits to a maximum depth of 3.0m below ground level (BGL) at proposed turbine locations and various infrastructure locations.
- Collection of samples for environmental and geotechnical testing.
- Works were supervised by Alison Delahunty BSc, MSc, CEng – Senior Geotechnical Engineer at FT.

13th May 2022

- Advancement of 5 No. trial pits to a maximum depth of 4.50m below ground level (BGL) at revised substation location.
- Collection of samples for environmental and geotechnical testing.
- Works were supervised by Aaron Clarke BSc, MSc, PGeo, EurGeol – Principal Geologist at FT.

5th July 2022

- Advancement of 8 No. trial pits to a maximum depth of 4.50m below ground level (BGL) at revised substation locations. Based on the investigation findings, the final substation location will be located to the south of the site where trial pits TP01 to TP04 were excavated.
- Trial pits were logged by Alan Whelan BEng, MIEI, GMICE – Graduate Engineer at FT.

9.3 Receiving Environment

The existing environment is described hereunder. This includes descriptions of the underlying quaternary and bedrock geology, areas of geological heritage, areas of economic interest with respect to geological resources, potential for soil contamination, aquifer classification, groundwater vulnerability and groundwater wells and springs. This section also includes a summary of site-specific information obtained during site walkovers and intrusive site investigations undertaken as part of the baseline assessment works.

The majority of turbine locations and associated infrastructure are underlain by Till derived from Lower Palaeozoic sandstones and shales. One turbine location (T5) is located in an area underlain by bedrock outcrop or sub-crop.

The majority of the GCR is underlain by Till derived from Devonian Sandstones with limited areas of bedrock sub-crop or outcrop, Till derived from Lower Palaeozoic sandstones and shales, Gravel derived from Lower Palaeozoic and Devonian sandstones and alluvium indicated along the proposed route.

During site walkovers limited areas of shallow Peaty Topsoil deposits were noted to be limited in extent and thin with typical thicknesses of between 0.1 – 0.2m. These deposits are not considered to constitute Peat but rather a highly organic Topsoil with a peaty appearance.

9.3.1 Quaternary (Subsoil) Geology

The GSI online 1:50,000 scale Quaternary Geology map (Figure 9-1) shows that the site comprises of the following:

- The northern portion of the site characterised by bedrock outcrop / sub-crop (Rck) (exposed on the slopes of Lackareagh Mountain);
- The central and southern portions of the site are underlain by Till derived from Lower Palaeozoic sandstones and shales (TLPSsS);
- The western extent of the site is predominantly underlain by gravels derived from Lower Palaeozoic sandstones and shales (GLPDSs); and
- Narrow (approximately 20-50m wide) linear deposits for Fen Peat (FenPt) and Alluvium (A) are mapped along the far western margin of the site.

9.3.2 Bedrock Geology

The GSI online 1:100,000 scale bedrock geology map (Figure 9-2) along with the Tuamgraney-Lisvarrinane cross-section (GSI Geology of Tipperary - Sheet 18) shows that the site is underlain by the following formations:

- Old Red Sandstone (ORS);
- Broadford Formation.

The ORS underlies most of the southern half of the site and is described as red conglomerates, sandstone and mudstone. The Broadford Formation underlies the northern half of the site and is described as fine to conglomeratic graded greywacke. The boundary between these two formations is mapped as an east-west trending unconformable contact, which juxtaposes younger ORS against Broadford Formation. This unconformable contact is broken by a similarly trending normal fault. Fault bound inliers of ORS, forming horst blocks within the surrounding Broadford Formation, are mapped to the north of the site.

The ORS and Broadford Formation form part of the northern limb of a regional scale east-west trending syncline, which is heavily fractured by a series of east-west, north-west and north-east trending normal and reverse faults. However, most of these faults (with the exception of the fault separating the ORS and Broadford Formation), are located either along the northern and eastern periphery of the site or outside of the site boundary.

Bedding dips across the site range from 3-35° with a general dip direction to the south.

The GCR route traverses the ORS Formation at various sections of the route. The remainder of the route passes through Lower Limestone Shale, Cratloes Formation, Ballysteen Formation and Waulsortian Limestone.

Bedrock outcrop is recorded within the northern portion of the site area.

9.3.3 Hydrogeology

9.3.3.1 Groundwater Vulnerability

Groundwater vulnerability, as defined by the GSI, is the term used to represent the intrinsic and hydrogeological characteristics that determine the ease of which groundwater could be contaminated by human activities. The vulnerability of an aquifer to contamination is influenced by the leaching characteristics of the topsoil, the permeability and thickness of the subsoil, the presence of an unsaturated zone, the type of aquifer, and the amount and form of recharge (the hydraulic process where water moved downward from surface water to groundwater).

Groundwater vulnerability is determined mainly according to the thickness and permeability of the subsoil that underlies the topsoil, as both properties strongly influence the travel times and attenuation process of contaminants that could be released into the subsurface from below the topsoil.

The Groundwater Vulnerability within the site ranges from 'H – High' to 'X – rock at or near surface'. Along the GCR, the vulnerability classification ranges from 'Moderate' to 'Extreme' with localised areas of exposed bedrock (X). The GSI distribution of groundwater vulnerability for the proposed project is shown in Figure 9-3.

Based on the GSI aquifer vulnerability mapping, overburden deposits are generally <3m deep across the majority of the site.

A summary of the groundwater vulnerability for the proposed project is presented in Table 9-6. This table outlines the standard ratings of vulnerability used by the GSI, with the existing site conditions highlighted based on the findings of the site investigations.

Table 9-6: Groundwater Vulnerability

Vulnerability Rating	Hydrogeological Conditions		
	Subsoil Permeability (Type) and Thickness		
	High Permeability (sand/gravel)	Moderate Permeability (sandy soil)	Low Permeability (clayey subsoil, clay, peat)
Extreme (E)	0 - 3.0 m*	0 - 3.0 m	0 - 3.0 m
High (H)	> 3.0 m*	3.0 -10.0 m	3.0 - 5.0 m
Moderate (M)	N/A	>10.0 m	5.0 - 10.0 m
Low (L)	N/A	N/A	>10 m

*Confined to the western portion of the site at Ballyquin Quarry where extensive deposits of sand and gravel are found.

9.3.3.2 Groundwater Bodies Description

The site is located within three groundwater bodies namely the Lough Graney, Tulla-Newmarket-on-Fergus, and Broadford Gravels Figure 9-4. The GRC is underlain predominantly by the Lough Graney GWB, with the northern area of the route underlain by Broadford Gravels GWB and the southern area of the route underlain by Ardnacrusha GWB.

The description of the GWBs within the study area have been taken from the 'Summary of Initial Characterisation' draft reports for each defined GWB published by the GSI in accordance with the Groundwater Working Group Publication: Guidance Document GW2 (2003). The GWB Characterisation Reports are available from the GSI Public Data Viewer. Site specific data including depth to bedrock and subsoil type encountered during intrusive investigations have been used to supplement and validate the published information. At the time of writing this Chapter, no information sheet was available for the Broadford Gravels GWB. It should be noted that the Broadford Gravels GWB extents do not encroach on any of the turbine locations, with the closest turbine at a distance of approximately 200m east of this GWB.

According to interim classification work carried out as part of the Water Framework Directive and published by the EPA, the Lough Graney GWB, Tulla-Newmarket-on-Fergus GWB, Ardnacrusha GWB and Broadford Gravels GWB are classified as having "Good" status in terms of quality and quantity. The overall risk result of "Review" is applied to Tulla--Newmarket-on-Fergus GWB and "Not at Risk" is applied to Lough Graney GWB, Ardnacrusha GWB and Broadford Gravels GWB.

A summary of the aquifer classifications are included in Table 9-7 and Figure 9-5.

Table 9-7: Summary of Aquifer Classifications

GWB	European Code	Aquifer Category	Flow Regime
Lough Graney	IE_SH_G_157	The GWBs straddle two distinct aquifer designations: • Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones • Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones	Poorly productive bedrock
Tulla-Newmarket-on-Fergus	IE_SH_G_229		Poorly productive bedrock
Broadford Gravels	IE_SH_G_095		Gravel
Ardnacrusha	IE_SH_G_009	Regionally Important Aquifer – Karstified (conduit)	Karstic

9.3.3.3 Groundwater Supply Sources

A review of published information on groundwater supply sources within the study area was undertaken to identify potential groundwater dependant receptors at potential risk from the proposed project. These include group water schemes (GWS), source protection zones and private supply wells with information on these features obtained from the GSI Groundwater database.

9.3.3.4 Public Water Supplies and Source Protection Zones

The GSI maintains a database of Public Supply Source Protection Areas. From a review of the database there are no Public Water Supplies (PWS's) or Public Supply Source Protection Areas within the site boundary or along the GCR.

There are however 3 No. Source Protection Areas for public water supply schemes in the wider study area, and these are:

- Scarriff Water Supply Scheme, approximately 19km north of the proposed project boundary;
- Whitegate Public Supply, approximately 18km northeast of the proposed project boundary;
- Murroe Public Supply, approximately 16km southeast of the proposed project boundary.

9.3.3.5 Group Water Schemes and Source Protection Zones

Based on a review of the current EPA and GSI groundwater databases, there are no groundwater source protection zones within the site. The nearest source protection zone is the Drombane Source Protection Areas located approximately 7km northeast of the site. However, the Bridgetown public water supply is located 1.4km south of the site but there is no drinking water protection area around the zone of contribution.

9.3.3.6 Groundwater Wells and Springs

Based on a review of the GSI Groundwater Wells and Springs database there are several wells recorded near the proposed development in the Lough Graney GWB and the Tulla-Newmarket-on-Fergus GWB. Based on GSI mapping, there is an accuracy of 10 to 1,000m of the well location. The available details of these wells are summarised below in Table 9.8. There may also be additional wells not included in the GSI dataset.

Table 9.8 below outlines details of groundwater wells and springs held within the GSI dataset within 1 km of the proposed project:

Table 9-8: Summary of Wells with 1km of the Proposed Project

Location ID	Easting	Northing	Type	Total Depth (m BGL)	Well Use	Yield Class	GSI Location Accuracy (m)	Nearest Infrastructure ID
1417SEW015	565321	671617	Borehole	94.5	Agri & domestic use	Moderate	1000	T7
1417SEW019	565321	671617	Borehole	108.5	Agri & domestic use	Poor	5000	T7
1417SEW027	565527	670241	Borehole	15.8	Domestic use only	Good	20	T8
1417SEW050	562348	671330	Borehole	48.8	Agri & domestic use	Good	20	T1
1415NEW070	562059	669740	Borehole	32.3	Agri & domestic use	Excellent	50	T1/T2
1415NEW077	561653	669076	Borehole	68.9	Agri & domestic use	Poor	50	T3/T4
1415NEW013	562047	668607	Dug well	2.7	Agri & domestic use	Poor	500	T4/GCR
1415NEW008	562756	668156	Borehole	77.4	Agri & domestic use	Poor	2000	GCR
1415NEW069	561488	668552	Borehole	54.3	Domestic use only	Good	100	GCR
1415NEW010	561824	667522	Borehole	8.2	Agri & domestic use	Poor	1000	GCR
1415NEW064	562219	666865	Borehole	31.4	N/A	N/A	500	GCR
1415NEW079	561088	667352	Borehole	49.7	Agri & domestic use	Moderate	50	GCR
1415NEW017	559894	666296	Dug well	34.1	Agri & domestic use	Poor	1000	GCR
1415NEW018	559870	666300	Dug well	33.5	Agri & domestic use	Poor	1000	GCR
1415NEW047	560341	665719	Borehole	123.4	Agri & domestic use	Poor	1000	GCR
1415NEW040	559139	665333	Dug well	32	Agri & domestic use	Poor	1000	GCR

Location ID	Easting	Northing	Type	Total Depth (m BGL)	Well Use	Yield Class	GSI Location Accuracy (m)	Nearest Infrastructure ID
1415NEW078	560268	665042	Borehole	1.8	Agri & domestic use	Good	20	GCR
1415NEW031	560167	664842	Borehole	10.2	Agri & domestic use	Poor	1000	GCR
1415NEW046	559496	663945	Borehole	111.6	Agri & domestic use	Poor	1000	GCR
1415NEW044	558705	663694	Borehole	49.4	Agri & domestic use	Moderate	1000	GCR
1415NEW045	558714	663642	Borehole	76.2	Agri & domestic use	Poor	1000	GCR
1415NEW021	559851	663492	Borehole	18.3	Other	N/A	1000	GCR
1415NEW022	559838	663466	Borehole	2.7	Agri & domestic use	Poor	1000	GCR
1415NEW019	560177	663205	Dug well	29	Agri & domestic use	Poor	1000	GCR
1415NEW020	560187	663120	Borehole	28.7	Agri & domestic use	Poor	1000	GCR
1415NEW076	559473	663045	Borehole	21.3	Agri & domestic use	Moderate	1000	GCR
1415NEW005	558177	661690	Borehole	15.2	Agri & domestic use	N/A	1000	GCR/Ardnacrusha Power Station
1415NEW066	559540	661830	Borehole	25.6	Public supply (Co Co)	Moderate	100	GCR/Ardnacrusha Power Station
1415NEW061	559460	661739	Borehole	56.7	Public supply (Co Co)	N/A	100	GCR/Ardnacrusha Power Station
1415NEW065	559240	661580	Borehole	93.6	Public supply (Co Co)	N/A	100	GCR/Ardnacrusha Power Station
1415NEW067	559268	661480	Spring	3.1	Industrial use	Intermediate Spring	100	GCR/Ardnacrusha Power Station
1415NEW062	558958	661141	Borehole	18.3	Public supply (Co Co)	N/A	100	GCR/Ardnacrusha Power Station

The GSI database is however not complete; it is probable that there are other wells in addition to those in the GSI databases, but are generally associated with houses, the offset to which from the turbines is a minimum of 750m.

