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CONSULTANTS IN ENGINEERING, ENVIRONMENTAL SCIENCE & PLANNING

ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR) FOR THE PROPOSED CROAGHAUN WIND FARM, CO. CARLOW

VOLUME 2 – MAIN EIAR

CHAPTER 9 – LAND, SOILS AND GEOLOGY

Prepared for: Coillte

COILLTE
GROW · TRANSFORM · SUSTAIN

Date: November 2020

Core House, Pouladuff Road, Cork

www.fehilytimoney.ie

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

The main wind farm site includes the wind turbines, internal access tracks, hard standings, the permanent meteorological mast, recreational amenity trail and associated signage, onsite substation, internal electrical and communications cabling, temporary construction compound, drainage infrastructure and all associated works related to the construction of the wind farm. The grid connection includes the buried grid connection cable route from the on-site substation to the existing grid substation at Kellistown, Co. Carlow and the proposed off-site substation, also at Kellistown. The turbine delivery route includes all aspects of the route from the M11/N30 junction to the site entrance including proposed temporary accommodation works to facilitate the delivery of wind turbine components. Replanting lands at Sroove, Co. Sligo and Crag, Co. Limerick have also been assessed for cumulative impacts. Reports detailing environmental assessments carried out on these sites are contained in Appendix 3.3 and 4.4 of this EIAR.

9.2 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:

Inland Fisheries Ireland (IFI)

IFI noted concerns regarding the potential for erosion of peat and subsoils during construction works and requested clarification on the extent of any proposed soil clearance and depth/extent of excavations for the proposed turbines bases. IFI also noted concerns over the use of borrow pit on the site for similar reasons.

Geological Survey of Ireland (GSI)

The GSI noted the presence of one County Geological Site (CGS) close to the grid connection route. This site is at Aclare House and is described as the largest lithium-bearing pegamite deposit in the Leinster Region. The GSI considered that for the proposed project, there are no envisaged direct impacts on this CGS by the proposed project.

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 remedial measures. The residual impacts from the proposed project are presented in Section 9.6 of this chapter. Cumulative impacts from other projects were assessed where multiple activities were likely to result in a significant impact.

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 9.5.

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 9.1 and 9.2) followed by an estimation of the magnitude of the impacts on geological and hydrogeological features (Tables 9.3 and 9.4).

This determines the significance of the impact prior to application of mitigation measures as set out in Table 9.1:

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

Magnitude	Criteria	Typical Example
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.

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 9.1 to 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 9.4.

9.2.6 Desk Study

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:

- OSI (2020), Current and historic Ordnance Survey Ireland mapping and ortho-photography.
- Taluntas (1980), General Soil Map of Ireland
- Geological Survey of Ireland (2020) GSI Public Data Viewer (www.spatial.dcenr.gov.ie)
- Environmental Protection Agency (2020) Review of the EPA online mapping (http://gis.epa.ie/Envision).
- Study of the proposed layout of the project.

9.2.7 Site Investigations and Field Assessments

Site walkovers and peat stability assessments were undertaken by Fehily Timoney and Company (FT) during July and November 2019 to determine the baseline characteristics of the proposed project site.

The site assessment works undertaken comprised the following:

- Walk over inspections of the main wind farm site with recording of salient geomorphological features at proposed infrastructure locations (see Figure 9.11).
- Peat depth probing and slope stability assessment at proposed infrastructure locations and where peat deposits were encountered.
- Recording of GPS co-ordinates of site investigation locations using a hand-held GPS.

Intrusive and non-intrusive site investigations were undertaken by Irish Drilling Ltd (IDL) under the supervision of FT during July and August 2020.

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

- Advancement of 5 no. rotary boreholes to a maximum depth of 15m below ground level (BGL) at proposed borrow pit locations and selected turbine locations.
- Advancement of 17 no. trial pit to a maximum depth of 2.8m below ground level (BGL) at turbine locations and selected locations along proposed access roads.
- Advancement of 1 no. rotary borehole to a maximum depth of 10m BGL at proposed horizontal directional drilling (HDD) location at the N80 road crossing along the proposed grid connection route.
- Collection of samples for geotechnical testing.

9.3 Existing 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 located within areas classified as bedrock outcrop or subcrop.

The majority of the proposed grid connection route is underlain by Till derived from Granites with limited areas of bedrock sub-crop or outcrop and alluvium indicated along the proposed grid connection route and at the proposed substation at Kellistown.

During site walkovers limited areas of shallow Peat/Peaty Topsoil deposits were noted to be limited in extent and thin with typical thicknesses of between 0.1 – 0.3m.

9.3.1 Bedrock Geology

The Geological Survey of Ireland (GSI) 1:100,000 scale bedrock geology map shows that the main wind farm site is underlain by the Maulin Formation, which is described as dark blue-grey slates, commonly laminated with pale siltstones; metamorphosed to phyllites and schists with sillimanite, garnet, staurolite, andalusite and biotite in granite aureole. The south and southeast of the site is predominantly underlain by Ballybeg Member, which is described as grey metagreywacke psammites and semi-pelitic schists interbedded with dark blue-grey pelitic schists and phyllites. To the north-west of the main wind farm site there are streaks of Equigranular Granite denoted as (C).

There is one main fault-line within the bedrock of the site boundary. The fault has north to south trend.

The proposed grid connection traverses the Maulin Formation, as described above, at the start of the route. The remainder of the route passes through Tullow Type 2 Granite – Sparsely Porphyritic (Tw2i) and Microcline Porphyritic (Tw2m), which also underlies the proposed off-site substation at Kellistown.

The bedrock geology of the proposed project and surrounding area is presented in Figure 9.2.

During site investigations weathered bedrock was encountered at depths ranging from 0.35m to 2.3m bgl. With intact bedrock encountered at between 2.0m to 3.4m bgl. Where intact bedrock was encountered it was generally as medium strong to strong thinly foliated fine-grained SHALE.

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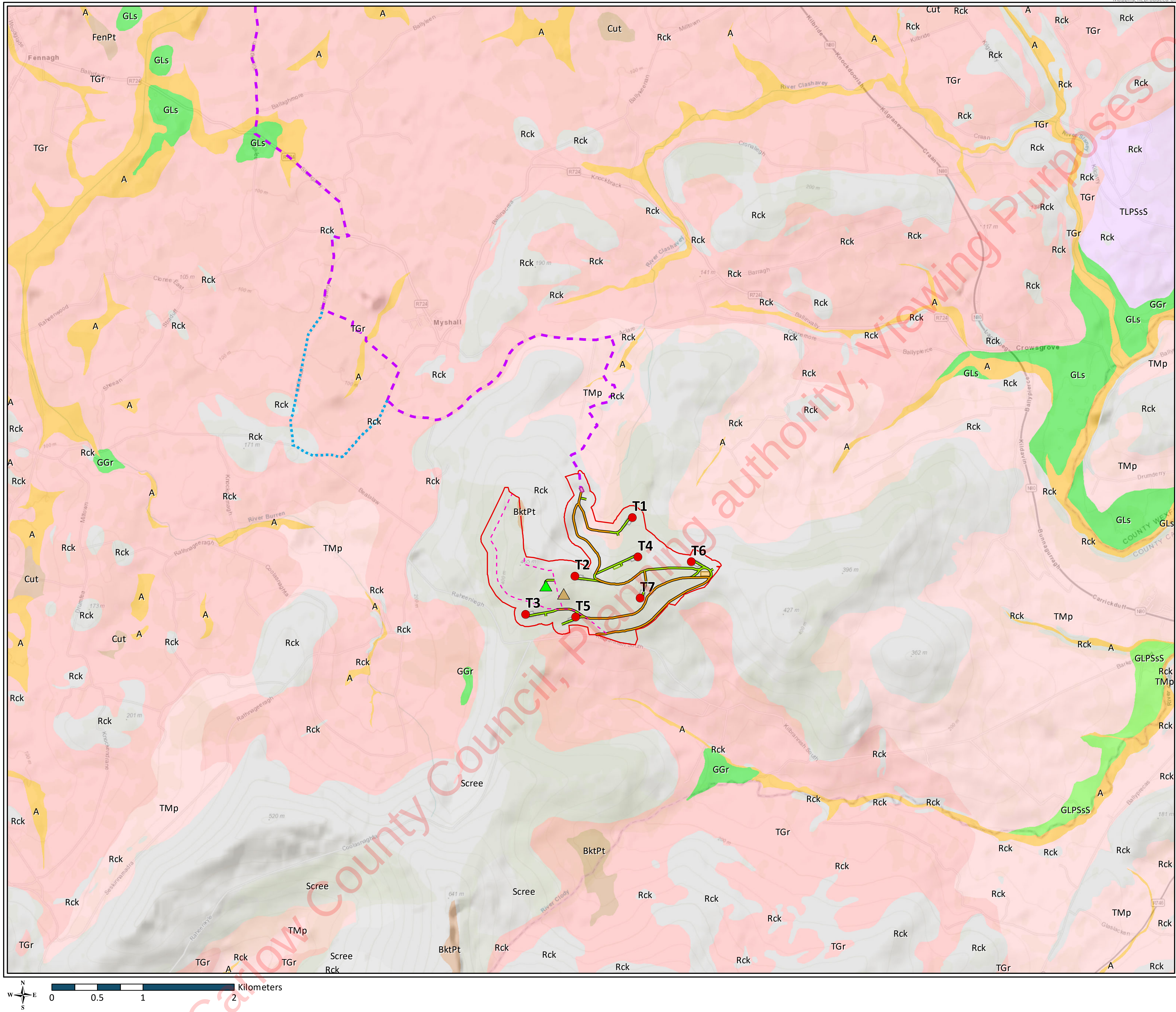

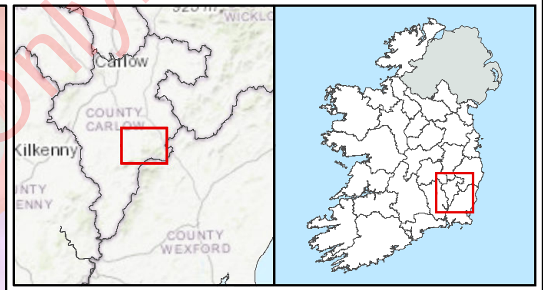

- Proposed Turbine Layout
- Proposed Development Boundary
- Existing 80m Met Mast
- Proposed Permanent 100m Met Mast
- Proposed Grid Connection Route
- Grid Connection Route Variant 1
- Proposed Croaghaun Loop
- Proposed Existing Road Upgrade
- Proposed New Road
- Proposed Turbine Hardstanding
- Proposed Borrow Pit
- Proposed Temporary Compound
- Proposed Substation Compound
- A, Alluvium
- BktPt, Blanket Peat
- Cut, Cut over raised peat
- FenPt, Fen Peat
- GGr, Gravels derived from granite
- GLPSsS, Gravels derived from Lower Palaeozoic sandstones and shales
- GLs, Gravels derived from Limestones
- Rck, Bedrock outcrop or subcrop
- Scree, Scree
- TGr, Till derived from granites
- TLPSsS, Till derived from Lower Palaeozoic sandstones and shales
- TMp, Till derived from Metamorphic rocks

TITLE:	Quaternary Geology 1/2		
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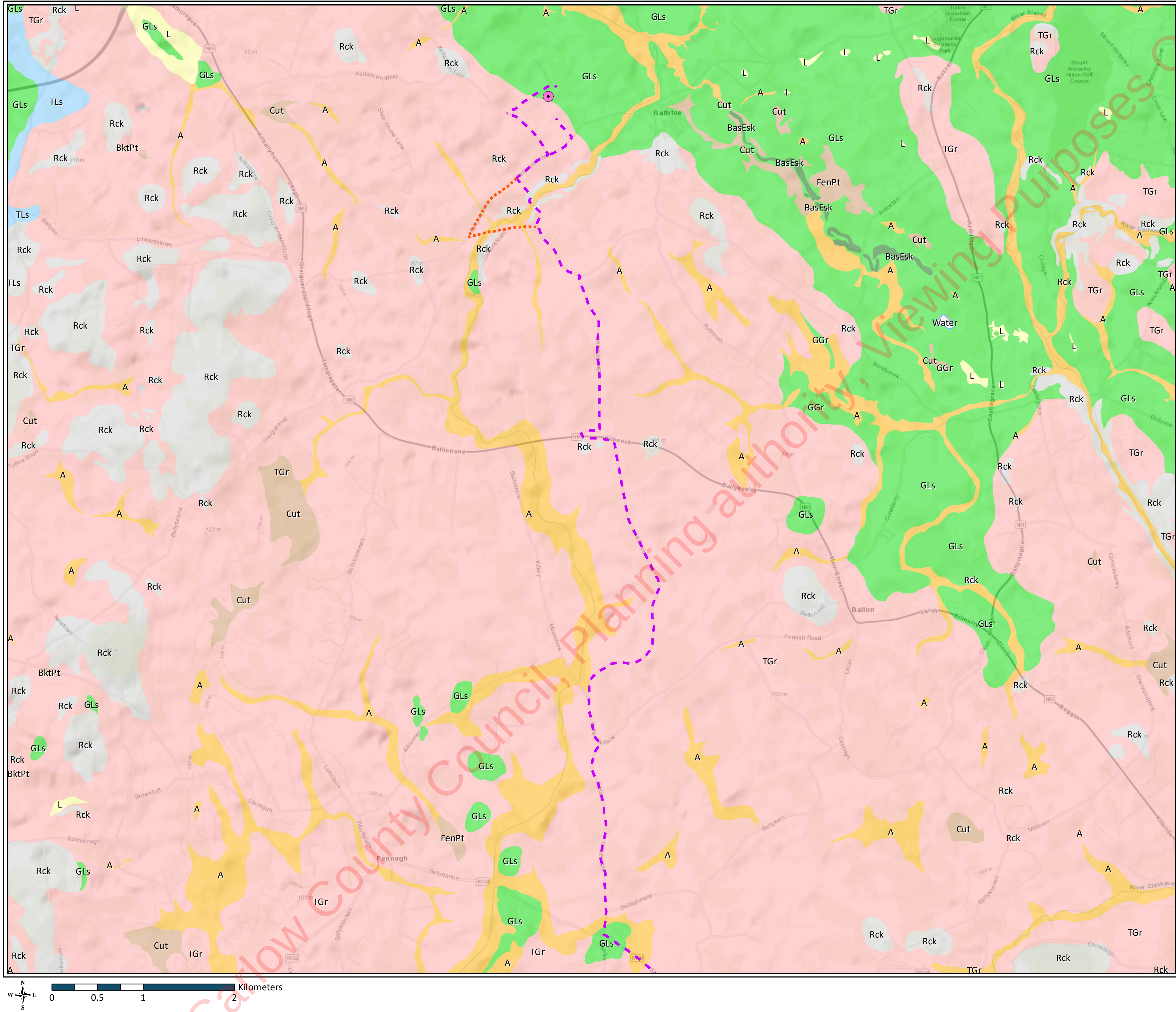

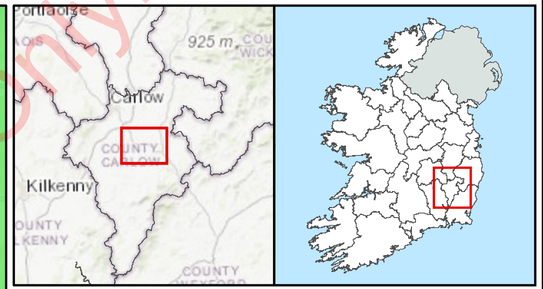

- Kellistown Substation
- Proposed Grid Connection Route
- Grid Connection Route Variant 2
- A, Alluvium
- BasEsk, Eskers comprised of gravels of basic reaction
- BktPt, Blanket Peat
- Cut, Cut over raised peat
- FenPt, Fen Peat
- GGr, Gravels derived from granite
- GLs, Gravels derived from Limestones
- L, Lacustrine sediments
- Rck, Bedrock outcrop or subcrop
- TGr, Till derived from granites
- TLs, Till derived from limestones
- Water

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PROJECT: Croaghaun Wind Farm	
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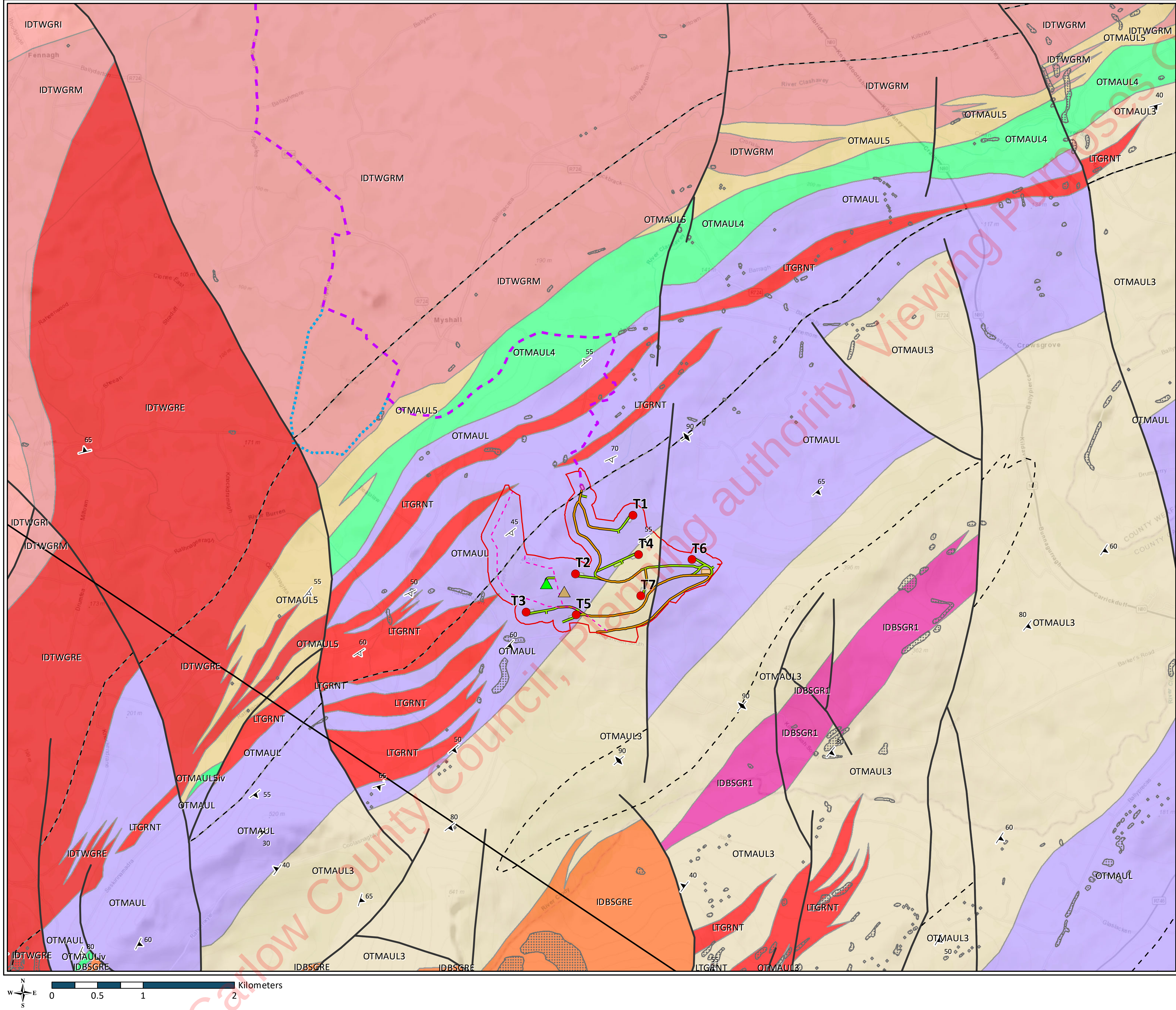

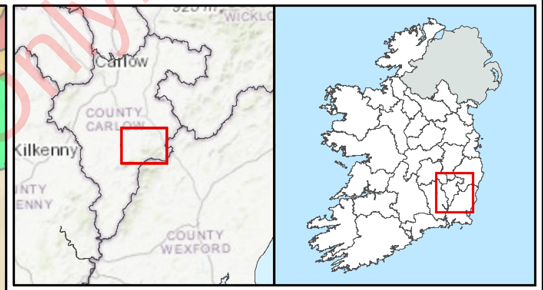

- Strike and dip of first foliation
- Strike and dip of second foliation
- Strike of vertical first foliation
- Proposed Turbine Layout
- Area
- Fault
- X-Section
- Proposed Development Boundary
- Existing 80m Met Mast
- Proposed Permanent 100m Met Mast
- Proposed Grid Connection Route
- Grid Connection Route Variant 1
- Proposed Croaghaun Loop
- Proposed Existing Road Upgrade
- Proposed New Road
- Proposed Turbine Hardstanding
- Proposed Borrow Pit
- Proposed Temporary Compound
- Proposed Substation Compound
- Bedrock Outcrop
- Blackstairs Type 1 Granite
- Blackstairs Type 2 Equigranular Granite
- Tullow Type 2 Equigranular Granite
- Tullow Type 2 Sparsely Porphyritic Granite
- Tullow Type 2 Microcline Porphyritic Grani
- Granite (undifferentiated)
- Maulin Formation
- Ballybeg Member
- Kilcarry Member
- Monaughrim Member
- in Monaughrim Member
- in Maulin Formation

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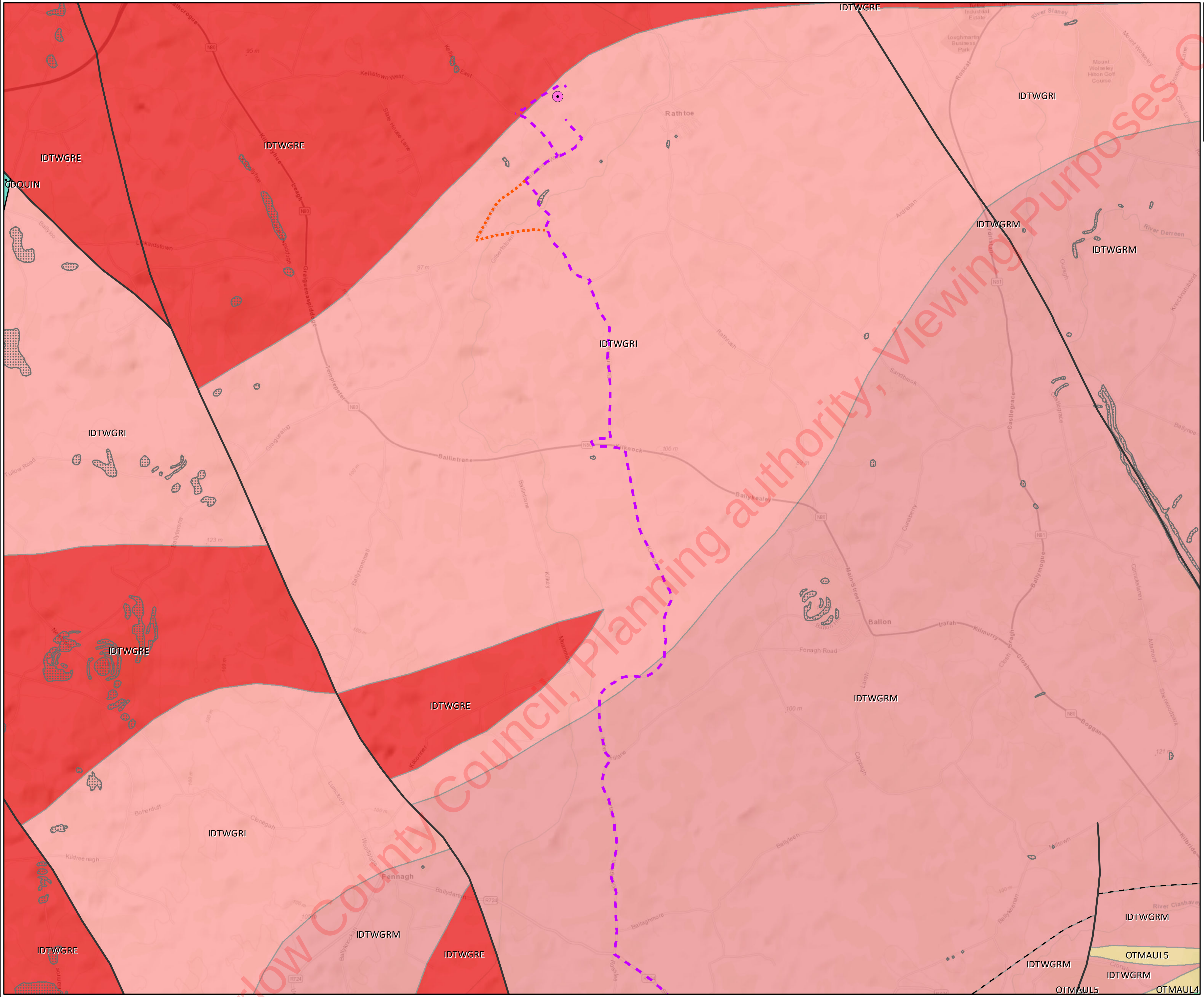

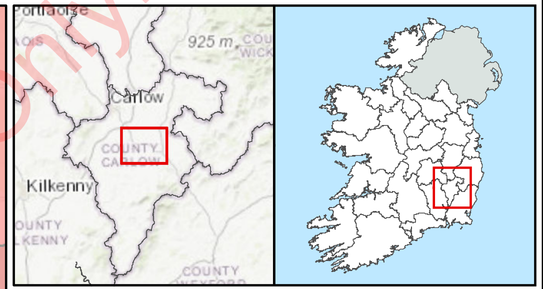

- - - Area
— Fault
Unconformity, dots on younger side
Kellistown Substation
Proposed Grid Connection Route
Grid Connection Route Variant 2
Bedrock Outcrop
Quinagh Formation
Tullow Type 2 Equigranular Granite
Tullow Type 2 Sparsely Porphyritic Granite
Tullow Type 2 Microcline Porphyritic Grani
Kilcarry Member
Monaughrim Member

0 0.5 1 2 Kilometers

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PROJECT:	Croaghaun Wind Farm
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9.3.2 Hydrogeology

9.3.2.1 Groundwater Vulnerability

The Groundwater Vulnerability within the main wind farm site is classified by the GSI as generally being classified as 'X – Rock Near Surface', with localised areas of 'High' to 'Extreme' also present within the proposed project site. Along the proposed grid connection, the vulnerability classification ranges from 'Moderate' to 'Extreme' with localised areas of exposed bedrock (X). At the off-site substation at Kellistown, the groundwater vulnerability is classified as 'High'. The GSI distribution of groundwater vulnerability for the proposed project is shown in Figure 9.5.