9.3.3.1 Karst Features

According to the GSI datasets, there are no karst features recorded within the main site or along the GCR. Karst features are not likely to occur within the site due to the absence of carbonate bedrock. However, a sinkhole was identified approximately 2.6km to the east of the GCR near Ardnacrusha Power Station. This feature straddles the limestone rocks of the Lough Gur Formation and Waulsortian Limestones. These carbonate rocks underly the southernmost 2km of the GCR and therefore the potential for karst should be considered in this area.

9.3.4 Geological Heritage

The GSI - Irish Geological Heritage Section (IGH) and NPWS (National Parks and Wildlife Service) have undertaken a programme to identify and select important geological and geomorphological sites throughout the country for designation as NHAs (Natural Heritage Areas). This is being addressed under 16 different geological themes. For each theme, a larger number of sites (from which to make the NHA selection) are being examined, to identify the most scientifically significant.

The criterion of designating the minimum number of sites to exemplify the theme means that many sites of national importance are not selected as the very best examples. However, a second tier of County Geological Sites (CGS) (as per the National Heritage Plan) means that many of these can be included in County Development Plans and receive a measure of recognition and protection through inclusion in the planning system.

The GSI Online Irish Geological Heritage database indicates that the proposed project is not located in an area of specific geological heritage interest. There are no audited or unaudited geological heritage areas within the site boundary. The nearest area is the Kilmastulla Meltwater Channels audited geological heritage site and is located approximately 5.5km east of the site. The heritage site has been described by GSI as deep channels that were formed by meltwater erosion.

The distribution of Geological Heritage sites is shown on Figure 9-6.

9.3.5 Economic Geology

The GSI Online Minerals database shows no metallic occurrences within the site. A lead deposit has been recorded within the Broadford Gravels approximately 1.4km north of the site. The quarry Ballyquin Pit operated by Roadstone Ltd. is located within the site boundary. The main product from Ballyquin Pit is sand and gravel for concrete and earthworks use. The distribution of mineral occurrences and active quarries is shown on Figure 9-7.

The GSI Aggregates database indicates that there is:

- a low to very high crushed rock aggregate potential across the site (Figure 9-8); and
- a very high granular aggregate potential within the western portion of the site (Figure 9-9).

9.3.6 Site Investigation - Results

As outlined in Section 9.2.7 a phased ground investigation was undertaken between February and July 2022 to determine the baseline characteristics of the proposed development site.

The detailed findings and conclusions of the site walkovers and site investigation works is provided in Appendix 9.1 – Geotechnical Assessment Report and have generally confirmed the anticipated geology described in the Desk Study outlined in Section 9.3. Factual findings from the intrusive site investigations are presented in Appendices 9.2 and 9.3. A brief description of the ground conditions encountered during the site walkovers and site investigations completed during the assessment of the receiving environment is provided in the following section.

9.3.6.1 Proposed Turbine Locations

Trial pits were excavated at all the turbine locations and a summary of ground and groundwater conditions are presented in Table 9-9.

Table 9-9: Summary of Geology Encountered at Turbine Locations

Hole ID	Strata depth from to (m BGL)					Groundwater Strike (m BGL)
	Topsoil	Glacial Till	Gravel Deposits	Possible Bedrock	Bedrock	
TP-T001	0.0-0.35	0.35-3.00	-	3.00 Note 2	-	1.80
TP-T002	0.0-0.30	0.30-2.50 Note1	-	2.50 Note 2	-	Dry
TP-T003	0.0-0.40	0.40-2.50	-	2.50 Note 2	-	1.00
TP-T004	0.0-0.20	0.20-1.70	1.70-2.30	2.30 Note 2	-	1.80
TP-T005	0.0-0.20	-	-	-	0.20-0.40	Dry
TP-T006	0.0-0.38	0.38-2.10	2.10-2.70	2.70 Note 2	-	Dry
TP-T007	-	0.0-2.3 Note1	-	2.30 Note 2	-	Dry
TP-T008	0.0-0.50	-	0.50-1.80 Note 3	1.80 Note 2	-	Dry
Note 1 – Strata comprises interbedded clayey silty GRAVEL and gravelly CLAY/SILT. Note 2 – Obstruction, possible rock. Note 3 – Strat displays COBBLES & BOULDERS below1.50m bgl.						

Ground conditions at the turbine locations generally comprises Glacial Till over Gravel deposits, which are in turn underlain by bedrock.

The Glacial Till typically comprises firm to stiff CLAY and SILT with a varying coarse-grained component. In trial pits TP-T002 and TP-T007 this stratum is punctuated by a relatively thin (0.4-0.5m thick) interbed of brown GRAVEL.

Gravel Deposits were encountered in three trial pits (TP-T004, TP-T006 and TP-T008) and typically underly the Glacial Till. This stratum comprises pinkish grey-brown GRAVEL with a varying fine-grained component. In TP-T008 this stratum transitions into a COBBLE and BOULDER bed at a depth of 1.80m.

Bedrock was encountered in all eight trial pits and was recorded as either flat angular sandstone GRAVEL (TP-T005) or as an “obstruction” or “hard digging” at the base of the pit.

9.3.6.2 Proposed Substation Location

Three potential substation locations were identified as part of this EIAR. Two separate investigations were undertaken to test ground and groundwater conditions at each of these sites. The first was undertaken in May 2022 and focused on a single area to the west of the site comprising five trail pits (TP-001 to TP-005 – presented in Appendix 9.2). The area being investigated was thought to be a former wash-out used by Roadstone during the operation of Ballyquin Quarry. The second ground investigation was undertaken in July 2022 and focused on two additional substation option locations. These were located to the north of Ballyquin quarry in an area of existing cut and within the southernmost extent of the site within a pastoral field and comprised eight trial pits (TP01-TP08 – Presented in Appendix 9.3). A summary of ground and groundwater conditions are presented in Table 9-10.

Table 9-10: Summary of Geology Encountered at Proposed Substation Locations

Hole ID	Strata depth from to (m BGL)					Groundwater Strike (m BGL)
	Topsoil	Made Ground (coarse-grained)	Made Ground (fine-grained)	Sand Deposits	Possible Bedrock	
TP-001	-	0.0-0.60	0.60-2.30 Note 1	-	-	2.30
TP-002	-	0.0-0.80	0.80-3.40 Note 1	-	-	3.40
TP-003	-	-	0.0-4.50	-	-	4.10
TP-004	-	0.0-2.50 Note 1	-	-	-	1.40
TP-005	-	0.0-3.40 Note 1	-	-	-	Dry
TP01	0.0-0.25	-	-	0.25-4.50	-	Dry
TP02	0.0-0.25	-	-	0.25-4.10 Notes 2 & 3	-	Dry
TP03	0.0-0.30	-	-	0.30-3.30	4.00 Note 3	Dry
TP04	0.0-0.40	-	-	0.40-3.80	4.00 Note 3	Dry
TP05	0.0-0.30	-	-	0.30-4.10 Note 1	-	Dry
TP06	-	-	-	0.0-4.50	-	Dry
TP07	-	0.0-0.60	-	0.60-4.00	4.00 Note 3	Dry
TP08	0.0-0.25	-	-	0.25-3.90 Note 1	-	Seepage at base

Note 1 – Could not reach scheduled depth of 4.50m due to sidewall collapse and/or water ingress.
Note 2 – 0.40m thick interbed of reddish slightly gravelly sandy CLAY below 0.90m.
Note 3 – Possible boulder or bedrock at base of hole. Could not advance to scheduled depth.

Ground conditions at the first substation option location (TP-001 to TP-005) comprise MADE GROUND deposits of interbedded fine silty SAND and soft to very soft CLAY/SILT. These deposits are thought to be the result of wash material originating from adjacent processing works within Ballyquin Quarry. The ground investigation did not identify evidence of contamination (either visual or olfactory) within the MADE GROUND. The base of these strata was not tested.

Ground conditions encountered at the second and third substation option locations (TP01 to TP08) comprise predominantly brown to light brown slightly gravelly SAND with a varying cobble and boulder component. Possible bedrock was encountered in three trial pits (TP03, TP04 and TP07) and was recorded as *'possible boulder or bedrock'* at the base of pit.

9.3.7 Existing Slope Stability

During the site walkovers a series of hand-held probes and shear vanes were undertaken to determine the presence/depth of peat and/or soft soils within the proposed development. Peaty Topsoil deposits were noted throughout the site, but these were generally very thin (0.1 to 0.2m thick) and were not considered to constitute Peat Deposits but rather a highly organic Topsoil with Peaty appearance.

From a desk top review of the GCR, most of the proposed route is situated within existing public highway. As such and given the limited extent of lateral and vertical excavations it was not considered a risk was posed to slope stability along the GCR.

A summary of the general topography and slopes at the proposed development are summarised below.

9.3.7.1 Topography of the Main Wind Farm Site

The western extent of the site (taking up the area of Ballyquin Quarry) is defined by flat to undulating topography frequently punctuated by quarry pits, cuttings and aggregate stockpiles. The GSI's Quaternary Geomorphology mapping indicate this topography (excluding contemporary excavations and stockpiles) is a result of a north-south trending glaciofluvial terrace, which dominates this portion of the site. Elevations generally increase to the east and range from 50 to 90m AOD.

The central and eastern portions of the site can be described as having a "mountain to hill" topography as defined by the GSI's Physiographic mapping. Elevations increase steadily towards the peak of Lackareagh Mountain ranging from 90 to 350m AOD.

Slopes at proposed turbine locations in the development range from 4 (T04) to 12 (T05) degrees.

9.3.7.2 Slope Stability Assessment

From a review of the GSI Landslide Susceptibility database, the proposed development and proposed infrastructure locations are generally located within areas of 'Low' to 'Moderate High' susceptibility, with localised areas classified as 'High' (northernmost extent of the site). A summary of the GSI landslide susceptibility with respect to the proposed development is provided in Figure 9-10.

No evidence of slope instability was observed at the site and there are no historical records of landslide activity within 1km of the site on the GSI database.

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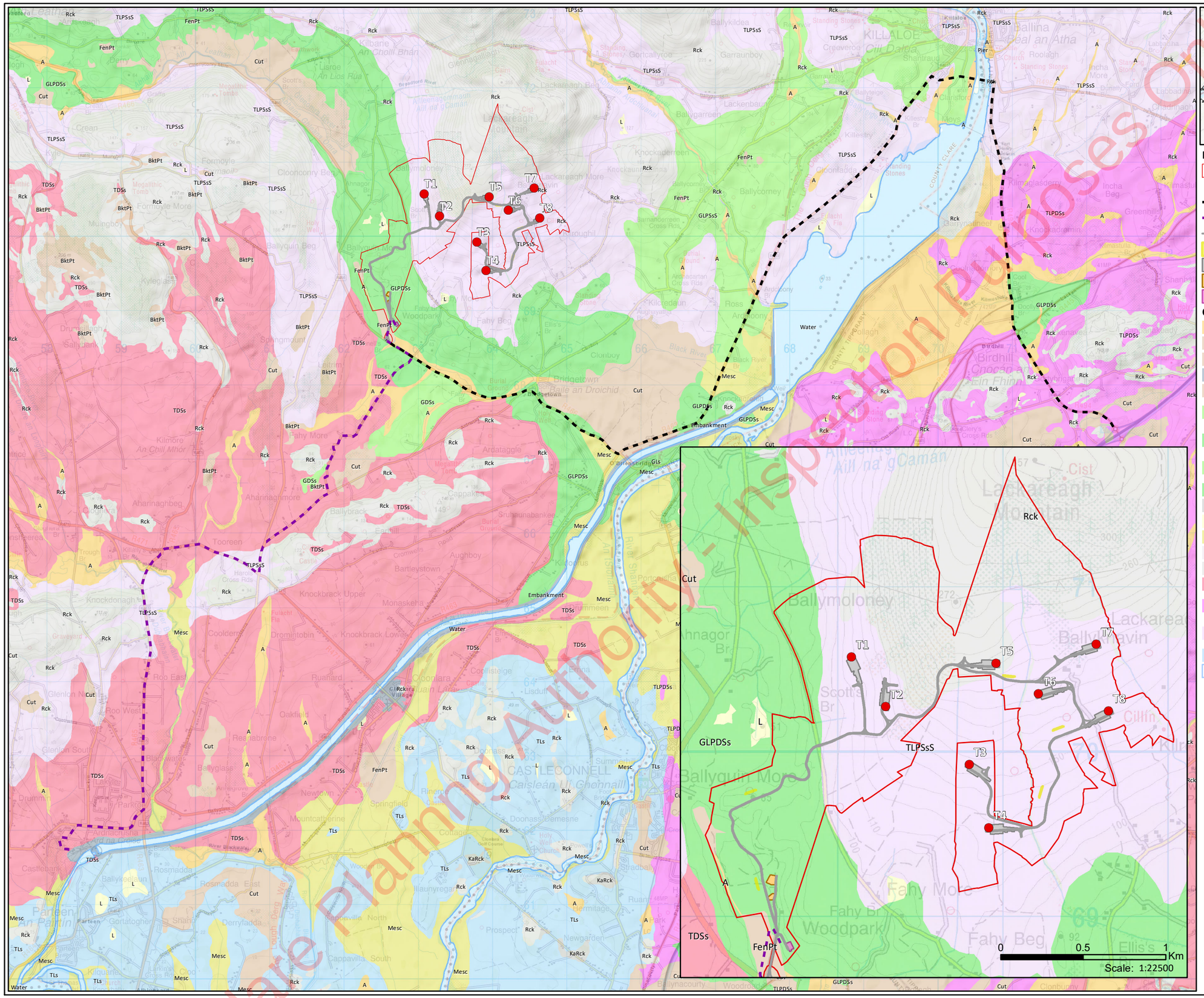