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

	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

9.3.2.2 Groundwater Bodies Description

The proposed main wind farm site and a portion of the proposed grid connection is located within the Ballyglass Groundwater Body (GWB). As shown in Figure 9.3 the majority of the grid connection and southwestern extremity of the proposed project site is underlain by the New Ross GWB.

The descriptions 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 has been used to supplement and validate the published information.

Table 9.7: Summary of Aquifer Classifications & Characteriestics

Groundwater Body	European Code	Aquifer Name	GSI Aquifer Classification	Status	Transmissivity (m^2/day)
Ballyglass	IE_SE_G_011	Unnamed	PI[1], LI[2]	Good	1-10 (estimated)
New Ross	IE_SE_G_152	Unnamed	PI, LI	Good	0.4-160

[1] PI: Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones

[2] LI: Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones

9.3.2.3 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.

9.3.2.4 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 main wind farm site boundary or along the grid connection route or the location of the off-site substation at Kellistown

There are however 4 No. Source Protection Areas for public water supply schemes in the wider study area, and these are:

- Graiguenamanagh, approximately 4.3km southeast of the proposed project boundary
- Paulstown, approximately 15km west of the proposed project boundary
- Baltinglass, approximately 17km northeast of the proposed grid connection route
- Kilkea, approximately 17km north-northwest of the proposed grid connection route.

9.3.2.5 Group Water Schemes and Source Protection Zones

Based on a review of the current EPA and GSI groundwater databases, there are no Group Water Schemes (GWS) within the boundary of the main wind farm site. However, there are a number of GWS's within the vicinity of the proposed project and in the wider study area. These are:

- Mullaun, approximately 4.3 km southeast of the proposed project boundary
- Ballingate, approximately 12 km east-northeast of the proposed project boundary
- St Mullins, approximately 16 km south of the proposed project boundary
- Ballyellen, approximately 13km west-southwest of the proposed project boundary
- Ballinabranna, approximately 9km west of the proposed grid connection route.

9.3.2.6 Groundwater Wells and Springs

Based on a review of the GSI Groundwater Wells and Springs database there are 16 No. Groundwater Wells recorded (accuracy up to 500 m, 500 m to 1 km and 1 km to 2km) within 1km of the main wind farm site.

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)	Current Use	Yield Class	GSI Location Accuracy (m)	Nearest Infrastructure ID
2615SEW049	282360	158360	Dug well	33.5	Unknown	Poor	to 1,000	T3
2615SEW059	282080	158850	Borehole	81.1	Unknown	Poor	to 500	T3
2615SEW016	282020	158900	Borehole	18	Unknown	Moderate	to 500	T3
2615SEW014	283110	159820	Dug well	15.2	Unknown	-	to 1,000	Substation
2615SEW079	283120	159660	Borehole	42.7	Unknown	Good	to 1,000	Substation
2615SEW017	283110	159760	Dug well	9.1	Unknown	-	to 1,000	Substation
2615SEW019	283110	159720	Borehole	16.2	Unknown	-	to 1,000	Substation
2615SEW013	283110	159880	Dug well	18.3	Unknown	-	to 1,000	Substation
2615SEW006	284690	159350	Borehole	12.8	Unknown	Moderate	to 500	Substation, T1
2615SEW012	284690	159270	Borehole	21.9	Unknown	Poor	to 500	Substation, T1
2615SEW009	284690	159310	Dug well	16.8	Unknown	Failure	to 500	Substation, T1
2615SEW084	285000	156000	Borehole	4.6	Unknown	Moderate	to 2,000	T5, T7
2615SEW085	282690	156210	Borehole	21.9	Unknown	Good	to 1,000	T3
2615SEW048	282690	156270	Borehole	48.8	Unknown	Poor	to 500	T3
2615SEW047	282690	156320	Borehole	47.9	Unknown	Poor	to 500	T3
2615SEW098	282000	156000	Borehole	23.5	Unknown	Moderate	to 1,000	T3

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.

9.3.2.7 Karst Features

According to the GSI datasets, there are no karst features recorded within the main wind farm site, along the grid connection or at the proposed off-site substation at Kellistown.

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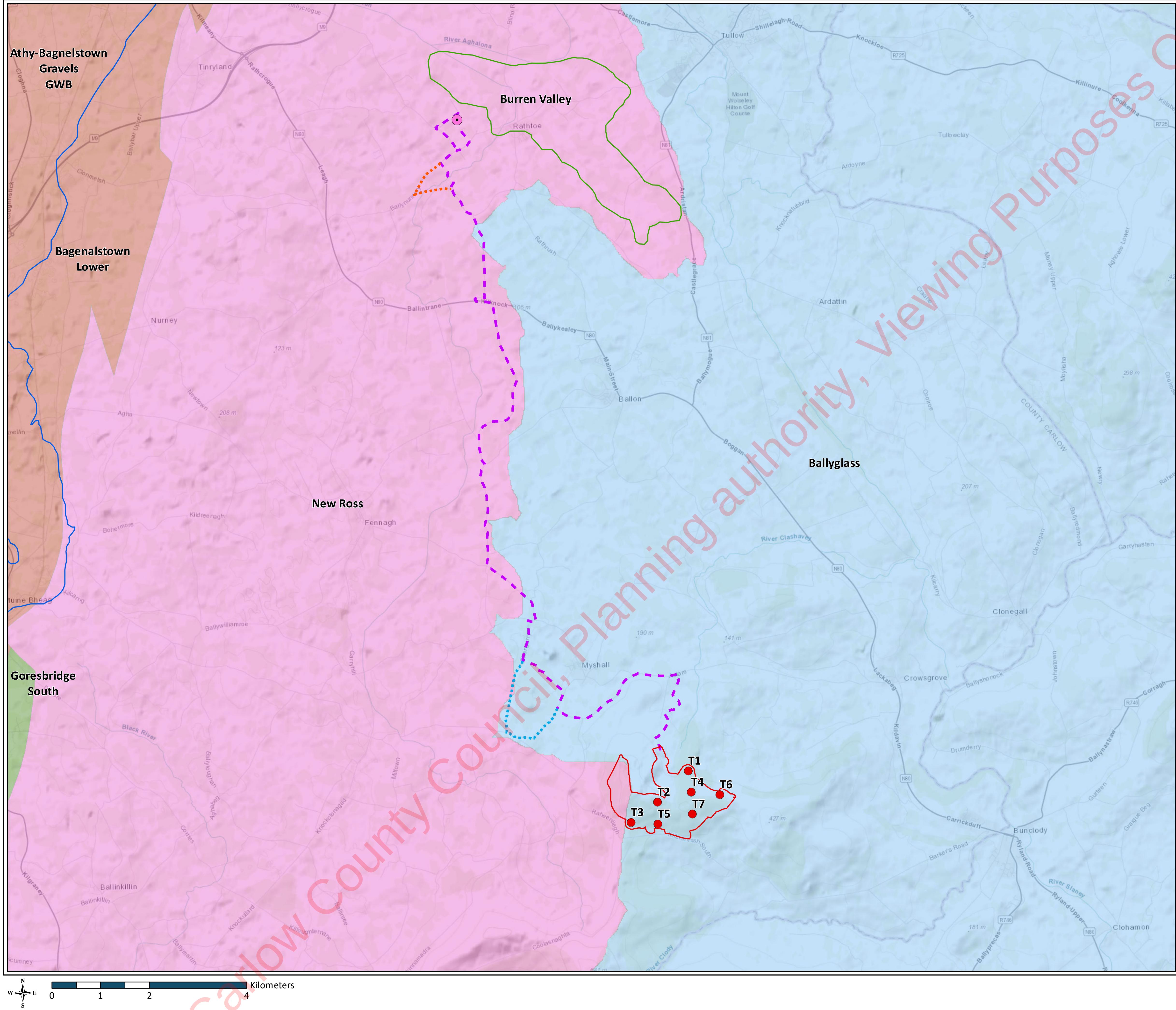

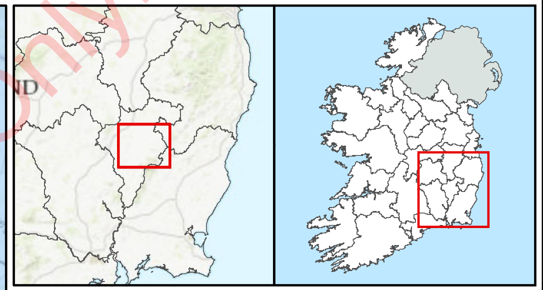

- Proposed Turbine Layout
- Proposed Development Boundary
- Kellistown Substation
- Proposed Grid Connection Route
- Grid Connection Route Variant 1
- Grid Connection Route Variant 2

WFD Ground Water Bodies

- Athy-Bagnelstown Gravels GWB
- Burren Valley
- Bagenalstown Lower
- Ballyglass
- Goresbridge South
- New Ross

TITLE:	Groundwater Bodies
PROJECT:	Croaghaun Wind Farm
FIGURE NO:	9.3
CLIENT:	Coillte
SCALE: 1:75000	REVISION: 0
DATE: 18/11/2020	PAGE SIZE: A3

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Path: R:\Map Production\2019\P1913\Workspace\EIAR\P1913_GIS_Fig9-4_AquiferClassification_A3.mxd

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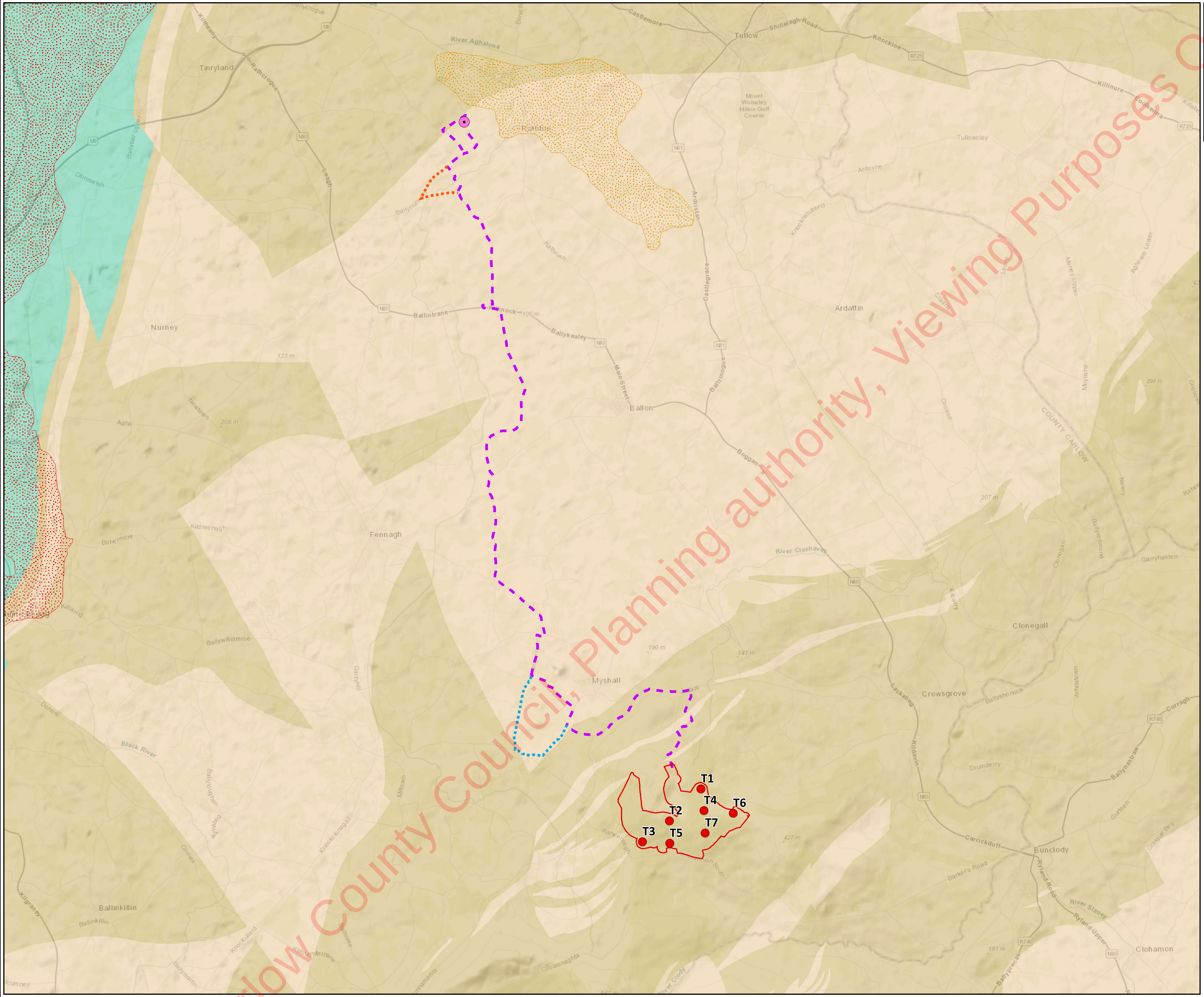

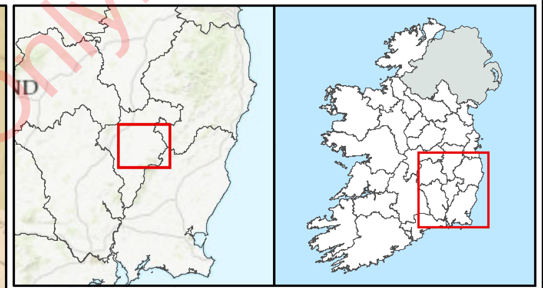

- Proposed Turbine Layout
- Proposed Development Boundary
- Kellistown Substation
- Proposed Grid Connection Route
- Grid Connection Route Variant 1
- Grid Connection Route Variant 2
- Locally important gravel aquifer
- Regionally important gravel aquifer
- LI: Locally Important Aquifer - Bedrock Mod Productive Locally
- PI: Poor Aquifer Bedrock Generally Unproductive Except Locally
- Rkd: Regionally Important Aquifer - Karstified (diffuse)

TITLE: Aquifer Classification			
PROJECT: Croaghaun Wind Farm			
FIGURE NO:	9.4		
CLIENT:	Coillte		
SCALE:	1:75000	**REVISION:**	0
DATE:	18/11/2020	**PAGE SIZE:**	A3

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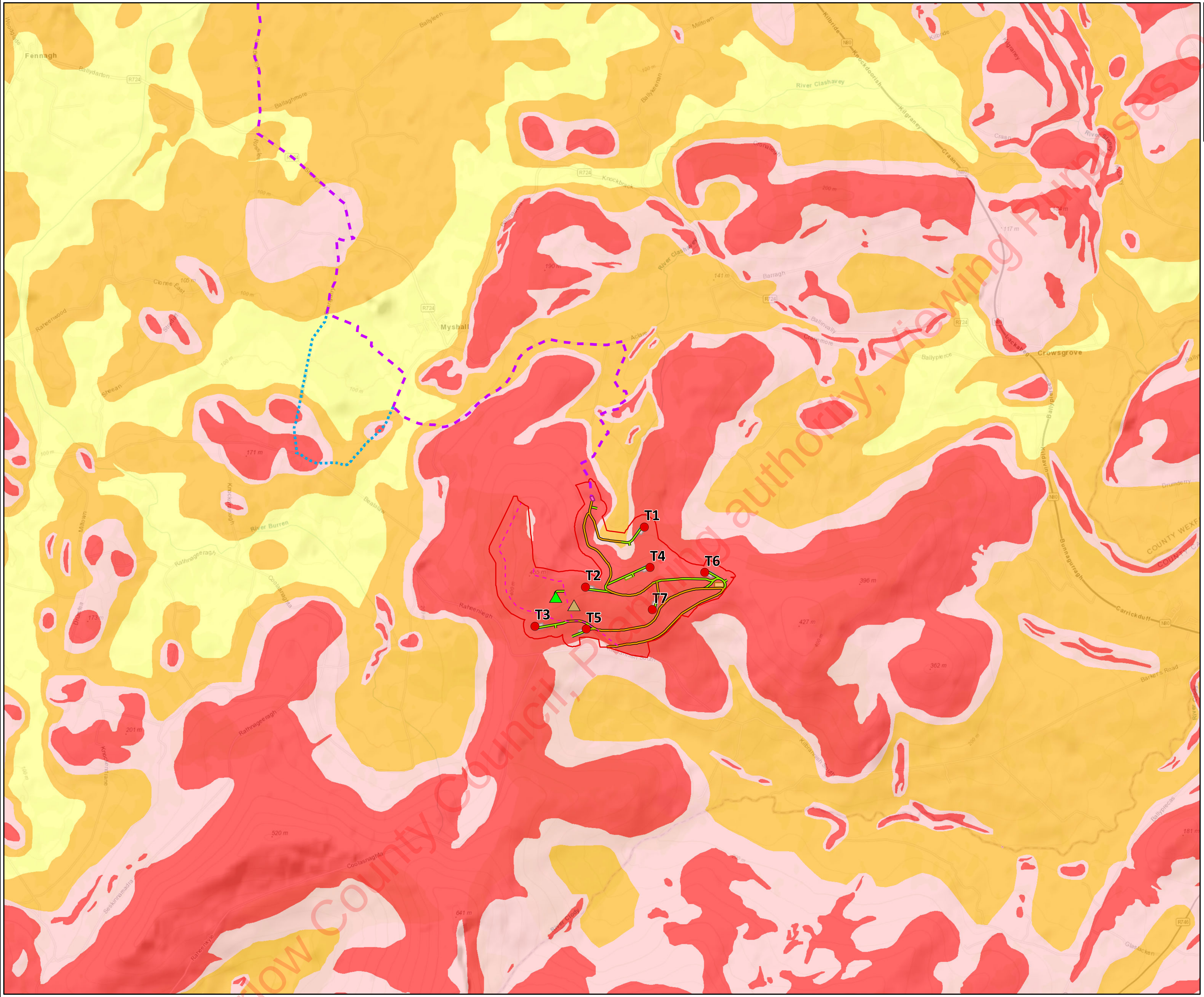

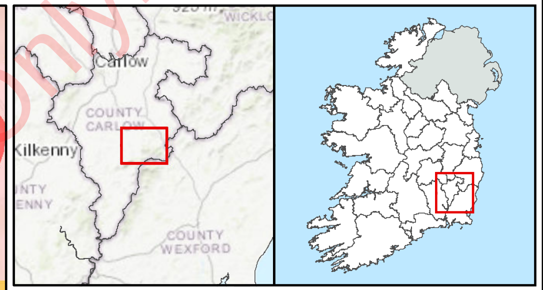

- Proposed Turbine Layout
- Proposed Development Boundary
- Existing 80m Met Mast
- Proposed Permanent 100m Met Mast
- Proposed Grid Connection Route
- Grid Connection Route Variant 1
- Proposed Croaghaun Loop
- Proposed Existing Road Upgrade
- Proposed New Road
- Proposed Turbine Hardstanding
- Proposed Borrow Pit
- Proposed Temporary Compound
- Proposed Substation Compound

Groundwater Vulnerability

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

TITLE:	Groundwater Vulnerability 1/2		
PROJECT:	Croaghaun Wind Farm		
FIGURE NO:	9.5.1		
CLIENT:	Coillte		
SCALE:	1:40000	REVISION:	0
DATE:	18/11/2020	PAGE SIZE:	A3

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0 0.5 1 2 Kilometers

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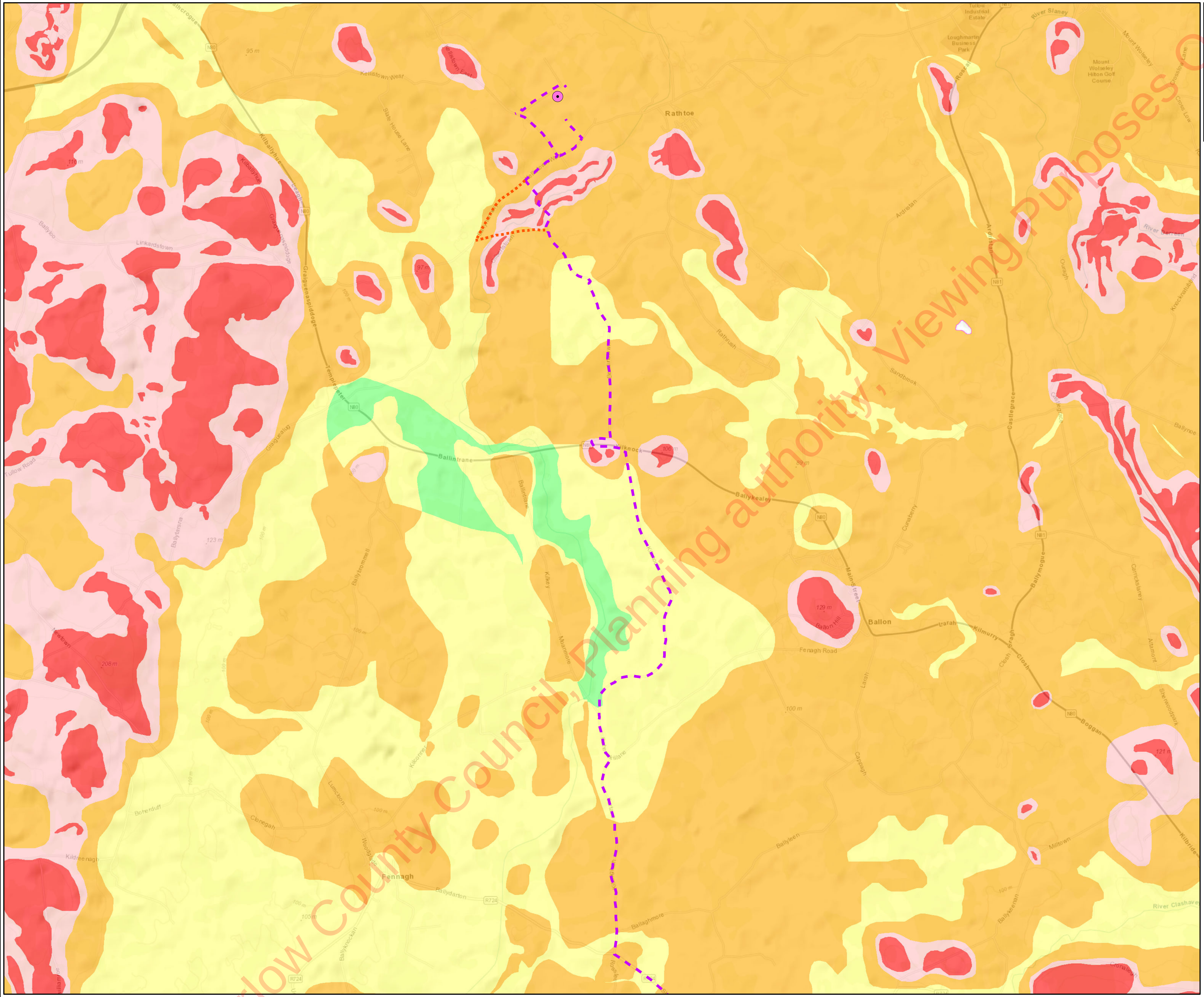

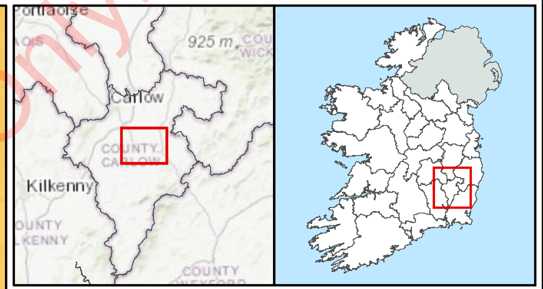

Kellistown Substation

Proposed Grid Connection Route

Grid Connection Route Variant 2

Groundwater Vulnerability

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

Kilometers
0 0.5 1 2

TITLE:	Groundwater Vulnerability 2/2
PROJECT:	Croaghaun Wind Farm
FIGURE NO:	9.5.2
CLIENT:	Coillte
SCALE: 1:40000	**REVISION:** 0
DATE: 18/11/2020	**PAGE SIZE:** A3

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9.3.3 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) – the Irish Geological Heritage Programme. 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. The nearest site of significant geological heritage feature to the study area is located approximately 2km to the north of the proposed project at Aclare. The feature is described by the GSI as comprising the largest lithium bearing pegmatite deposit in the Leinster Region.