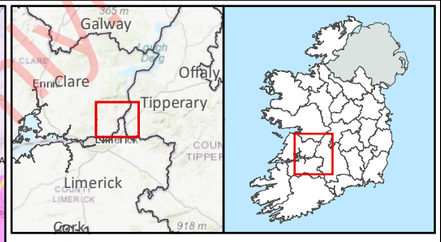

Legend

- Wind Farm Site Boundary
- Proposed Turbine Layout
- Turbine Delivery Route
- Grid Connection Route
- Onsite Access Roads
- Passing Bays
- Turbine Hardstanding Area
- Construction Compound
- Substation Compound

Quaternary Sediments

- A, Alluvium
- BktPt, Blanket Peat
- Cut, Cut over raised peat
- Embankment
- FenPt, Fen Peat
- GDSs, Gravels derived from Devonian sandstones
- GLPDSs, Gravels derived from Lower Palaeozoic and Devonian sandstones
- GLPSsS, Gravels derived from Lower Palaeozoic sandstones and shales
- GLs, Gravels derived from Limestones
- KaRck, Kartsified bedrock outcrop or subcrop
- L, Lacustrine sediments
- Mesc, Esturine silts and clays
- Pier
- Rck, Bedrock outcrop or subcrop
- TDSs, Till derived from Devonian sandstones
- TLPDSs, Till derived from Lower Palaeozoic and Devonian sandstones
- TLPSsS, Till derived from Lower Palaeozoic sandstones and shales
- TLs, Till derived from limestones
- Water

TITLE:	Quaternary Geology		
PROJECT:	Fahy Beg Wind Farm, Co. Clare		
FIGURE NO:	9.1		
CLIENT:	RWE Renewables Ireland Ltd.		
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DATE:	07/10/2022	**PAGE SIZE:**	A3

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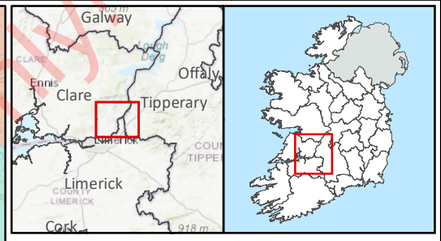

Legend

- Wind Farm Site Boundary
- Proposed Turbine Layout
- Turbine Delivery Route
- Grid Connection Route
- Onsite Access Roads
- Passing Bays
- Turbine Hardstanding Area
- Construction Compound
- Substation Compound

Bedrock Geology

- Ballysteen Formation
- Ballynash Member
- Lough Gur Formation
- Lower Limestone Shale
- Rathkeale Formation
- Visean Limestones (undifferentiated
- Waulsortian Limestones
- Old Red Sandstone (undifferentiated
- Keeper Hill Formation
- in Broadford Formation
- Volcanics
- Broadford Formation
- in Broadford Formation
- Hollyford Formation
- Cratloes Formation

TITLE: Bedrock Geology			
PROJECT: Fahy Beg Wind Farm, Co. Clare			
FIGURE NO:	9.2		
CLIENT:	RWE Renewables Ireland Ltd.		
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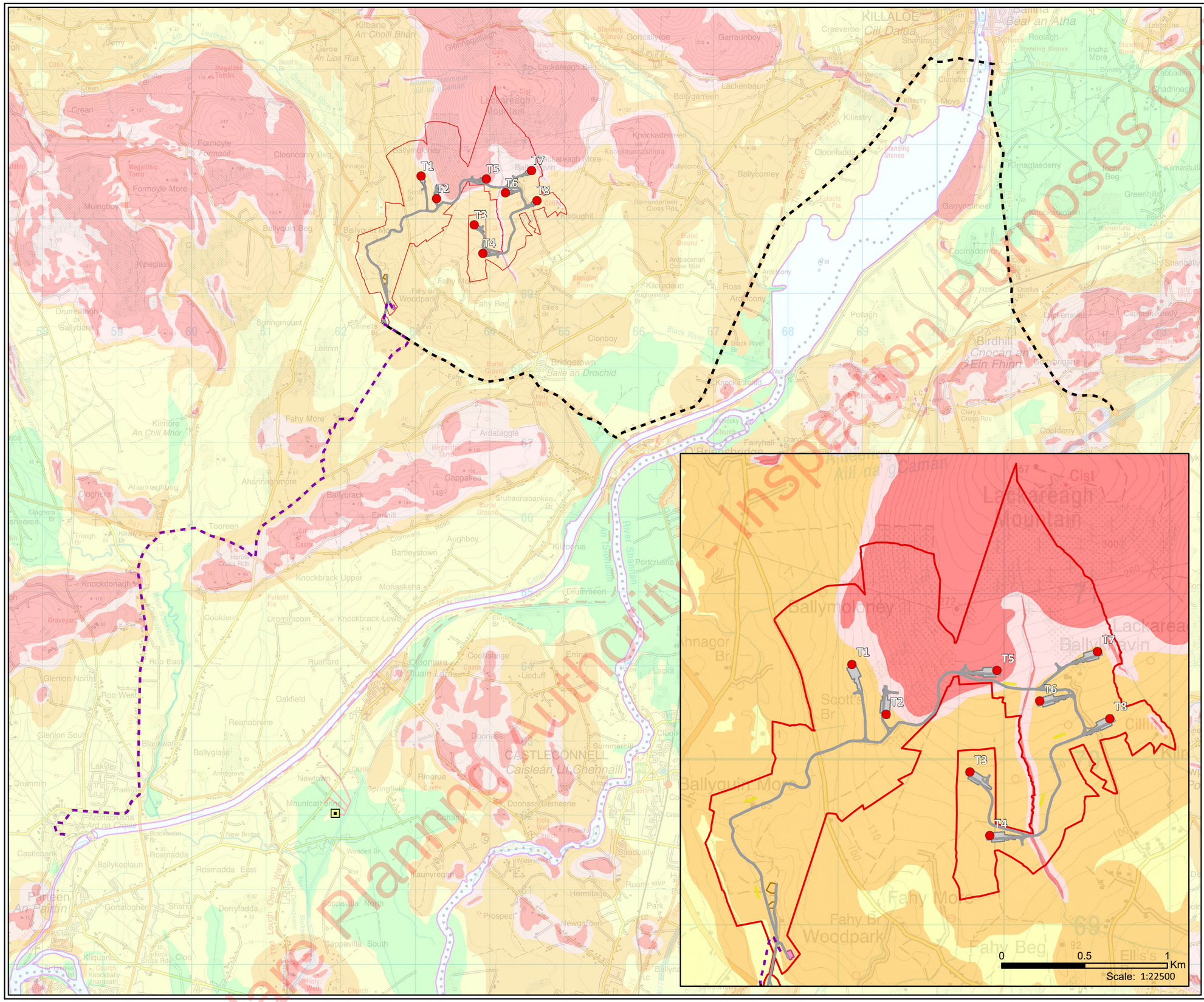

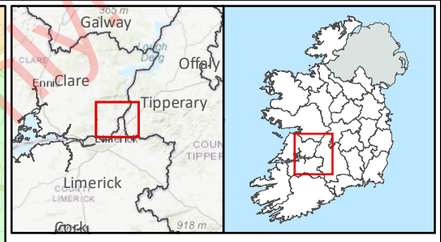

Legend

- Wind Farm Site Boundary
- Proposed Turbine Layout
- Turbine Delivery Route
- Grid Connection Route
- Onsite Access Roads
- Passing Bays
- Turbine Hardstanding Area
- Construction Compound
- Substation Compound

Karst Features

- Swallow Hole

Groundwater Vulnerability

- E - Extreme
- H - High
- M - Moderate
- L - Low
- Water
- X - Rock Near Surface or Karst

TITLE:	Groundwater Vulnerability		
PROJECT:	Fahy Beg Wind Farm, Co. Clare		
FIGURE NO:	9.3		
CLIENT:	RWE Renewables Ireland Ltd.		
SCALE:	1:50000	**REVISION:**	0
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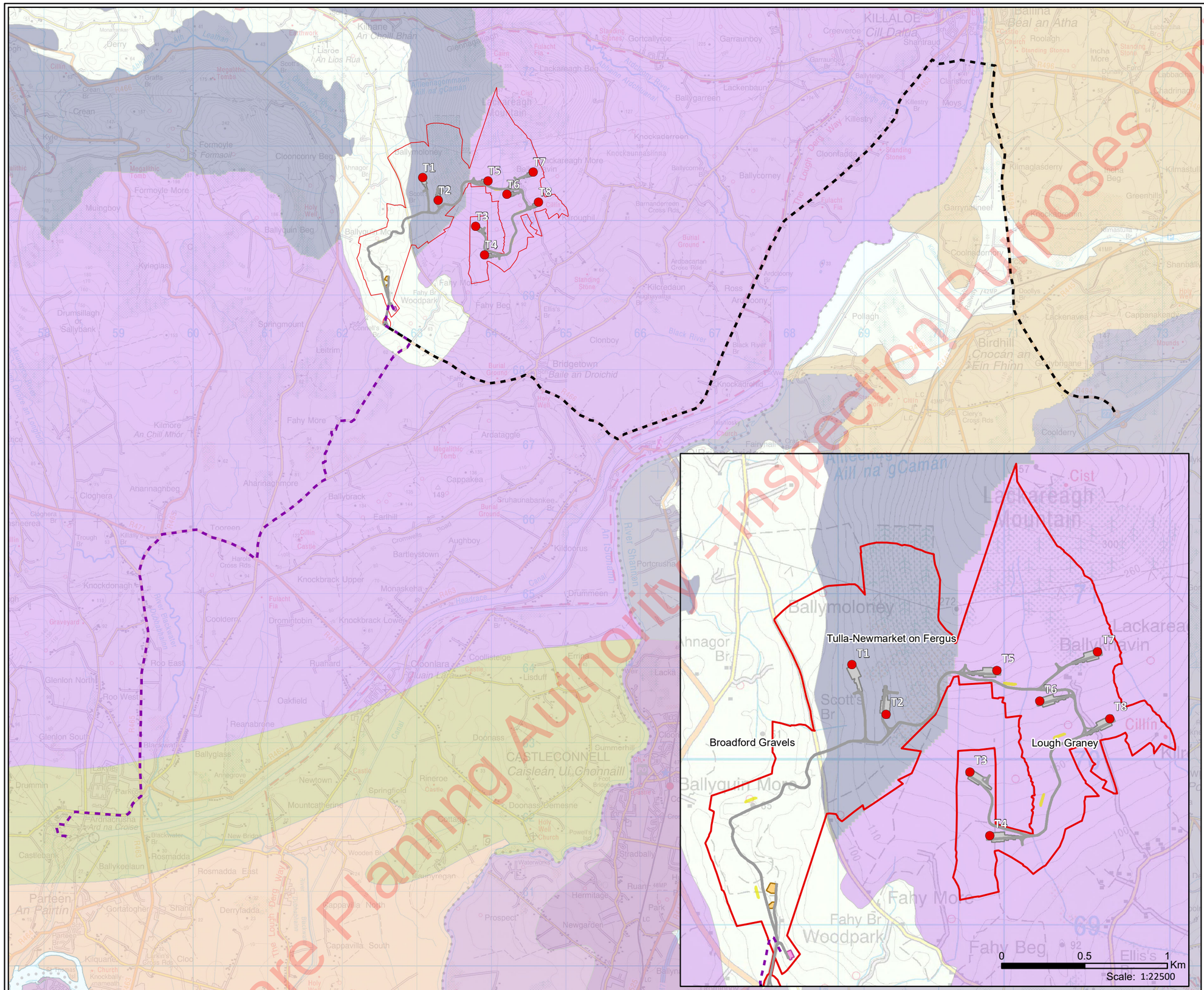

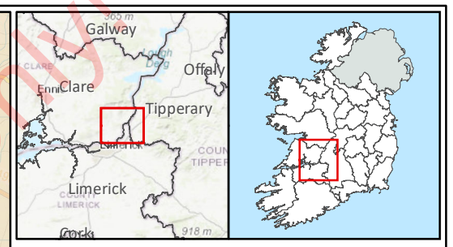

Legend

- Wind Farm Site Boundary
- Proposed Turbine Layout
- Turbine Delivery Route
- Grid Connection Route
- Onsite Access Roads
- Passing Bays
- Turbine Hardstanding Area
- Construction Compound
- Substation Compound

WFD Ground Water Bodies

- Ardnacrusha
- Castleconnell
- Limerick City East
- Limerick City North
- Lough Graney
- Nenagh
- Slieve Phelim
- Tulla-Newmarket on Fergus

TITLE:	Groundwater Bodies		
PROJECT:	Fahy Beg Wind Farm, Co. Clare		
FIGURE NO:	9.4		
CLIENT:	RWE Renewables Ireland Ltd.		
SCALE:	1:50000	**REVISION:**	0
DATE:	07/10/2022	**PAGE SIZE:**	A3

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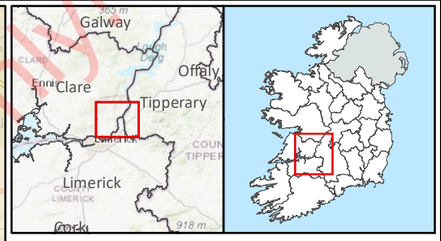

Legend

- Wind Farm Site Boundary
- Proposed Turbine Layout
- Turbine Delivery Route
- Grid Connection Route
- Onsite Access Roads
- Passing Bays
- Turbine Hardstanding Area
- Construction Compound
- Substation Compound
- Wells and Springs (10-50m Accuracy)
- LI: Locally Important Aquifer - Bedrock Mod Productive Locally
- Lm: Locally Important Aquifer - Bedrock Generally Mod Productive
- Pl: Poor Aquifer Bedrock Generally Unproductive Except Locally
- Rkd: Regionally Important Aquifer - Karstified (diffuse)

1417SEW041, 1417SEW045, 1417SEW052, 1417SEW043, 1417SEW042, 1417SEW051, 1417SEW023, 1417SEW035, 1417SEW050, 1417SEW049, 1417SEW038, 1417SEW053, 1417SEW027, 1415NEW070, 1415NEW077, 1415NEW075, 1715NWW004, 1717SWW107, 1717SWW220, 1715NWW090, 1415NEW074, 1415NEW059, 1415NEW079, 1415NEW060, 1415NEW002, 1415NEW078, 1415NEW063, 1415NEW072, 1415NEW071

T1, T2, T3, T4, T5, T6, T7, T8

TITLE:	Aquifer Classification
PROJECT:	Fahy Beg Wind Farm, Co. Clare
FIGURE NO:	9.5
CLIENT:	RWE Renewables Ireland Ltd.
SCALE:	1:50000
REVISION:	0
DATE:	07/10/2022
PAGE SIZE:	A3

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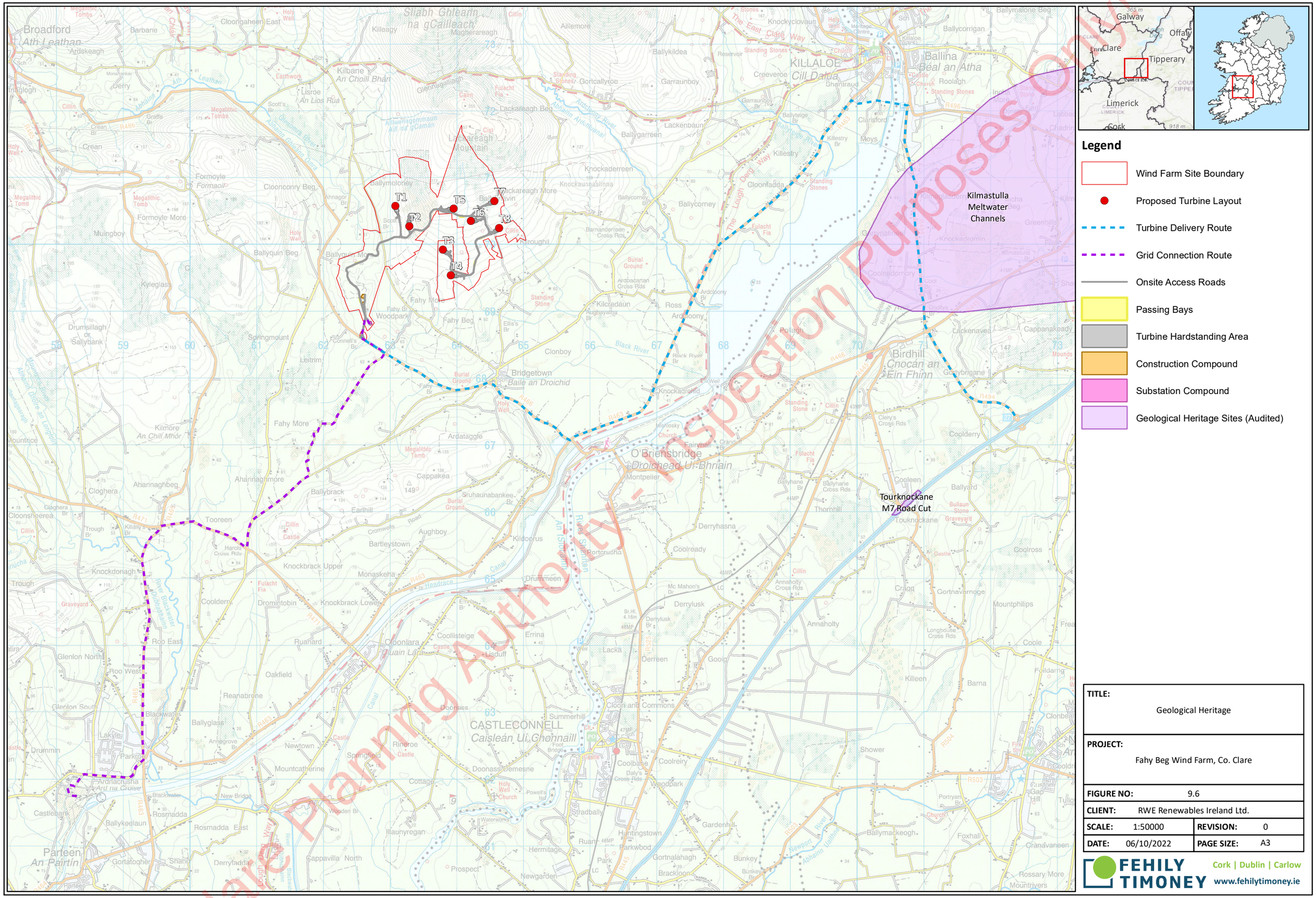

Legend

- Wind Farm Site Boundary
- Proposed Turbine Layout
- Turbine Delivery Route
- Grid Connection Route
- Onsite Access Roads
- Passing Bays
- Turbine Hardstanding Area
- Construction Compound
- Substation Compound
- Geological Heritage Sites (Audited)

TITLE:	Geological Heritage		
PROJECT:	Fahy Beg Wind Farm, Co. Clare		
FIGURE NO:	9.6		
CLIENT:	RWE Renewables Ireland Ltd.		
SCALE:	1:50000	**REVISION:**	0
DATE:	06/10/2022	**PAGE SIZE:**	A3

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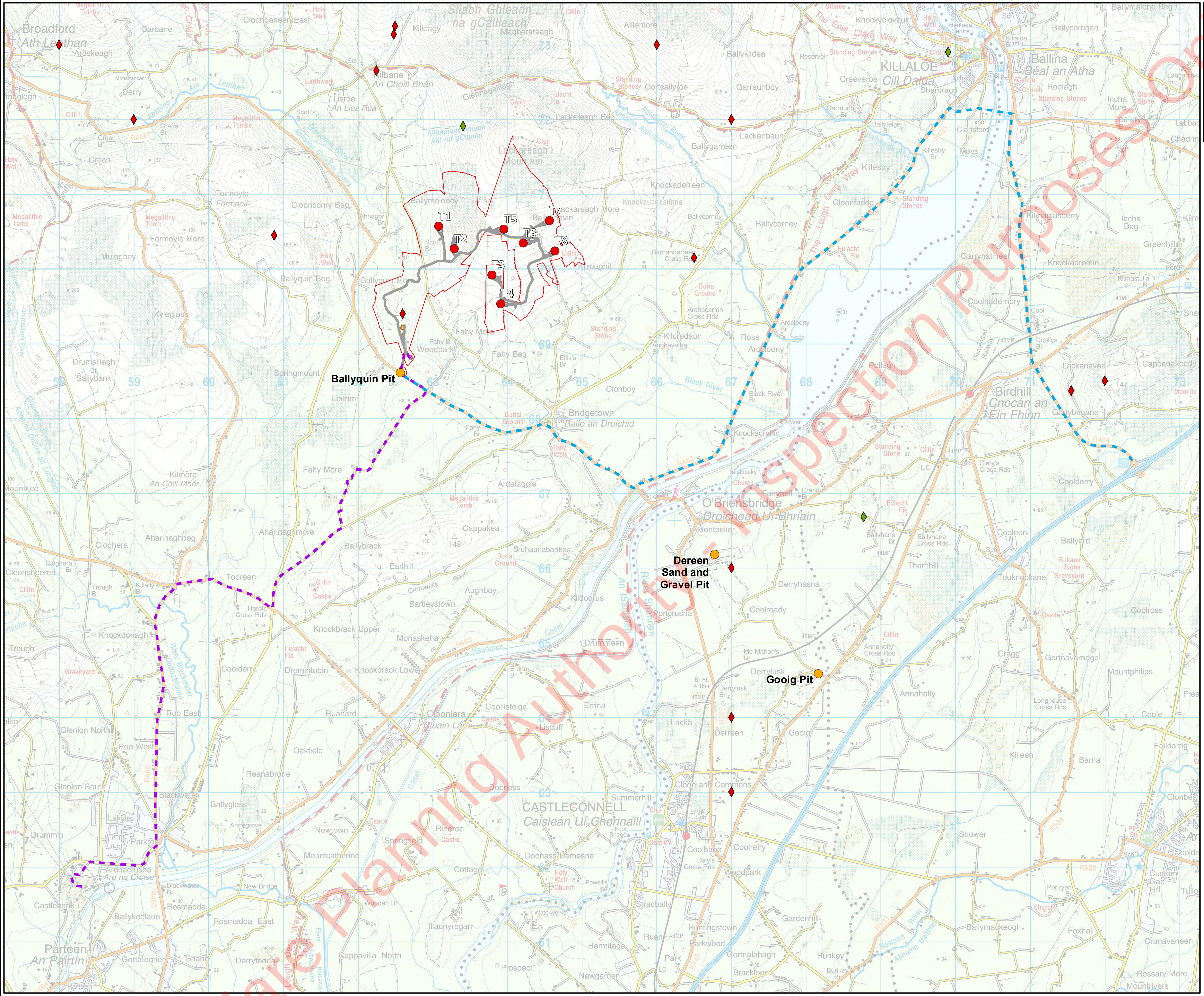

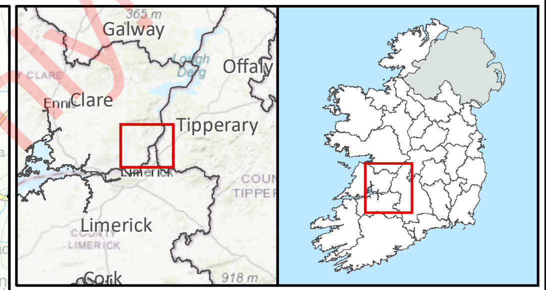

Legend

- Wind Farm Site Boundary
- Proposed Turbine Layout
- Turbine Delivery Route
- Grid Connection Route
- Onsite Access Roads
- Passing Bays
- Turbine Hardstanding Area
- Construction Compound
- Substation Compound

Active Quarries

- Sand and Gravel

Mineral Localities

- Metallic
- Non-metallic

0 1 2 4 Kilometers

TITLE:	Economic Geolgy
PROJECT:	Fahy Beg Wind Farm, Co. Clare
FIGURE NO:	9.7
CLIENT:	RWE Renewables Ireland Ltd.
SCALE: 1:50000	REVISION: 0
DATE: 06/10/2022	PAGE SIZE: A3

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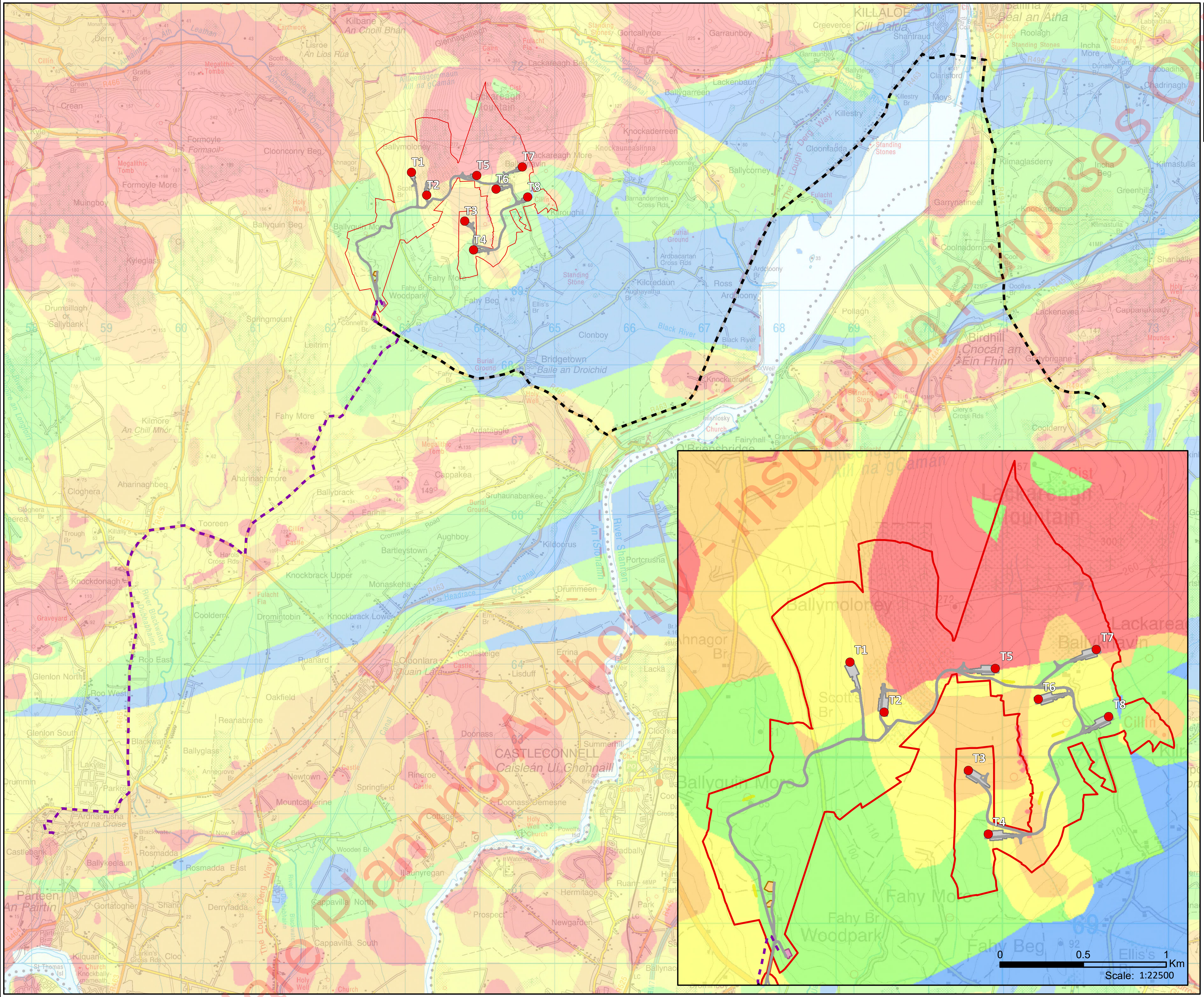