The distribution of Geological Heritage sites is shown on Figure 9.6.

9.3.4 Economic Geology

The GSI Online Minerals Database accessed via the Public Data Viewer shows a number of active and historic quarries and mineral occurrences surrounding the study area. These consist of rock quarries, a sand and gravel quarry and recorded mineral occurrences, none of which are located within the site boundary, see Figure 9.7.

The GSI Aggregates database indicates that there is a very low to low potential for crushed rock or granular aggregate across the main wind farm site, as shown in Figures 9.8 and 9.9.

Path: R:\Map Production\2019\P1913\Workspace\EIAR\P1913_GIS_Fig9-6_GeologicalHeritage_A3.mxd

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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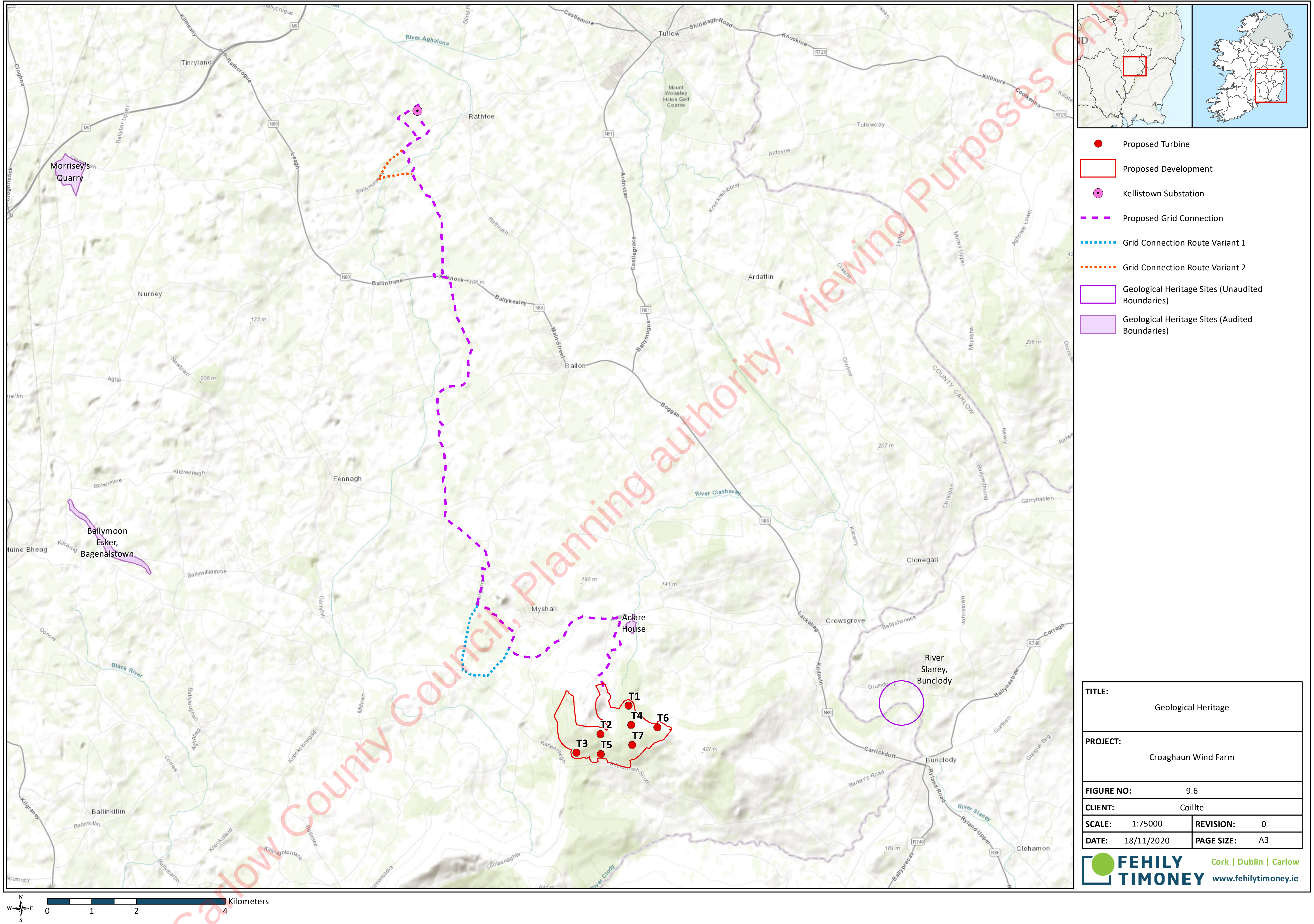

- Proposed Turbine
- Proposed Development
- Kellistown Substation
- Proposed Grid Connection
- Grid Connection Route Variant 1
- Grid Connection Route Variant 2
- Geological Heritage Sites (Unaudited Boundaries)
- Geological Heritage Sites (Audited Boundaries)

TITLE: Geological Heritage	
PROJECT: Croghaun Wind Farm	
FIGURE NO: 9.6	
CLIENT: Coillte	
SCALE: 1:75000	**REVISION:** 0
DATE: 18/11/2020	**PAGE SIZE:** A3

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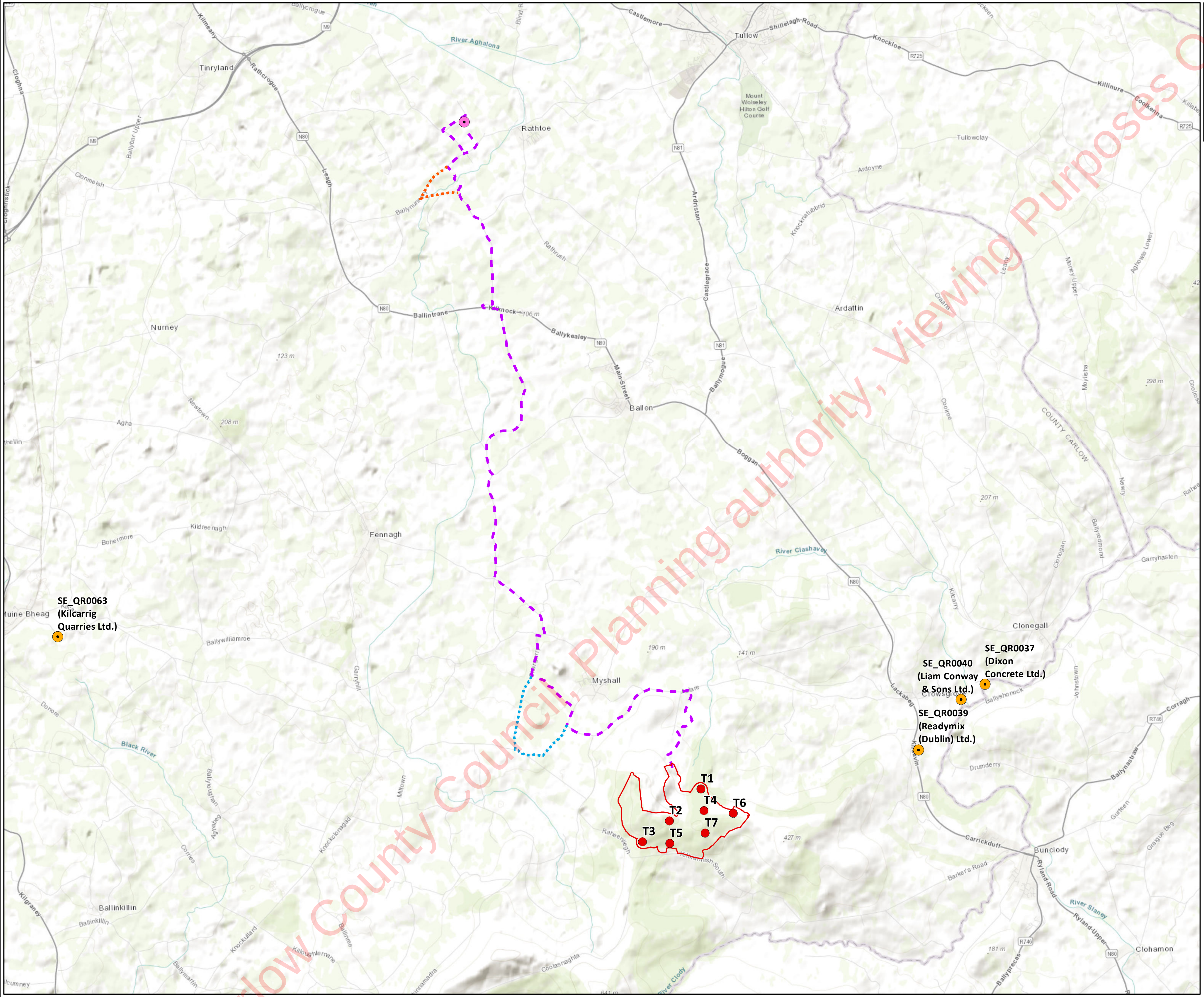

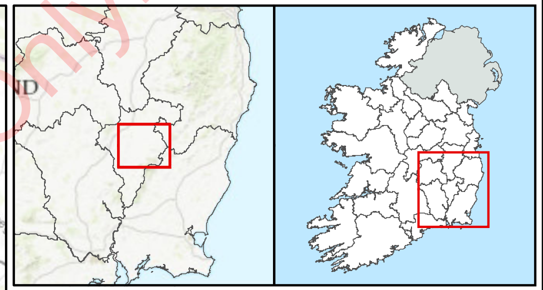

Quarries

Proposed Turbine Layout

Proposed Development Boundary

Kellistown Substation

Proposed Grid Connection Route

Grid Connection Route Variant 1

Grid Connection Route Variant 2

TITLE:	Economic Geology
PROJECT:	Croaghaun Wind Farm
FIGURE NO:	9.7
CLIENT:	Coillte
SCALE: 1:75000	**REVISION:** 0
DATE: 18/11/2020	**PAGE SIZE:** A3

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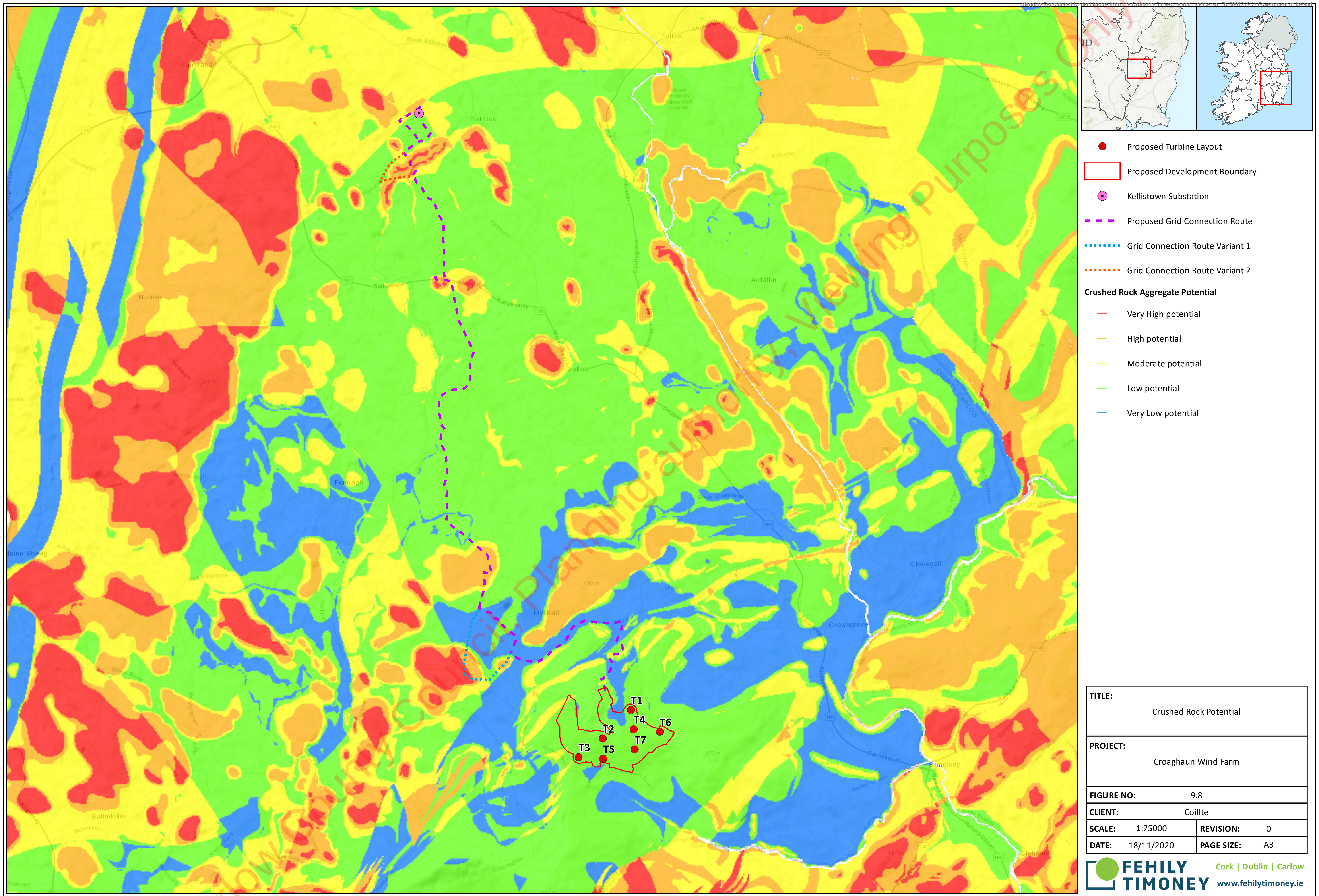