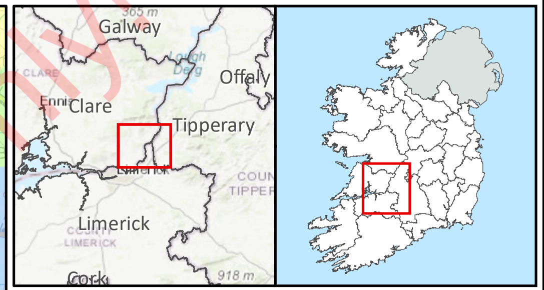

Legend

- Wind Farm Site Boundary
- Proposed Turbine Layout
- Turbine Delivery Route
- Grid Connection Route
- Onsite Access Roads
- Passing Bays
- Turbine Hardstanding Area
- Construction Compound
- Substation Compound

Crushed Rock Aggregate Potential

- Very High potential
- High potential
- Moderate potential
- Low potential
- Very Low potential

TITLE:	Crushed Rock Potential
PROJECT:	Fahy Beg Wind Farm, Co. Clare
FIGURE NO:	9.8
CLIENT:	RWE Renewables Ireland Ltd.
SCALE:	1:50000
REVISION:	0
DATE:	07/10/2022
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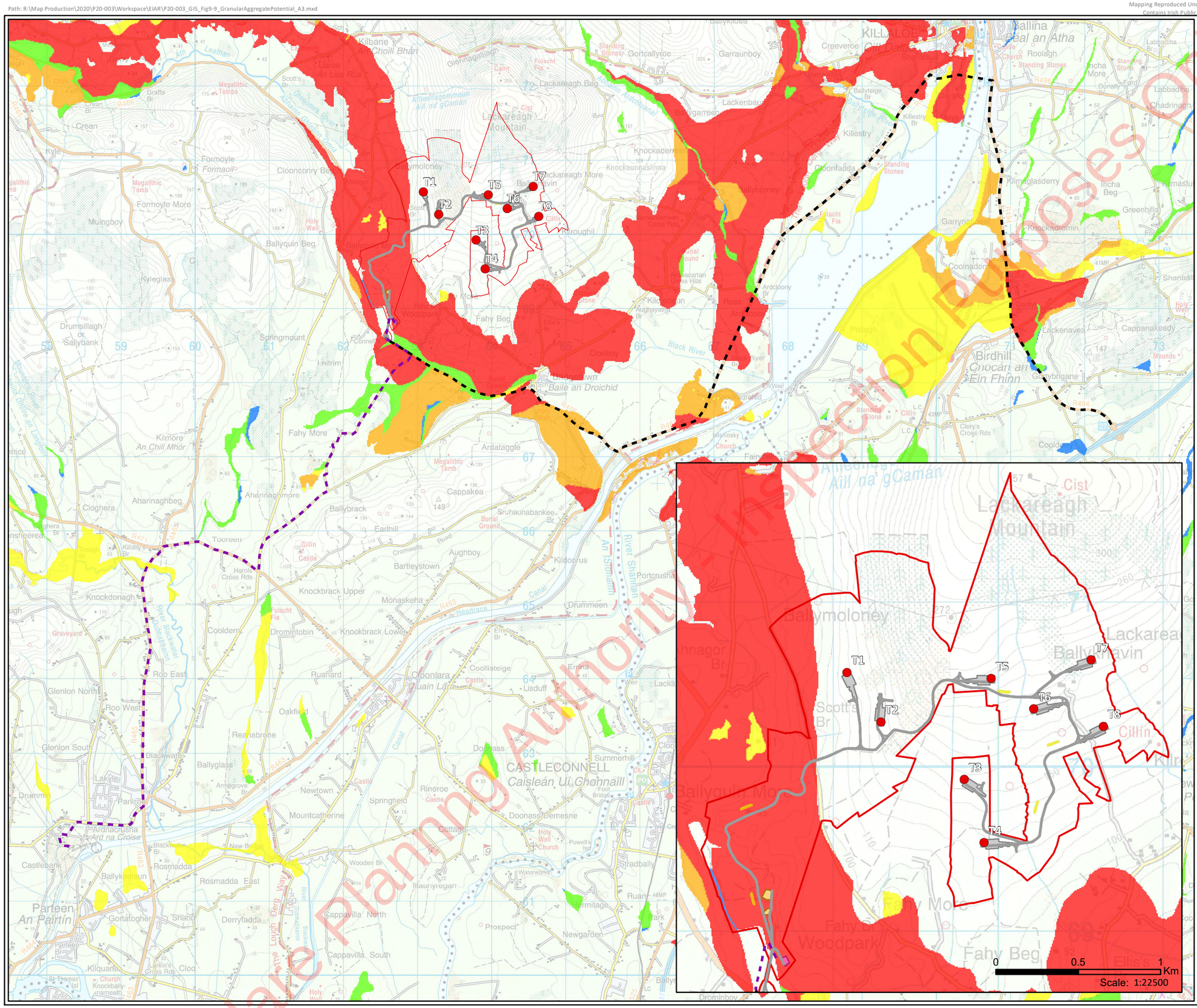

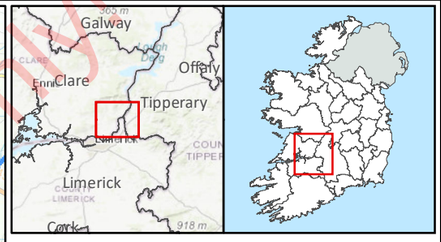

Legend

- Wind Farm Site Boundary
- Proposed Turbine Layout
- Turbine Delivery Route
- Grid Connection Route
- Onsite Access Roads
- Passing Bays
- Turbine Hardstanding Area
- Construction Compound
- Substation Compound

Granular Aggregate Potential

- Very High potential
- High potential
- Moderate potential
- Low potential
- Very Low potential

TITLE:	Granular Aggregate Potential		
PROJECT:	Fahy Beg Wind Farm, Co. Clare		
FIGURE NO:	9.9		
CLIENT:	RWE Renewables Ireland Ltd.		
SCALE:	1:50000	**REVISION:**	0
DATE:	07/10/2022	**PAGE SIZE:**	A3

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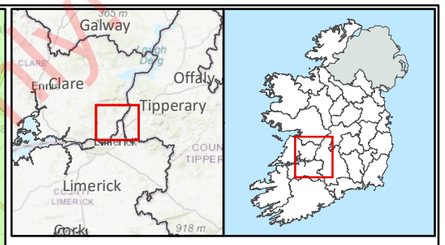
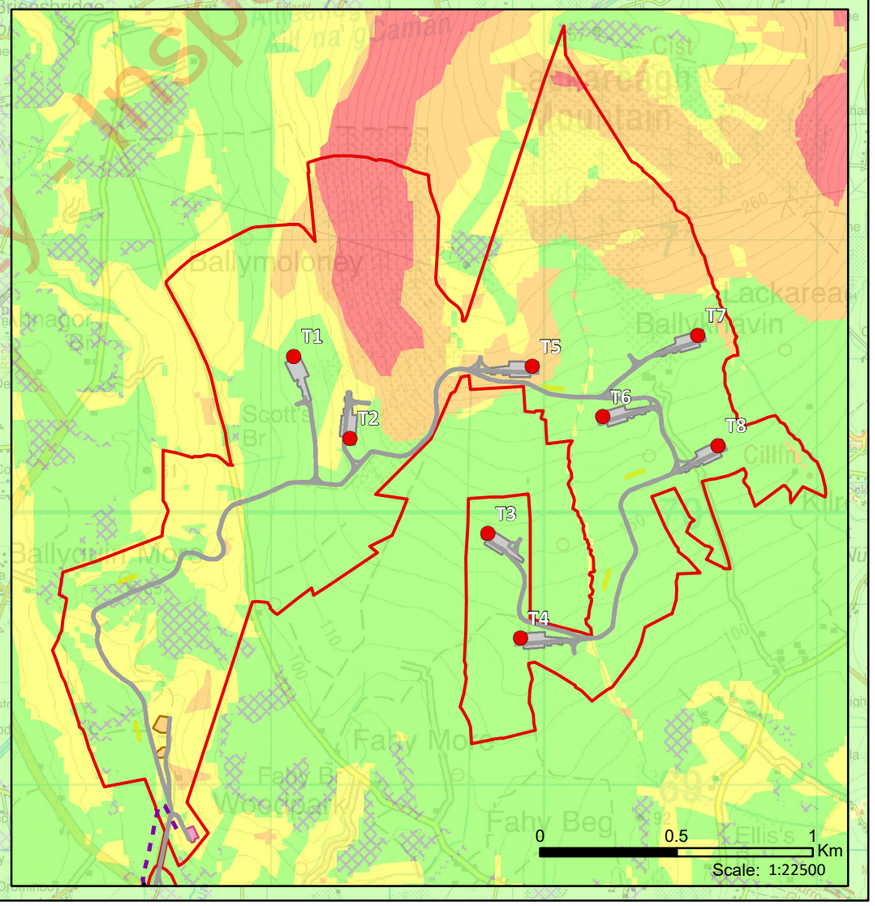


Legend

- Wind Farm Site Boundary
- Proposed Turbine Layout
- Turbine Delivery Route
- Grid Connection Route
- Onsite Access Roads
- Passing Bays
- Turbine Hardstanding Area
- Construction Compound
- Substation Compound

Landslide Susceptibility

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



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PROJECT:	Fahy Beg Wind Farm, Co. Clare		
FIGURE NO:	9.10		
CLIENT:	RWE Renewables Ireland Ltd.		
SCALE:	1:50000	**REVISION:**	0
DATE:	07/10/2022	**PAGE SIZE:**	A3

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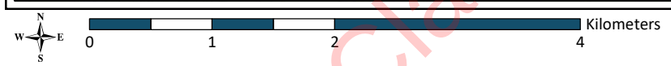

9.4 Characteristics of the Proposed Project

The proposed development will typically involve removal of subsoils for access roads, turbine foundations, internal cable network, hardstanding emplacement, substation, crane hardstands, construction compounds, and met mast installation.

Aggregate and crushed rock for construction will be sourced from local authorised quarries.

Estimated volumes of overburden (topsoil and mineral soil) to be removed are shown in Table 9-11. Excavated material will be used for reinstatement and landscaping works around the site, as well as being side cast alongside the access roads. Rock excavated from hardstand excavations will be reused within the access tracks and hardstands.

Table 9-11: Estimated Excavation Volumes

Item	Excavation Volumes (m^3) Subsoils	Fill Volume (m^3)
Access Roads	15,100	31,500
Turbine foundations, internal cable network, hardstanding emplacement, substation, crane hardstands, construction compounds, and met mast installation.	71,300	120,200

9.5 Potential Effects

The potential effects on the underlying land, soils and geology at the proposed project are assessed in the following sections for the activities associated within each phase (construction, operation and decommissioning) for the proposed project as described in Chapter 3.

The potential impacts are assessed in accordance with the evaluation criteria outlined in Section 9.2. The unmitigated potential impacts are summarised in Table 9-15 and Table 9-16. The proposed mitigation measures are then considered to reduce or eliminate potential impacts.

9.5.1 Do Nothing Impact

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

9.5.2 Construction Phase

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

9.5.2.1 Tree Felling

Four turbines are located within forestry and consequently tree felling will be required as part of the project. Permanent felling of approximately 17.7ha of forestry is required within and around the site infrastructure to accommodate the construction of some turbines, hardstands, crane pads, access tracks, onsite substation, borrow pits, GCR, temporary compounds and permanent met masts.

These works will be the subject of a Felling Licence Application to the Forest Service prior to construction as per the Forest Service's policy on granting felling licenses for wind farm developments. The proposed areas to be felled are illustrated on Figure 3.1 in Chapter 3, Description of the Proposed Development.

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

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

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

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

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

9.5.2.2 Earthworks

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

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

The following earthworks excavations will be required:

- Excavation of Topsoil deposits;
- Excavation of Glacial Till to bedrock (as required);
- Excavation of Gravel deposits to bedrock (as required);
- Excavation of bedrock at Turbine bases.

The following filling and material deposition operations will be required:

- Deposition of surplus topsoil and spoil in berms for reinstatement purposes around turbine bases hardstands and along access roads. Material placed alongside access roads will not exceed 1m in height and will be shaped and sealed to prevent the ingress of water.
- Importation and Filling of site won and imported General Fill and Engineering Aggregates.

Following the completion of preliminary site investigations and consideration of wind turbine manufacturer specifications for wind turbines of the size proposed at Fahy Beg Wind Farm, it is expected that wind turbine foundations shall be reinforced concrete gravity foundations with depths of 3.5m and diameters of 25m. Flexibility of $^{+}/_{-}$ 1.5m in the finished levels is required to allow for sloping topography and ground conditions. Ideally, a suitable bearing stratum is encountered within 3m from ground surface so that the turbine foundation can be finished at / near existing ground level. Where deeper excavations (3-5m) are required to reach a suitable bearing stratum, soil replacement (engineered fill) is used to bring up the excavation so that the turbine foundation is finished at / near existing ground level.

Borrow pit locations have not been proposed. It is anticipated that all general Class 1 fill and structural fill will be imported from local authorised quarries.

Surplus Topsoil, Gravel deposits and Glacial Till recovered from excavations will be used for the reinstatement proposed around turbine bases, hardstands and the temporary construction compound. All associated quantities have been calculated in Section 9.4 and no excavated material will leave the site.

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

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

The Magnitude of the impact from these works is considered to be Small Adverse in nature. The importance of the soils and geology receptors (subsoils, bedrock) is considered to be 'Low' in the area of the turbines. However, to the east of the site where the substation, temporary construction compound and access roads are proposed the importance of these receptors is considered to be "High" due to the presence of sand and gravel pits. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Moderate/Slight significance.**

The Impact Classification is negative, moderate/slight significance, permanent, direct and high probability (Likely Effects).

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

- Potential for groundwater pollution from the removal of overburden deposits particularly at proposed turbine locations. The aquifer underlying the proposed site and the majority of the GCR is classified by the GSI as ranging from 'High' to 'Extreme' with areas of exposed bedrock also present in these areas. It is proposed to remove the overlying soft ground and Glacial Till deposits as outlined in the proposed design.
- The vulnerability of the aquifer to groundwater pollution particularly during construction stage will be increased as overburden is removed thus reducing the level of protection from groundwater pollution.
- Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Soil erosion as a result of exposure of soils in open excavations and temporary storage of excavated materials represents a potential impact to the underlying groundwater aquifer.
- Reduction in groundwater levels from dewatering of excavations as required during the construction stage if high groundwater is encountered. This impact is most likely during the excavation of turbine foundations. There are no groundwater supply wells recorded in the immediate vicinity of proposed turbine locations. It is considered that other excavations associated with substation, temporary compound and GCR trenches will not extend into the underlying bedrock aquifers. It is possible however that perched groundwater may exist locally within overburden deposits or weathered bedrock. Upon completion of the construction phase, it is considered that groundwater levels will revert to the pre-construction situation when there is no longer a requirement to control groundwater levels.

The Magnitude of the impact from these works is considered to be Moderate Adverse in nature. The importance of the groundwater receptors is considered to be 'Medium'. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Moderate significance.**

The Impact Classification is negative, moderate, permanent, direct and high probability (Likely Effects).

9.5.2.3 Slope Stability

The proposed development and proposed infrastructure locations are generally located within areas of 'Low' to 'Moderately High' susceptibility. Localised areas of "High" landslide susceptibility are located to the north of the site but are outside the proposed infrastructure areas. As such it is considered construction activities at these locations pose a potential risk to sensitive receptors from potential landslide/slope failures. However, results from the two site walkover surveys show no evidence of recent or historic landslides. No failures within the underlying till deposits were recorded.

Given the sporadic and shallow nature (0.1 to 0.2m thick) of peat deposits (described as highly organic Topsoil with a peaty appearance) across the site, and in accordance with the guidance in the Scottish Executive – Peat Landslide Hazard and Risk Assessments (2017), a peat stability analysis has not been carried out.

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

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

The Magnitude of the impact from these works is considered to be Small Adverse in nature. The importance of the soils and geology receptors (subsoils, bedrock) is considered to be 'Low' in the area of the turbines. However, to the east of the site where the substation, temporary construction compound and access roads are proposed the importance of these receptors is considered to be "High" due to the presence of sand and gravel pits. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Moderate/Slight significance.**

The Impact Classification is negative, moderate/slight, short term, direct and low probability (Unlikely Effects).

The Magnitude of the impact from these works is considered to be Moderate Adverse in nature. The importance of the groundwater receptors is considered to be 'Medium'. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Moderate significance.**

The Impact Classification is negative, moderate, short term, direct and low probability (Unlikely Effects).

9.5.2.4 Internal Access Roads, Hardstands, Temporary Construction Compound and Substation

There will be approximately 8.5km of internal access tracks associated with the proposed site. This will be a combination of existing track upgrade and construction of new tracks; approximately 7.1km of new track construction and approximately 1.4km of existing track upgrade. Hardstand areas will be provided at each turbine location.

All access tracks will be approximately 5m wide along straight sections and wider at bends and as required as shown on planning application drawings. The tracks will be finished with a well graded aggregate. The drainage system will be installed adjacent to the internal access tracks. Existing drainage infrastructure will be maintained and upgraded where necessary.

The following filling and material deposition operations will be required:

- Deposition of surplus topsoil, Gravel and Glacial Till deposits in berms for reinstatement purposes around, hardstands, temporary construction compound and substation compound.
- Importation and Filling of site won and imported General Fill and Engineering Aggregates.

It is anticipated that the stone required for the construction of the internal access roads, hardstands, temporary construction compound and the substation will be sourced from local authorised quarries.

The likely off-site, source quarries for the supply of imported crushed rock aggregate during the construction phase of the development are presented in Table 9-12:

Table 9-12: Source Quarries for Imported Aggregate (Crushed Rock)

Name	Distance from site	Products	Rock type
Ballycar Quarry	8km (SW)	Series 600 crushed rock aggregate.	Greywacke
McGraths Quarry	15km (NW)	Series 600 and 900, Clauses 803 and 806 crushed rock aggregate.	Limestone
Bunratty Quarry (Roadstone)	20km (SW)	Series 600 Clauses 803, 804, 805 and 806 crushed rock aggregate.	Limestone

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

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

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

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

The Magnitude of the impact from these works is considered to be Small Adverse in nature. The importance of the soils and geology receptors (subsoils, bedrock) is considered to be 'Low' in the area of the turbines.

However, to the east of the site where the substation, temporary construction compound and access roads are proposed the importance of these receptors is considered to be "High" due to the presence of sand and gravel pits. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Moderate/Slight significance.**

The Impact Classification is negative, moderate/slight, permanent, direct and high probability (Likely Effects).

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

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

The Magnitude of the impact from these works is considered to be Moderate Adverse in nature. The importance of the groundwater receptors is considered to be 'Medium'. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Moderate significance.**

The Impact Classification is negative, moderate, permanent, direct and high probability (Likely Effects).

9.5.2.5 Internal Cabling and Grid Connection

As outlined in Chapter 3 of this EIAR, electricity generated from wind turbines shall be collected at medium voltage (20/33kV) by an internal circuit of buried cables which will follow on-site access tracks. This circuit shall be terminated at a proposed onsite substation before being exported to the grid via a 38kV buried cable to the existing 110kV Ardnacrusha substation.

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

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

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

- The GCR, associated excavations and ducting may present a preferential pathway for the movement of groundwater and/or contamination in the subsurface. However, the subsoil at the proposed development is predominantly Glacial Till which has a low permeability throughout the majority of the GCR.
- The excavations for the GCR trenches and joint bays can have a direct impact on the exposed soils and rock in the form of increased erosion from surface water ingress.
- Where the material excavated from the GCR excavations are not suitable for reuse as backfill or deposition on site this material will be disposed of at a facility licenced (subject to environmental testing and classification) to accept this waste type.

The Magnitude of the impact from these works is considered to be Small Adverse in nature. The importance of the soils and geology receptors (subsoils, bedrock) is considered to be 'Low' in the area of the turbines. However, to the east of the site where the substation, temporary construction compound and access roads are proposed, the importance of these receptors is considered to be "High" due to the presence of sand and gravel pits. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Moderate/Slight significance.**

The Impact Classification is negative, moderate/slight significance, permanent, direct and high probability (Likely Effects).

The Magnitude of the impact from these works is considered to be Small Adverse in nature. The importance of the groundwater receptors is considered to be 'Medium'. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Slight significance.**

The Impact Classification is negative, slight significance, permanent, direct and high probability (Likely Effects).

9.5.2.6 Horizontal Directional Drilling (HDD)

HDD will be employed at 4 no. locations along the GCR to cross an existing watercourse as described in Section 3.1.2.1 of the CEMP.

The operation shall take place from one side of the watercourse within the public road corridor and will be carried out by an experienced HDD specialist. The crossing is expected to take place in a single day under one mobilisation.

The process will involve setting up a small, tracked drilling rig on one side of the watercourse at least 10m back from the stream bank. A shallow starter pit will be excavated at the point of entry and shall be located at a sufficient distance from the watercourse to achieve a minimum 3m clearance depth below the bed of the watercourse.

A pilot hole will be bored as per the agreed alignment and shall be tracked and controlled using a transmitter in the drill head. By tracking the depth, position and pitch of the drill head the operator can accurately steer the line of the drilling operation. Typically, the drilling operation is lubricated using a fluid. When the pilot hole has been drilled to the correct profile, its diameter is increased, if necessary, to match the external diameter of the cable duct.

The flexible plastic ducting is then pulled through the pre-drilled hole and sealed at each end until required for cable installation.

A detailed method statement with site specific mitigation measures for this activity is included in the CEMP (Appendix 3.1).

Direct impacts to the existing environment associated with the proposed HDD works include:

- Potential for contamination to groundwater from spills/leakages during construction phase earthworks and HDD operations. The use of construction plant and associated refuelling and storage of fuels and hydrocarbons with potential for spills or leaks could result in contamination of the underlying aquifers.
- Potential for overburden collapse at the proposed HDD location during the advancement of the HDD bore.

The Magnitude of the impact from these works is considered to be Small Adverse in nature. The importance of the soils and geology receptors (subsoils, bedrock) is considered to be 'Low'. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Slight significance.**

The Impact Classification is negative, slight significance, permanent, direct and high probability (Likely Effects).

The Magnitude of the impact from these works is considered to be Small Adverse in nature. The importance of the groundwater receptors is considered to be 'Medium'. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Slight significance.**

The Impact Classification is negative, slight significance, permanent, direct and high probability (Likely Effects).

9.5.2.7 Turbine Delivery Route (TDR)

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

Key elements of the temporary accommodation works for the delivery of turbines are summarised in Table 9-13 below:

Table 9-13: TDR Temporary Accommodation Works

TDR Node Reference Number (POI)	Location	Summary Description of Proposed Temporary Accommodation Works
1	Foynes Port Gate	
2	Foynes Port Access Road Rail Crossing	
3	Foynes Port Access Road /N69	Removal of Street Furniture, Trim Vegetation, Lay Load Bearing Surface.
4	N69 Overhead Utilities	

TDR Node Reference Number (POI)	Location	Summary Description of Proposed Temporary Accommodation Works
5	N69 Vertical Constraint	Haulier will increase suspension.
6	N69 Tree Canopy	Throughout route, Trim Tree Canopy.
7	N69 Vertical Constraint	Haulier will increase suspension.
8	N69 Clarina Roundabout	Remove Street Furniture, Lay Load Bearing Surface, Clear Trees and Vegetation.
9	N69 / N18 Dock Road West Roundabout	Lay Load Bearing Surface, Remove Street Furniture.
10	N69 / N18 Dock Road East Roundabout	Remove Street Furniture, Lay Load Bearing Surface.
11	M7 Junction 27	Lay Load Bearing Surface, Remove Street Furniture.
12	R494 Birdhill Roundabout	Lay Load Bearing Surface, Remove Street Furniture.
13, 14	R494 Beginning of Bypass Improvements	Remove Street Furniture
15,16	R494 Bypass at Forthenry Business Park	Remove Street Furniture
17	R494 Bypass at Fort Henry	Remove Street Furniture
18	R494 Roundabout at Templehollow	Remove Street Furniture, Lay Load Bearing Surface.
19	R493 Roundabout Northeast of Cloverfield	Remove Street Furniture, Lay Load Bearing Surface.
20	R493 Bends South of Cloverfield	Trim Vegetation.
21	R463 Bends Southwest of Bellisle	Trim Vegetation.
22	R463 North of Garranroe	Trim Canopy.
23	R463 Ardcloony Bridge at Garranroe	Trim Vegetation, Remove Street Furniture, Lay Load Bearing Surface, Increase Suspension.
24	R46 South of Garranroe	Trim Canopy.
25, 26	R463 Bends South of Knockdrohid	Trim Vegetation and Trees, Remove Street Furniture
27	R463 / R466 Junction	Trim Trees and Vegetation, Remove Street Furniture, Lay Load Bearing Surface.
28, 29, 30	R466 Bends Northwest of O'Briensbridge Cross	Trim Trees and Vegetation.
31	R466 Bends Southeast of Bridgetown	Trim Trees and Vegetation, Remove Street Furniture, Lay Load Bearing Surface.

TDR Node Reference Number (POI)	Location	Summary Description of Proposed Temporary Accommodation Works
32	R466 Left Bend at Bridgetown	Remove Trees and Wall, Trim Vegetation, Remove Street Furniture, Lay Load Bearing Surface.
33	R466 Proposed Site Access	Upgrade access track.

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

The Magnitude of the impact from these works is considered to be Small Adverse in nature. The importance of the soils and geology receptors (peat, subsoils, bedrock) is considered to be 'Low'. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Imperceptible significance**.

The importance of the groundwater receptors is considered to be 'Medium'. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Slight significance.**

Following the identification of the potential direct impacts during the construction phase, as outlined above, mitigation measures to reduce the risk to an acceptable level are discussed in Section 9.6.2 of this Chapter.