Proposed Turbine Layout
Proposed Development Boundary
Kellistown Substation
Proposed Grid Connection Route
Grid Connection Route Variant 1
Grid Connection Route Variant 2

Crushed Rock Aggregate Potential

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

TITLE:	Crushed Rock Potential
PROJECT:	Croghaun Wind Farm
FIGURE NO:	9.8
CLIENT:	Coillte
SCALE: 1:75000	**REVISION:** 0
DATE: 18/11/2020	**PAGE SIZE:** A3

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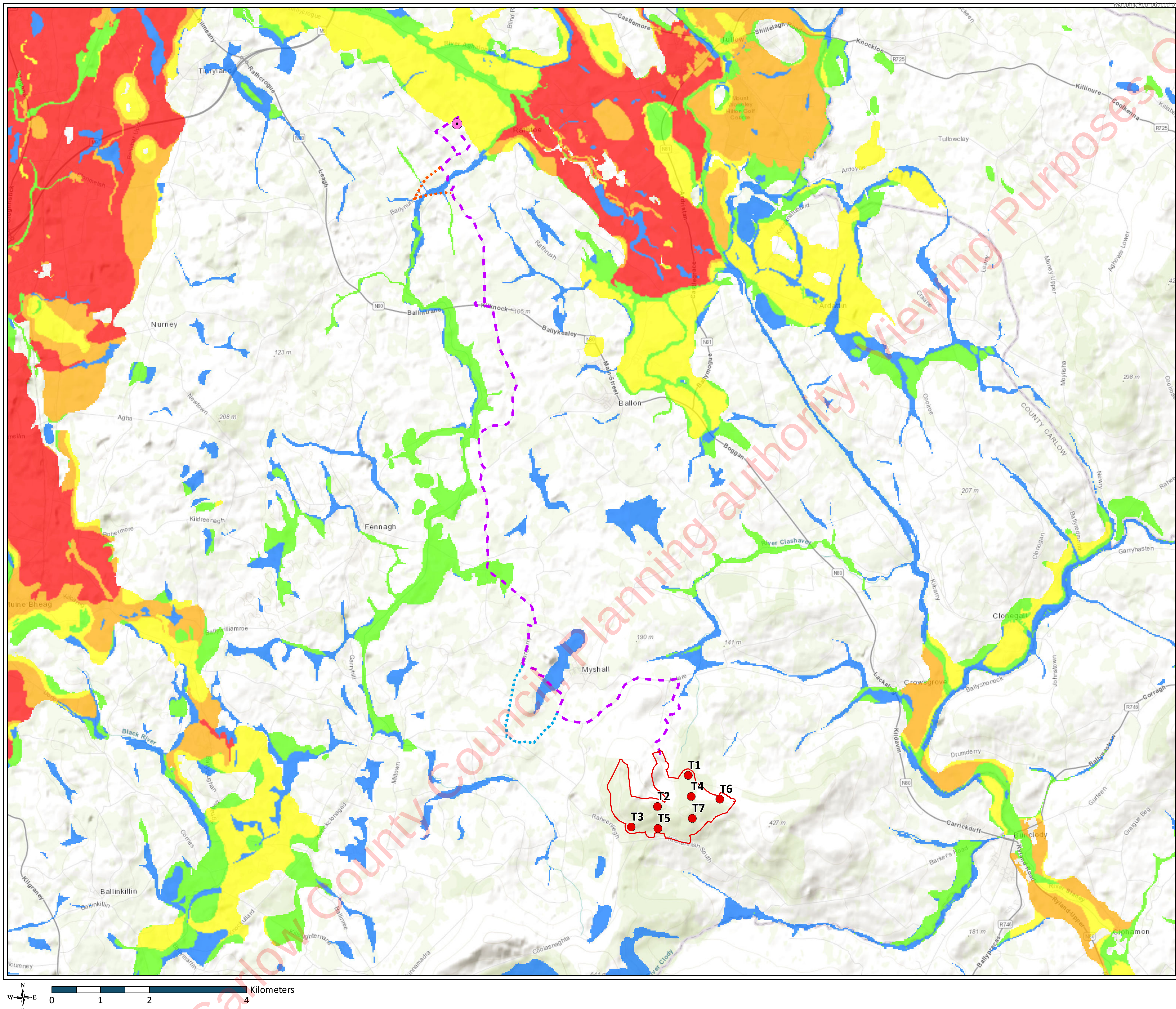

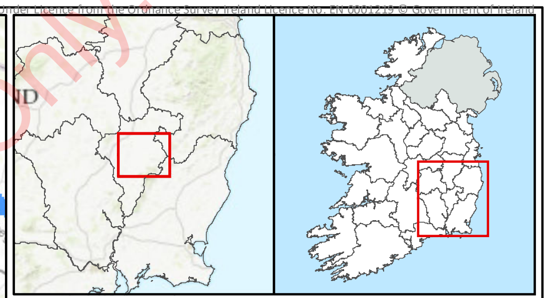

- Proposed Turbine Layout
- Proposed Development Boundary
- Kellistown Substation
- Proposed Grid Connection Route
- Grid Connection Route Variant 1
- Grid Connection Route Variant 2

Granular Aggregate Potential

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

TITLE: Granular Aggregate Potential	
PROJECT: Croaghaun Wind Farm	
FIGURE NO: 9.9	
CLIENT: Coillte	
SCALE: 1:75000	**REVISION:** 0
DATE: 18/11/2020	**PAGE SIZE:** A3

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9.3.5 Site Investigations

As outlined in Section 9.2.7 site walkovers and peat stability assessments were undertaken by Fehily Timoney and Company (FT) during July and November 2019 to determine the baseline characteristics of the main wind farm site. Intrusive site investigations were undertaken by Irish Drilling Ltd (IDL) under the supervision of FT during July and August 2020.

Intrusive investigations were undertaken at the proposed borrow pit location, at selected proposed turbine locations and at the proposed HDD road crossing location on the proposed grid connection route. The purpose of the intrusive works was to confirm the geological succession underlying the site. The site investigations comprised the excavation of 17 no. trial pit to a maximum depth of 2.8m BGL and 6 No. rotary boreholes to a maximum depth of 15m BGL.

Topsoil was encountered across the site and at each infrastructure location during the site walkover and intrusive investigations. The Topsoil ranged from *soft to firm, peaty Topsoil* with *peaty Clay* deposits also encountered to a maximum depth of 0.6m bgl.

Peat deposits were generally noted to be limited in extent and thin with typical thicknesses of between 0.1 – 0.3m.

The Topsoil/Peat deposits described above were found to overlie cohesive Glacial Till deposits. Cohesive deposits encountered typically comprised *soft to firm silty gravelly CLAY* to a maximum depth of investigation of 2.3m bgl in trial pit TP14.

Weathered Bedrock of the Maulin Formation was encountered during site investigations at depths from 0.1 to 2.3m bgl where is was typically described as comprising *Weathered SHALE, recovered as angular fine to medium gravel size clasts of medium strong shale*. Competent Bedrock was encountered in trial pit and boreholes at depths of between 2.0m to 3.4m bgl. Bedrock cores retrieved from the site investigation boreholes were typically described as *Medium strong thinly foliated fine-grained SHALE.*

Groundwater was not recorded in rotary boreholes advanced at turbine locations or at the proposed borrow pit location.

During trial pit excavations minor shallow (perched) groundwater seepage was noted in one trial pit, TP02, at a depth of 0.6m. Table 9.9 shows the groundwater strikes encountered during the intrusive site investigations. The remainder of site investigation locations were noted as being dry during the works. Groundwater monitoring standpipes were installed in two of the rotary coreholes, and groundwater levels recorded during September 2020 are noted in Table 9.10.

Table 9.9: Summary of Groundwater Strikes Recorded

Trial Pit ID	Groundwater Strike (m BGL)
TP02	0.6

Table 9.10: Summary of Groundwater Measurements

Borehole ID	Groundwater Level (m BGL)
T05	4.35
BP01	2.62

The detailed findings and conclusions of the site walkovers and site investigation works is provided in Appendix 9.1 – Geotechnical Assessment Report. 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 with a summary provided below in Table 9.11.

Table 9.11: Site Assessment Summary

Proposed Infrastructure	Land Use	Quaternary Deposits (GSI)	Ground Conditions	Average Peat Depth (m)	Slope (degrees)	Depth to Bedrock (m)	Groundwater Vulnerability
T01	Forestry	Bedrock outcrop or subcrop	Peaty topsoil over firm Clay and weathered bedrock	0.3	6	2.0	X – Rock Near Surface
T02	Forestry	Bedrock outcrop or subcrop	Firm peaty topsoil over weathered bedrock	0.3	6.5	0.7	X – Rock Near Surface
T03	Agriculture	Bedrock outcrop or subcrop	Gravel over weathered bedrock	0	10.4	2.1	X – Rock Near Surface
T04	Forestry	Bedrock outcrop or subcrop	Soft Clay over weathered bedrock	0	8.2	1.8 – 2.2	X – Rock Near Surface
T05	Forestry	Bedrock outcrop or subcrop	Firm Clay over weathered bedrock	0	10	2.5 - 3.4	X – Rock Near Surface
T06	Peat Bog	Bedrock outcrop or subcrop	Firm Clay over weathered bedrock	0.1	6.3	1.3	X – Rock Near Surface
T07	Forestry	Bedrock outcrop or subcrop	Firm Clay over	0.1	9.6	1.3	X – Rock Near Surface

Proposed Infrastructure	Land Use	Quaternary Deposits (GSI)	Ground Conditions	Average Peat Depth (m)	Slope (degrees)	Depth to Bedrock (m)	Groundwater Vulnerability
			weathered bedrock				
Substation	Forestry	Bedrock outcrop or subcrop	Firm Clay over weathered bedrock	0	3	0.8	X – Rock Near Surface
Temporary Compound	Forestry	Bedrock outcrop or subcrop	Firm peaty topsoil over weathered bedrock	0.3	3	1.3	X – Rock Near Surface

9.3.6 Existing Slope Stability

During the site walkovers a series of hand-held probes were undertaken to determine the presence/depth of peat and/or soft soils within the proposed site. From a desk top review of the proposed grid connection route, the majority of the proposed route is situated within existing public highway. As such and given the limited extent of lateral and vertical excavations on and off road, there is limited risk of slope instability along the grid connection route. A summary of the general topography and slope stability at the proposed project is summarised below.

Topography of the Main Wind Farm Site

The slopes in the southern portion of the main wind farm site fall to the south with typical elevations of between 400m to 300m AOD with moderate slopes throughout the area. Slopes within the proposed project and at proposed infrastructure locations generally comprise slopes of between 7 to 14 degrees.

The slopes in the central and northern portion of the main wind farm site slope to the north, with typical elevations of between 400m to 300m AOD.

Slopes at proposed turbine locations in this portion of the main wind farm site range from gentle to moderate with maximum slope angles of 14 degrees. Slopes at the proposed borrow pit are typically in the order of 8-10 degrees sloping to the north.