9.5.3 Operational Phase

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

9.5.3.1 Potential Direct Impacts

Very few potential direct impacts are envisaged during the operational phase of the proposed project. These are:

- Some construction traffic may be necessary for maintenance of turbines, hardstands and access tracks which could result in minor accidental leaks or spills of fuel/oil.
- The grid transformer in the substation and transformers in each turbine are oil cooled. A back up battery energy storage system along with ancillary civil and electrical infrastructure will also be located at the proposed substation. There is potential for spills / leaks of oils/battery fluids from this equipment resulting in contamination of soils and groundwater.

The Magnitude of the impact from these works is considered to be Small Adverse in nature. The importance of the soils and geology receptors (subsoils, bedrock) is considered to be 'Low' in the area of the turbines. However, to the east of the site where the substation, temporary construction compound and access roads are proposed the importance of these receptors is considered to be "High" due to the presence of sand and gravel pits. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Moderate/Slight significance.**

The Impact Classification is negative, moderate/slight significance, shot-term, direct and low probability (Unlikely Effects).

The Magnitude of the impact from these works is considered to be Negligible in nature. The importance of the groundwater receptors is considered to be 'Medium'. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Imperceptible significance.**

The Impact Classification is negative, imperceptible significance, shot-term, direct and low probability (Unlikely Effects).

9.5.3.2 Potential Indirect Impacts

A small amount of granular material may be required to maintain access tracks during operation which will place intermittent minor demand on local quarries listed in Section 9.5.2.4.

The Magnitude of the impact from these works is considered to be Small Adverse in nature. The importance of the soils and geology receptors (subsoils, bedrock) is considered to be 'Low'. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Imperceptible Significance.**

The Impact Classification is negative, imperceptible significance, shot-term, indirect and low probability (Unlikely Effects).

9.5.4 Potential Impacts during Decommissioning

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

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

Other impacts such as possible soil compaction and contamination by fuel leaks will remain but will be of reduced magnitude. Nevertheless, as noted in the Scottish Natural Heritage guidance on restoration and decommissioning of onshore wind farms (SNH, 2013) reinstatement proposals for a wind farm are made approximately 30 years in advance, so within the lifespan of the wind farm, technological advances and preferred approaches to reinstatement are likely to change. It is therefore '*best practice not to limit options too far in advance of actual decommissioning but to maintain informed flexibility until close to the end-of-life of the wind farm*'.

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

No significant effects on the soils and geology receptors are envisaged during the decommissioning stage of the proposed project.

9.5.5 Potential Cumulative Impacts

As part of the assessment of cumulative impacts, planning searches were undertaken using the following online planning enquiry portals to search for large scale developments within 20km of the site:

- Clare County Council;
- Limerick County Council;
- Tipperary County Council;
- An Bord Pleanála.

The majority of the applications were of a scale and/or distance that they would not cause a cumulative effect in relation to land, soils and geology.

Relevant projects, which are likely to have an impact on the Land, Soils & Geology, in proximity to the proposed project including the GCR are listed in Table 9-14:

Table 9-14: Potential Cumulative Impact from other Developments

Development	Distance to Proposed project	Status	Interface	Potential Cumulative Impact
Lackareagh Wind Farm	2km (N)	Proposed	Groundwater	Negligible
			Subsoils and bedrock	Small Adverse
Carrownagowan Wind Farm	4.6km (N)	Pending Approval	Groundwater	Negligible
			Subsoils and bedrock	Small Adverse
110kV grid connection between Carrownagowan Wind Farm and Ardnacrusha	N/A	Pending Approval	N/A	N/A

The Lackareagh Wind Farm is located approximately 2km north of the site and is currently in pre-planning development. The Carrownagowan Wind Farm is located approximately 4.6km north of the site and is currently pending planning approval. If construction for these projects overlap or run concurrently with the proposed development, there may be a supply issue with local quarries providing imported aggregate. The magnitude of the impact from these works is considered to be 'Small Adverse' in nature. The importance of the subsoils and bedrock receptors are considered to be 'Medium'. The magnitude of this potential cumulative impact is considered to be of **Slight significance.** There is the potential for groundwater pollution from run-off impacting on the groundwater receptor from both sites. The Magnitude of the impact from these works is considered to be Negligible in nature. The importance of the groundwater receptors is considered to be 'Medium'. The magnitude of this potential cumulative impact is considered to be of **Imperceptible significance.**

The Carrownagowan Wind Farm shares part of the grid connection route with the proposed development. The construction of the grid connection works will only require relatively localised excavation works, will be short duration, and will be linear and transient in nature and therefore will not contribute to any significant cumulative effects.

9.5.6 Summary of Potential Impacts

A summary of unmitigated potential impacts on land, soils and geology attributes from the proposed project is provided in Table 9-15 with the potential impacts on hydrogeological attributes provided in Table 9-16.

Table 9-15: Summary of Potential Unmitigated Impact Significance on Land, Soils and Geology

Activity	Potential Impact	Receptor	Importance	Prior to Mitigation	
				Magnitude	Significance
Construction Phase					
Felling Activities	Exposure of underlying overburden leading to increased erosion. Felling machinery resulting soil compaction of soft deposits and an increase in surface water runoff resulting in increased erosion of exposed soils.	Localised organic soils and Glacial Till deposits.	Low	Moderate Adverse	Slight
Earthworks (Turbine bases)	Removal of overburden material, open excavations and subsequent exposure underlying overburden and bedrock leading to increased erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill and concrete.	Localised organic soils, Glaciofluvial deposits, Glacial Till deposits and bedrock.	Low	Small Adverse	Imperceptible
Earthworks associated with the construction of the proposed project and associated infrastructure	Slope Failure.	Localised organic soils Glaciofluvial deposits, Glacial Till deposits and bedrock	High	Small Adverse	Moderate/Slight*

Activity	Potential Impact	Receptor	Importance	Prior to Mitigation	
				Magnitude	Significance
Construction of Internal Site Access Tracks, Hardstands, Temporary Compound, Substation	Open excavations, increased runoff causing erosion of underlying overburden and bedrock. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill.	Localised organic soils Glaciofluvial deposits and Glacial Till deposits. Bedrock Local quarries	High	Small Adverse	Moderate/Slight*
Internal Cabling and Grid Connection	Removal of overburden material and exposure of underlying subsoil and bedrock to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill and concrete products. Disposal of surplus excavated material to licenced facility.	Localised organic soils Glaciofluvial deposits, Glacial Till deposits and bedrock. Local quarries Licenced Waste Facilities	High	Small Adverse	Moderate/Slight*
HDD at crossing point(s)	Overburden collapse due to advancement of HDD bore	Local Glacial Till deposits. Bedrock	Low	Small Adverse	Imperceptible

Activity	Potential Impact	Receptor	Importance	Prior to Mitigation	
				Magnitude	Significance
Accommodation works along TDR	Removal of overburden material and exposure of underlying subsoil and bedrock to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill. Disposal of surplus excavated material to licenced facility.	Subsoils. Bedrock. Local quarries. Licenced waste facilities.	Low	Small Adverse	Imperceptible
Operational Phase					
Construction traffic for maintenance of turbines, hardstands and access tracks. Operation of substation and turbines.	Release of hydrocarbons or fuel spill	Localised organic soils Glaciofluvial deposits, Glacial Till deposits and bedrock.	High	Small Adverse	Moderate/Slight*
Maintenance of access tracks	Importation of engineering fill	Local quarries	Low	Small Adverse	Imperceptible

Activity	Potential Impact	Receptor	Importance	Prior to Mitigation	
				Magnitude	Significance
Decommissioning Phase					
Removal of Turbines and Hardstands	Construction traffic resulting in soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils.	Localised organic soils Glaciofluvial deposits, Glacial Till deposits and bedrock.	Low	Small Adverse	Imperceptible
Cumulative Impacts					
Construction of the proposed project and associated infrastructure	Cumulative impacts on local quarries from extraction of fill for proposed project	Local quarries	Medium	Small Adverse	Slight
*The soil receptors within the eastern portion of the site (Ballyquin Quarry) would be considered to have a "High" importance as per NRA Guidance. However, the portion of the site where the turbines are proposed are underlain by subsoils/bedrock that would be considered as having a "Low" importance. If this is taken into consideration the site area outside of Ballyquin Quarry can be considered as having an **"Imperceptible"** significance ratings.					

Table 9-16: Summary of Potential Unmitigated Impact Significance on Hydrogeology

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Construction Phase					
Felling Activities	Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages from felling machinery	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Small Adverse	Slight
Earthworks (Turbine Base, Substation and Access Tracks)	Potential for groundwater pollution from the removal of overburden deposits Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during construction phase earthworks. Reduction in groundwater levels from dewatering of excavation as required during the construction phase.	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Moderate Adverse	Moderate
Construction of Internal Site Access Tracks, Hardstands, Temporary Compound and Substation	Potential for groundwater pollution from the removal of overburden deposits Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during construction phase earthworks. Potential for ground water pollution from the use of cement-based compounds during the construction phase.	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Moderate Adverse	Moderate

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Construction of Turbine and Substation Foundations	Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during construction phase earthworks. Potential for ground water pollution from the use of cement-based compounds during the construction phase. Reduction in groundwater levels from dewatering of excavation as required during the construction phase.	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Moderate Adverse	Moderate
Construction of the Grid Connection and Internal Cabling	Potential for ground water pollution from the removal of overburden deposits. Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during construction phase earthworks.	Locally Important Bedrock Aquifers Groundwater Wells and Springs	Medium	Small Adverse	Slight
Earthworks associated with the construction of the proposed project and associated infrastructure	Slope Failure	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Moderate Adverse	Moderate
Operational Phase					
Operational traffic, refuelling of vehicles	Some operational traffic will be necessary for maintenance plus normal operational traffic which could result in minor accidental leaks or spills of fuel/oil.	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Small Adverse	Slight

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Decommissioning Phase					
Removal of Turbines and Hardstands	Potential for groundwater pollution from the disturbance of overburden deposits. Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during decommissioning phase earthworks.	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Small Adverse	Slight
Cumulative Impacts					
Lackareagh and Carrownagowan Wind Farms	Potential for groundwater pollution from runoff from wind farm	Potential cumulative impact on: Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Negligible	Imperceptible

9.6 Mitigation Measures

The following section outlines appropriate mitigation measures by design and best practice to avoid or reduce the potential impact of the proposed project. Further details are given in Section 4.3 of the CEMP, which is contained in Appendix 3.1 of Volume 3.

9.6.1 Mitigation by Design and Best Practice

With regard to the proposed project, design and best practice has been and will be implemented as follows:

The primary mitigation measure employed has been the design of the site in terms of locating the turbines, access roads, material storage areas and other site infrastructure within an area comprising existing quarry pits, agricultural pastoral land and commercial forestry where the soils are extensively worked and drained.

In order to reduce the impacts on geology, hydrogeology and slope stability, infrastructure has been primarily located within areas of thinner, soft ground and lower slope gradients. Extensive work has already been undertaken at the preliminary design stage to apply risk avoidance by design which included:

- Peat probing and site walkover surveys to identify geotechnical constraints (e.g. peat deposits and evidence of historic landslip) likely to adversely affect the design of the site;
- Excavation of trial pits to establish ground and groundwater conditions;
- Preparation of Slope Stability Assessments, included in the Geotechnical Assessment Report, Appendix 9.1 of this EIAR;
- Relocation and micro-siting of turbines, hardstanding's and access roads based on the site assessments and geotechnical assessments in order to reduce ground risk associated with the proposed project;
- The works have been designed and checked by geotechnical and civil engineers, who are suitably qualified and experienced in excavation and earthworks design and construction methodologies. Details of experience and competence is included in Chapter 1.

The following will also be implemented:

- Any excavation and construction related works will be subject to a design risk assessment at detailed design stage to determine risk levels for the construction, operation and maintenance and decommissioning of the works. Identified impacts will be minimised by the application of principles of avoidance, prevention and protection. Information on residual impacts will be recorded and relayed to appropriate parties
- A detailed method statement for each element of the works will be prepared by the Contractor prior to any element of the work being carried out.
- Given that the works comprise a significant proportion of excavation and earthworks, suitably qualified and experienced geotechnical personnel will be required on site to supervise the works.
- The Contract will require programming of the works such that earthworks are not scheduled during severe weather conditions.

9.6.2 Construction Phase

The following sections outline appropriate mitigation measures to avoid or reduce the potential impact of the proposed project during the construction phase.

9.6.2.1 Construction Environmental Management Plan (CEMP)

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

The CEMP sets out the key environmental management measures associated with the construction, operation and decommissioning of the site, to ensure that during these phases of the development, the environment is protected, and any potential impacts are minimised. The final CEMP will be developed further at the construction stage, on the appointment of the main contractor to the project to address the requirements of any relevant planning conditions, including any additional mitigation measures that are conditioned and shall be submitted to the planning authority.

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

9.6.2.2 Tree Felling

As outlined in Section 9.5.2.1 potential impacts to the existing environment from the proposed tree felling works have been identified. The works will lead to the exposure of underlying soils to surface water runoff, which could result in soil erosion. This also could lead to an increase in sediment and nutrient concentrations in the surface water run-off which may in turn impact groundwater in the Locally Important Aquifer beneath the proposed project site.

One of the primary mitigation measures to be employed at the construction phase of the development is the management of silt laden runoff. The potential impact from silt laden surface water runoff from increased erosion of exposed overburden deposits has been assessed, particularly at new and existing drainage locations and where tree felling works are proposed.

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

Best practices will be employed in the prevention of silt laden run-off from entering watercourses as discussed in Chapter 10.

The use of plant and machinery during tree felling works will require the storage and use of fuels and oils. Details of oil spill protection measures adjacent to sensitive receptors and emergency spill response procedures are outlined in Section 4.3.5 of the CEMP which is contained in Appendix 3.1 of Volume 3.

Storage tanks, used to store fuel for the various items of machinery, will be self-contained and double-walled.

Refuelling of felling plant and equipment will be carried out from these tanks or from delivery vehicles at designated refuelling areas. Specific mitigation measures relating to the management of hydrocarbons are as follows:

- Any diesel, fuel or hydraulic oils stored on site will be stored in bunded storage tanks – the bund area will have a volume of at least 110 % of the volume of such materials stored.
- Refuelling of plant during construction will only be carried out at designated refuelling station locations on site.
- Emergency drip trays and spill kits will be kept available on site, to ensure that any spills from vehicles are contained and removed off site. The emergency response procedure is provided in Section 1.8 of SWMP.

9.6.2.3 Earthworks

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

Details of the proposed methodology and mitigation measures are summarised below and are also outlined in Section 4.3.4 of the CEMP in Appendix 3.1 of Volume 3.

One of the primary mitigation measures employed at the preliminary design stage was the minimisation of volumes of excavated overburden deposits to be exported off site. All excavated overburden will be retained on-site.

This will include:

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

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

Some temporary stockpiles (not exceeding 2m in height) of material will be necessary adjacent to the excavation areas prior to reinstatement, however no long-term stockpiles of material will remain after construction and no surplus/waste soil or rock will be removed from the proposed project site. Temporary stockpiles will be shaped and sealed to prevent the ingress of water from rainfall and placed away from open excavations, sloping / soft ground as not to create an instability risk during temporary works.

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

To mitigate against erosion of the exposed soil or rock, all excavations will be constructed and backfilled as quickly as possible. Excavations will stop during or prior to heavy rainfall events (>10mm/hour).

To mitigate against possible contamination of the exposed soils and bedrock, refuelling of machinery and plant will only occur at designated refuelling areas.

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

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

9.6.2.4 Control of Sediment Laden Runoff

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

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

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

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

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

9.6.2.5 Measures for Spills

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

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

- Fuels, lubricants and hydraulic fluids for equipment used on the construction site will be carefully handled to avoid spillage.
- Any spillage of fuels, lubricants or hydraulic oils will be immediately contained, and the contaminated soil removed from the site and properly disposed of;

- Waste oils and hydraulic fluids will be collected in leak-proof containers and removed from the site for disposal or re-cycling; and
- Appropriate spill control equipment, such as oil soakage pads, will be kept within the construction area and in each item of plant to deal with any accidental spillage.

9.6.2.6 Slope Stability

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

- The works will be supervised by a suitably qualified and experienced geotechnical engineer or engineering geologist, and hydrologist or drainage engineer.
- Drainage infrastructure will be put in place in advance of excavations. Drains will divert surface water and groundwater away from excavations into the existing and proposed surface drainage network. Uncontrolled, direct and concentrated discharges of water onto the ground surface will be avoided.
- Loading or stockpiling of materials on the surface of soft ground will be avoided. Loading or stockpiling on other deposits will not be undertaken without first establishing the adequacy of the ground to support loads by an appropriately qualified geotechnical engineer experienced in construction within upland conditions. No stockpiling of material shall take place on steep slopes.
- Excavation will be carried out from access roads or hardstanding areas to avoid tracking of construction plant across areas of soft ground.
- An assessment of the stability at proposed infrastructure locations has been carried out as part of this EIAR based on worst case conditions in accordance with the principals of Eurocode 7 (IS EN 1997-1) i.e. at turbine locations (T1 and T3), which displayed the steepest topography and require the deepest cut/fill operations. A further assessment will be undertaken at detailed design stage by a suitably qualified and experienced geotechnical engineer prior to the commencement of all excavations to confirm the findings of this assessment.
- Blasting of rock will not be permitted.
- Excavations which could have the potential to undermine the up-slope component of an existing slope will be sufficiently supported to resist lateral slippage and careful attention will be given to the existing drainage.
- Earthworks will not be commenced when heavy or sustained rainfall (orange or red weather warnings) is forecast. A series of rainfall gauges will be installed across the site to provide a record of rainfall intensity. An inspection of site stability and drainage by the Geotechnical Engineer will be carried out on site when a daily rainfall of over 10mm/hr or 25mm/day is recorded on site, works will only recommence after heavy rain with the prior approval of the Geotechnical Engineer following their inspection
- An emergency plan (included in Section 6 of the CEMP – Appendix 3.1 of Volume 3 of this EIAR) will be updated at pre-construction stage detailing the action plan which would be implemented in the unlikely event of a landslide/slope failure. Should a landslide/slope failure occur or if signs of instability/ground movement are observed, work will cease immediately.

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

9.6.2.7 Groundwater

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

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

The GSI database is however not complete; it is probable that there are other wells in addition to those in the GSI databases, but are generally associated with houses, the offset to which from the turbines is a minimum of 750m. It is assumed in this assessment that there is a well present in every household within 1km of the site boundary. Given the limited depth of the excavations during the construction phase and the distance to sensitive groundwater receptors the potential risk posed to groundwater supply wells is considered to be Imperceptible following the implementation of mitigation measures discussed above.

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

The GSI holds records of groundwater wells in the vicinity of the GCR. However, trenches are shallow (1.2m deep) and will only be open for a couple of days at most.

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

The GCR and internal cable trenches could provide preferential pathways for groundwater and contaminant movement. Trenches will be excavated during dry periods in short sections (of approximately 50m – 100m) and left open for minimal periods, to avoid acting as a conduit for surface water flows. No excavations will be carried out in heavy rainfall. To further mitigate the risk of cable trenches becoming preferential pathways, clay plugs (or other low permeability material) will be installed at regular intervals along the trench to stop / inhibit water movement.

9.6.3 Mitigation Measures during Operation

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

The main potential residual impact during the operation phase would be the risk to groundwater from contamination from spills. Storage tanks, used to store fuel for the various items of machinery, will be self-contained and double-walled.

Refuelling of maintenance vehicles will be carried out from these tanks or from delivery vehicles at designated refuelling areas. Specific mitigation measures relating to the management of hydrocarbons are as follows:

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

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

9.6.4 Mitigation Measures during Decommissioning

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

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

It is considered that leaving the turbine foundations, access tracks and hardstanding areas in-situ will cause less environmental damage than removing and recycling them. It is proposed to retain these elements of the construction. Turbine bases will be covered with overburden material to allow for re-vegetation of the development site. It is proposed that the internal site access tracks and hard standings will be left in place and the land reinstated at these locations. The GCR infrastructure including substations and ancillary electrical equipment shall form part of the national grid and will be left in-situ.

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

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

9.7 Residual Impacts

It can be observed from Table 9-17 and Table 9-17 that, following the implementation of mitigation measures, the residual impact significance to the receiving environment would be imperceptible during the construction period and imperceptible during the operation of the proposed development. Mitigation measures will be monitored throughout the construction, operational and decommissioning phases.

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

9.8 Cumulative Impacts

During the construction of the proposed project there will be the requirement for the importation of engineered fill from source quarries. Should these coincide with demand for imported aggregate for construction works at the proposed Lackareagh and Carrownagowan Wind Farms there would a cumulative impact in terms of demands placed on local quarries for aggregate. As such , it is considered there will be a **Slight** cumulative impact during construction stage.

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

Table 9-17: Residual Impact Significance for Sensitive Geological Attributes

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction Phase							
Felling Activities	Exposure of underlying overburden leading to increased erosion. Felling machinery resulting soil compaction of soft deposits and an increase in surface water runoff resulting in increased erosion of exposed soils.	Localised organic soils and Glacial Till deposits.	Low	Moderate Adverse	Slight	Negligible	Imperceptible
Earthworks (Turbine bases)	Removal of overburden material, open excavations and subsequent exposure underlying overburden and bedrock leading to increased erosion. Construction traffic resulting in soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill and concrete	Localised organic soils, Glaciofluvial deposits, Glacial Till deposits and bedrock.	Low	Small Adverse	Imperceptible	Negligible	Imperceptible
Earthworks associated with the construction of the proposed project and associated infrastructure	Slope Failure	Localised organic soils Glaciofluvial deposits, Glacial Till deposits and bedrock	High	Small Adverse	Moderate/Slight*	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction of Internal Site Access Tracks, Hardstands, Temporary Compound, Substation	Open excavations, increased runoff causing erosion of underlying overburden and bedrock. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill.	Localised organic soils Glaciofluvial deposits and Glacial Till deposits. Bedrock Local quarries	High	Small Adverse	Moderate/Slight*	Negligible	Imperceptible
Internal Cabling and Grid Connection	Removal of overburden material and exposure of underlying subsoil and bedrock to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill and concrete products. Disposal of surplus excavated material to licenced facility.	Localised organic soils Glaciofluvial deposits, Glacial Till deposits and bedrock. Local quarries Licenced Waste Facilities	High	Small Adverse	Moderate/Slight*	Negligible	Imperceptible
HDD under existing Road	Overburden collapse due to advancement of HDD bore.	Local Glacial Till deposits. Bedrock	Low	Small Adverse	Imperceptible	Negligible	Imperceptible
Accommodation works along TDR	Removal of overburden material and exposure of underlying subsoil and bedrock to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill.	Subsoils. Bedrock. Local quarries. Licenced waste facilities.	Low	Small Adverse	Imperceptible	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
	Disposal of surplus excavated material to licenced facility						
Operational Phase							
Construction traffic for maintenance of turbines, hardstands and access tracks. Operation of substation and turbines.	Release of hydrocarbons or fuel spill	Localised organic soils Glaciofluvial deposits, Glacial Till deposits and bedrock.	High	Small Adverse	Moderate/Slight*	Negligible	Imperceptible
Maintenance of access tracks	Importation of engineering fill	Local quarries	Low	Small Adverse	Imperceptible	Negligible	Imperceptible
Decommissioning Phase							
Removal of Turbines and Hardstands	Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils.	Localised organic soils Glaciofluvial deposits, Glacial Till deposits and bedrock.	Low	Small Adverse	Imperceptible	Negligible	Imperceptible
Cumulative Impacts							
Construction of the proposed project and associated infrastructure	Cumulative impacts on local quarries from extraction of fill for proposed project.	Local quarries	Medium	Small Adverse	Slight	Negligible	Imperceptible

*The soil receptors within the eastern portion of the site (Ballyquin Quarry) would be considered to have a "High" importance as per NRA Guidance. However, the portion of the site where the turbines are proposed are underlain by subsoils/bedrock that would be considered as having a "Low" importance. If this is taken into consideration the site area outside of Ballyquin Quarry can be considered as having an **"Imperceptible"** significance ratings.

Table 9-18: Residual Impact Significance for Sensitive Hydrogeological Attributes

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction Phase							
Felling Activities	Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages from felling machinery	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Small Adverse	Slight	Negligible	Imperceptible
Earthworks (Turbine Bases, Substation and Access Tracks)	Potential for groundwater pollution from the removal of overburden deposits. Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during construction phase earthworks. Reduction in groundwater levels from dewatering of excavation as required during the construction phase.	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Moderate Adverse	Moderate	Negligible	Imperceptible
Construction of Internal Site Access Tracks, Hardstands, Temporary Compound and Substation	Potential for groundwater pollution from the removal of overburden deposits. Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during construction phase earthworks.	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Moderate Adverse	Moderate	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
	Potential for ground water pollution from the use of cement-based compounds during the construction phase.						
Construction of Turbine and Substation Foundations	Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during construction phase earthworks. Potential for ground water pollution from the use of cement-based compounds during the construction phase. Reduction in groundwater levels from dewatering of excavation as required during the construction phase.	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Moderate Adverse	Moderate	Negligible	Imperceptible
Construction of the Grid Connection and Internal Cabling	Potential for ground water pollution from the removal of overburden deposits. Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during construction phase earthworks.	Locally Important Bedrock Aquifers Groundwater Wells and Springs	Medium	Small Adverse	Slight	Negligible	Imperceptible
Earthworks associated with the construction of the proposed project and associated infrastructure	Slope Failure	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Moderate Adverse	Moderate	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Operational Phase							
Operational traffic, refuelling of vehicles	Some operational traffic will be necessary for maintenance plus normal operational traffic which could result in minor accidental leaks or spills of fuel/oil.	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Small Adverse	Slight	Negligible	Imperceptible
Decommissioning Phase							
Removal of Turbines and Hardstands	Potential for groundwater pollution from the disturbance of overburden deposits. Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during decommissioning phase earthworks.	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Small Adverse	Slight	Negligible	Imperceptible
Cumulative Impacts							
Lackareagh and Carrownagowan Wind Farms	Potential for groundwater pollution from runoff from wind farm.	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Negligible	Imperceptible	Negligible	Imperceptible

9.9 Conclusions

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

The proposed development site is not a sensitive site in terms of land, soil hydrogeology & geology and poses a low risk for landslide.

A number of potential impacts have been identified associated with the excavation of soil and rock on the site. The significance of these potential impacts is assessed as being slight to moderate significance prior to mitigation.

The findings of the Geotechnical Assessment (Appendix 9.1) showed that the proposed development site has an acceptable margin of safety and is suitable for the proposed development.

The site is not expected to result in any significant, negative cumulative effects with other existing or permitted developments in the vicinity.

With mitigation measures, outlined in Section 9.6, put in place during construction, operational and decommissioning stage the proposed development will have imperceptible significance on the land, soils, hydrogeology and geology.

9.10 References

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