Slope Stability Assessment

From a review of the GSI Landslide Susceptibility database, the main wind farm site and proposed infrastructure locations are generally located within areas of 'Moderate' susceptibility. A summary of the GSI landslide susceptibility with respect to the proposed project 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 or close to the main wind farm site on the GSI database.

Site investigations completed at proposed turbine locations comprised the advancement of a trial pit to a maximum depth of 2.8m bgl at each location. At three number turbine locations (T3, T4 and T5) rotary corehole were drilled to a depth of 15m bgl. Bedrock was recorded at turbine locations at a depth of 0.3 to 3.4m bgl.

A more detailed summary of the site investigations completed at these locations and the results of the slope stability assessment are included the Geotechnical Assessment Report in Appendix 9.1 of the EIAR. In summary, given the absence of significant deposits of soft ground and the shallow depth of bedrock, a safety ratio for potential slope failures for drained conditions of 1.72 was calculated at proposed turbine location T5. A safety ratio of greater than 1.0 indicates that the slope is considered stable in the long-term drained conditions.

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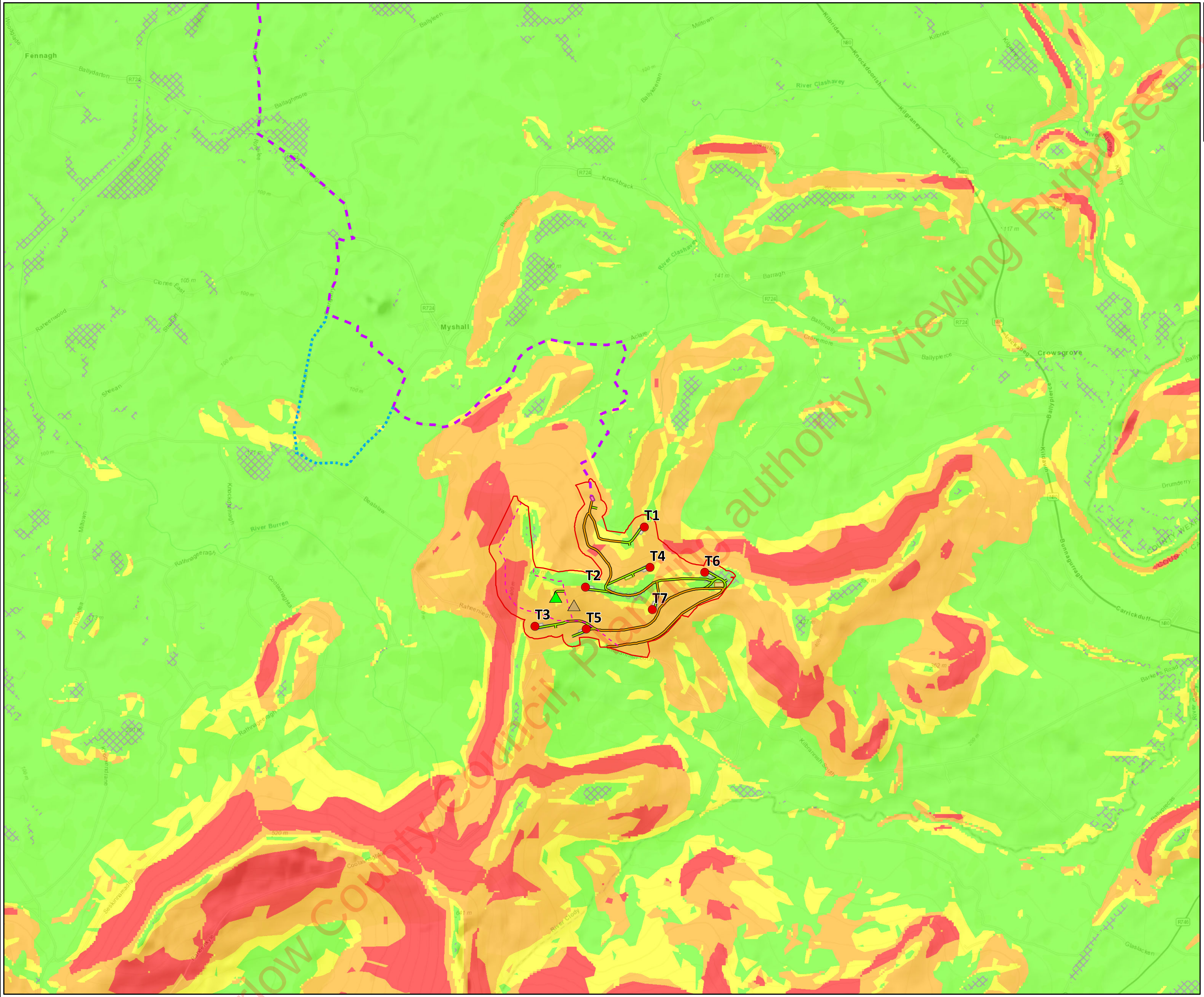

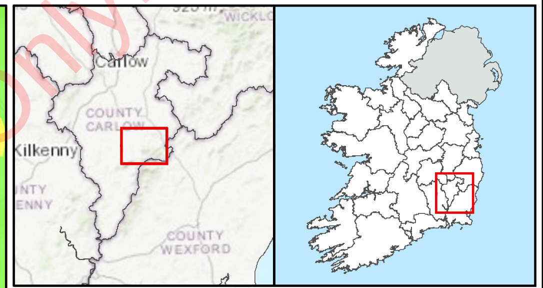

- Proposed Turbine Layout
- Proposed Development Boundary
- Existing 80m Met Mast
- Proposed Permanent 100m Met Mast
- Proposed Grid Connection Route
- Grid Connection Route Variant 1
- Proposed Croaghaun Loop
- Proposed Existing Road Upgrade
- Proposed New Road
- Proposed Turbine Hardstanding
- Proposed Borrow Pit
- Proposed Temporary Compound
- Proposed Substation Compound

Landslide Susceptibility

- Low
- Low (inferred)
- Moderately Low
- Moderately Low (inferred)
- Moderately High
- High

TITLE:	Landslide Susceptibility 1/2
PROJECT:	Croaghaun Wind Farm
FIGURE NO:	9.10
CLIENT:	Coillte
SCALE: 1:40000	**REVISION:** 0
DATE: 18/11/2020	**PAGE SIZE:** A3

FEHILY TIMONEY
Cork | Dublin | Carlow
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0 0.5 1 2 Kilometers

Path: R:\Map Production\2019\P1913\Workspace\EIAR\P1913_GIS_Fig9-10_LandslideSusceptibility_A3.mxd

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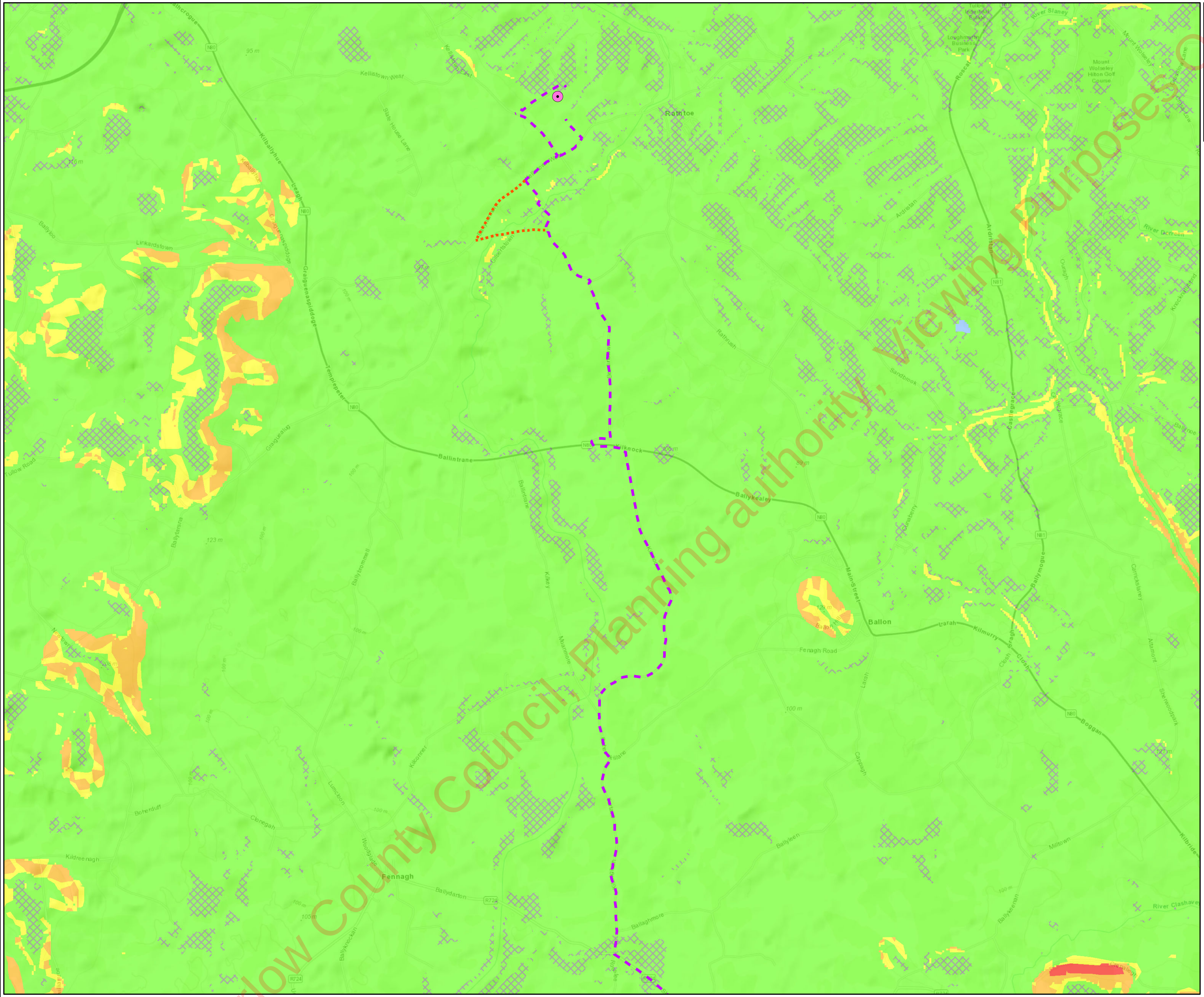

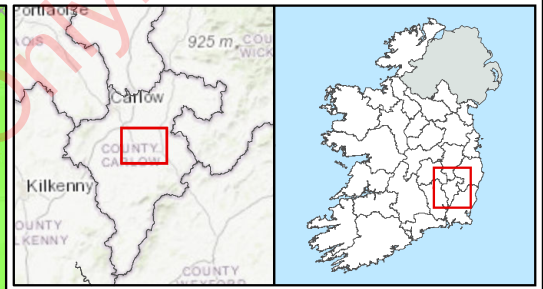

Kellistown Substation
Proposed Grid Connection Route
Grid Connection Route Variant 2

Landslide Susceptibility

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

TITLE:	Landslide Susceptibility 2/2		
PROJECT:	Croaghaun Wind Farm		
FIGURE NO:	9.10		
CLIENT:	Coillte		
SCALE:	1:40000	**REVISION:**	0
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Peat Stability Assessment

Following the site walkover and given the presence of small areas of Peat deposits and peaty Topsoil within the main wind farm site boundary, a review of the published checklist for peat landslide hazard and risk assessment was carried out. This was undertaken in accordance with the following best practice guidance: Scottish Executive – Peat Landslide Hazard and Risk Assessments (2017).

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

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

A peat survey was carried out by an FTC Engineering Geologist during July and November 2019. The peat deposits were relatively thin (maximum 0.3m thick, average thickness 0.15m).

Soft Peaty Topsoil deposits were noted at proposed infrastructure locations, but these were generally very thin (0.1 to 0.3m thick) and were not considered to constitute Peat Deposits but rather a highly organic Topsoil with Peaty appearance.

As such and in accordance with the Scottish Executive Best Practice Guide for Proposed Electricity Generation Developments (2017), as peat deposits were <0.5m in depth a peat stability assessment was not undertaken.

9.3.7 Soil Contamination

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

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

9.3.8 Replant Lands

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

As it is proposed to fell approximately 24.4 ha of coniferous forestry for the proposed project, replant lands of the same area are required. The replacement replanting of forestry can occur anywhere in the State subject to licence.

Potential replanting sites have been identified at Sroove, Co. Sligo and Crag Co. Limerick. These lands have been assessed as part of this EIAR in Appendix 3.3 and 3.4, and in terms of potential cumulative impacts. If these replant lands become unavailable, other similarly approved lands will be acquired for replanting should the proposed wind farm receive planning permission.

Sroove, Co. Sligo

The site at Sroove is underlain with a band of Oakport Limestone Formation to the west and a band of Moygara Formation to the east. They are described as "Pale grey massive limestone" and "Red conglomerate & pebbly sandstone," respectively. Sandstone till subsoil covers the site with areas of blanket peat and found to the north, west and south and bedrock at surface found to the east.

The vulnerability rating of the aquifer within the site is 'High' in the west which corresponds to the band of Oakport Limestone Formation. To the east, the vulnerability rating of the aquifer comprises areas of 'E' Extreme Vulnerability and 'X' Rock at or Near Surface and roughly corresponds to the Moygara Formation area. The surrounding area comprises a mix of these categories with large areas of 'Low' Vulnerability to the north and south.

Crag, Co. Limerick

The site at Crag is underlain by the Feale Sandstone Formation & Ballynahown Sandstone Formation. The former is described as "Rhythic repetition of brown to green sandstone and shale with occasional coal seams" and the latter described as a type of sandstone and shale where "Plant fragments are abundant. An anthracite seam and thin carbonaceous shales occur". The subsoil comprises alluvium along the eastern boundary with a band of 'Bedrock at or near Surface' running north-south towards the east, west and south. The centre of the site comprises Shales and Sandstones till of Namurian derivation.

The vulnerability rating of the aquifer within the site is categorised as 'High' due to the presence of bedrock relatively close to the surface. To the south and east of the site, the groundwater vulnerability is categorised as 'Extreme' (E) and 'Rock near surface or karst' (X) which is likely to be as a result of the presence of bedrock at or within 1 to 3 metres of the surface.

9.4 Characteristics of the Proposed Project

The proposed project will involve the removal of topsoil, overburden and bedrock (where present) for the construction of access roads and hardstands.

Bedrock for construction of these access roads and hardstands will be sourced from the site borrow pit. It is proposed that the borrow pit will be reinstated using spoil material excavated on-site.

Estimated volumes of overburden (topsoil and spoil) and bedrock to be removed are shown in Table 9.12 and Table 9.13 respectively. Not all of the spoil excavated will be sent to the borrow pit, a portion 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.

Settlement ponds [within the wind farm] where constructed will be volume neutral, i.e. all material excavated will be used to form side bunds and landscaping around the ponds. There will be no excess material from settlement pond construction. The material will also be reinstated during decommissioning where appropriate.

Table 9.12: Estimated Excavation Volumes

Item	Excavation Volume (m^3)	Fill Volume (m^3)
Access Roads	80,000	20,000
Turbine Hardstands, Construction Compound, Substation	120,000	70,000

Table 9.13: Estimated Borrow Pit (Stone) Excavation Volume

Borrow Pit	Volume (m^3)
BP01	45,000

9.5 Potential Impact

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 9.13 and Table 9.14. 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

An area of the proposed project site comprises commercial coniferous forestry. Felling of approximately 25.7ha of coniferous forestry is required within and around the wind farm infrastructure to accommodate the construction of some turbines, hardstands, crane pads, access tracks, onsite substation, borrow pit, grid connection, temporary compounds and permanent met masts. A total of 3 No. turbines are located within forestry and consequently tree felling will be required as part of the project.

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 project.

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 project 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 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 **Slight significance.**

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

- Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer.

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.**

9.5.2.2 Earthworks (Turbine and Borrow Pit Excavations)

The proposed project will require construction phase earthworks associated with the excavation of turbine bases, removal of overburden deposits for the construction of turbine foundations and the excavation of overburden and bedrock from the borrow pit.

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

The following earthworks excavations will be required:

- Excavation of Topsoil deposits
- Excavation of Glacial Till to bedrock (as required)
- Excavation of Bedrock at Turbine bases and Borrow Pit

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, along access roads and in the borrow pit. Material placed alongside access roads will not exceed 1m in height and will be shaped and sealed to prevent the ingress of water.

Turbines of the size proposed for the Croaghaun Wind Farm will have foundation depths of 4m and a base diameter of up to 22m, depending on the manufacturer and ground conditions. Flexibility of $^{+}/_{-}$ 1.5m in the finished levels is required to allow for sloping topography and ground conditions.

A proposed borrow pit location (BP01) has been identified as a source of site won granular fill for construction activities. The location was selected as a source of general fill (Class 1 material) for the proposed project using the criteria of no peat deposits, low landslide susceptibility and proximity to existing access tracks and proposed infrastructure.

The proposed borrow pit is underlain by the Maulin Formation which is classified by the GSI as having 'Low' potential for crushed rock aggregate. However, as outlined in Section 9.3.6, intrusive site investigations undertaken at the proposed borrow pit location identified bedrock deposits comprising weathered and intact Bedrock suitable for use as general fill for the construction of the proposed project.

The proposed borrow pit will have a footprint area of approximately 5,000m^2. This will provide a potential volume of approximately 45,000m^3 of site won granular fill, which when combined with bedrock excavated at hardstand locations will provide sufficient fill material for the proposed access roads and hardstands. A breakdown of volumes is provided in Section 9.4.

At the borrow pit location approximately 1.5m of overburden material will be required to be stripped to access the underlying deposits. This material will be temporarily stockpiled adjacent to the borrow pit prior to re-use in the reinstatement of the borrow pit. No permanent stockpiles of material will remain after construction.

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

Surplus topsoil and overburden recovered from excavations will be used for the reinstatement of the proposed borrow pit and for 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 main wind farm site.

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

- Soil compaction may occur due to movement of construction traffic. This will occur within overburden deposits which are exposed and trafficked 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 rock from the borrow pit will represent a reduction in the availability of an exhaustible resource. The crushed rock potential across the site is classified as 'very low' to 'low', indicating that the bedrock in the area is not considered to be of high 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 (peat, subsoils, bedrock) is considered to be 'Low'. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Imperceptible significance.**

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

- Potential for groundwater pollution from the removal of overburden deposits particularly at proposed turbine locations and at the borrow pit location. The aquifer underlying the proposed wind farm site and the majority of the proposed grid connection route is classified by the GSI as ranging from '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. There are no groundwater supply wells recorded in the immediate vicinity of proposed turbine or borrow pit locations. It is considered that other excavations associated with substation, temporary compound and grid connection trenches will not extend into the underlying bedrock aquifers. It is possible however that perched groundwater may exist locally within overburden deposits or weathered bedrock. Upon completion of the construction phase, it is considered that groundwater levels will revert to the pre-construction situation

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.**

9.5.2.3 Slope Stability

The proposed project and proposed infrastructure locations are generally located within areas of 'Moderately High' landslide susceptibility . As such it is considered that construction activities at these locations pose a potential risk to sensitive receptors from potential landslide/slope failures.

A slope at T05 was selected for slope stability assessment in accordance with the principals of Eurocode 7 (IS EN 1997-1) , representing the steepest natural slope angles recorded in the vicinity of the turbines . The results of this analysis are summarised in the Geotechnical Assessment Report in Appendix 9.1 of the EIAR.

In summary, safety ratios for potential slope failures indicates that the slopes are considered stable in the long-term drained conditions.

Given the absence of blanket peat deposits 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 (peat, subsoils, bedrock) is considered to be 'Low'. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Imperceptible significance.**

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

There will be 9.2km of internal access tracks associated with the main wind farm site. This will be a combination of existing track upgrade and construction of new tracks; approximately 3.9km of new track construction and approximately 5.2km of existing track upgrade. Hardstand areas will be provided at each turbine location. A temporary construction compound will be created for the construction works, and an on-site substation will also be constructed.

All access tracks will be 5m wide along straight sections and wider at bends and as required. 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, peat 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 the on-site borrow pit with material for the finishing layer on the access roads and hardstands imported from quarries in the vicinity.

As outlined in Chapter 13 of the EIAR the likely off-site, source quarries for the supply of imported aggregate during the construction phase of the development are located at:

- Clonmelsh, Co. Carlow. Located 24km from Croaghaun.
- Millford, Co Carlow. Located 25km from Croaghaun.

Access tracks will consist of a minimum 500mm hardcore on a geotextile membrane. The construction methodology for access tracks will be as follows:

- The topsoil/subsoil will be stripped back to a suitable formation layer of firm subsoil.
- Well graded granular fill 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 overburden 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 (peat, subsoils, bedrock) is considered to be 'Low'. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Imperceptible significance.**

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 Kellistown substation.

Construction of the 38kV underground cable to export power from the site to the national grid will involve the installation of ducting, joint bays, drainage and ancillary infrastructure and the subsequent running of cables along the existing road network and within forestry, along forest tracks and through agricultural lands. 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. Where cable trenches traverse private agricultural lands, tracks or forestry where agricultural vehicles are expected to drive as part of future agricultural or forestry activities, cable trenches shall be backfilled with suitable backfill material.

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. Where internal cables follow existing forestry tracks that are not earmarked for upgrade as part of the internal wind farm access track network, cable ducts will be laid in the centre of the forest track and backfilled with suitable fill material.

The location of buried internal cables within the main wind farm site are shown on planning application drawings.

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

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

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

Works will also be required in proximity to the Kellistown substation to accommodate the proposed project. The works will allow the voltage from the wind farm grid connection to be 'stepped up' to 110kV. The proposed substation compound will be self-contained and positioned in a neighbouring field to that of the existing Kellistown substation. The proposed design for the offsite substation is a worst-case scenario in terms of footprint and scale of infrastructure. The final design for shall be carried out by the network operator subject to upgrade requirements and grid connection agreement.

The dimensions of the proposed substation compounds will be up to 61m x 50m and will include a substation control building and electrical components necessary to export the electricity generated from the wind farm to the existing substation at Kellistown.

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'. Excavations for the proposed substation will be limited in extent and depth and therefore the magnitude of these potential impacts, prior to mitigation, is of **Imperceptible** Significance.

9.5.2.6 Horizontal Directional Drilling (HDD)

HDD will be employed under the existing road at one location along the proposed grid connection route as part of the development as shown in Chapter 10, Figure 10.5.

The operation shall take place from one side of the public road corridor or verge 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 road. A shallow starter pit will be excavated at the point of entry and shall be located at a sufficient distance from the road to achieve a minimum clearance depth below any services present beneath the road.

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. 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 if 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.

The depth of the bore shall be at least 2m below the level of the public road. A pre-construction survey of buried services within the public road will be carried out by the contractor prior to commencement of the operation to confirm the conditions predicted in this EIAR.

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 (peat, subsoils, bedrock) is considered to be 'Low'. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Imperceptible significance.**

9.5.2.7 Turbine Delivery Route (TDR)

The proposed turbine delivery route (TDR) is described in detail in Chapter 13 of this EIAR.

The following are key elements of the temporary accommodation works are required along the TDR at the following locations:

- POI18: M11 / N30 Interchange Roundabout – Removal of street furniture;
- POI29: N80 / L2026 Junction – Removal of street furniture, removal of low wall and trees. Preparation of local load bearing surfaces for vehicle over-run. Removal of overhead utilities and obstructions;
- POI30: L2026 West of Bunclody – Preparation of local load bearing surface and localised vegetation trimming. Removal of stone wall. Removal of street furniture;

- POI43: L2026 Kilbranish – Removal of road signs and telegraph pole. Road widening with localised load bearing surface to verges. Removal of trees and vegetation;
- POI52: Proposed Turning Point – Extension of existing car park hard standing to facilitate vehicle turning. Load bearing surface to existing field. Removal of trees and vegetation.

The accommodation works associated with the TDR route will include the localised excavation of existing overburden deposits. The potential impact will 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.**

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.

<u>Potential Indirect Impacts</u>

Quantities of granular material will be required for the proposed project. This will place a demand on local aggregate extraction facilities; however, this impact is considered to be Imperceptible.. No other significant indirect impacts on the Land, Soils & Geology are anticipated.

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

A list of existing licensed waste facilities in the vicinity of the proposed project can be found in Chapter 3 and the CEMP in Appendix 3.1.

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 substations. 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 (peat, subsoils, bedrock) is considered to be 'Low'. The magnitude of these potential impacts, prior to mitigation, is considered to be of **Imperceptible Significance.**

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 9.4.2.5.

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 .**

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 'b*est 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*'.

Grid connection 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 Carlow County Council and Wexford County Council online planning enquiry portals to search for large scale developments within 20km of the Croaghaun Wind Farm project area. The Carlow County Council planning portal was also searched for small scale developments. The majority of the applications were of a scale and/or distance that they would not cause a cumulative effect in relation to land, soils and geology.

Relevant projects, that are likely to have an impact on the Land, Soils & Geology, in proximity to the proposed project including the grid connection and off-site substation at Kellistown, are listed in Table 9.14.

Table 9.14: Potential Cumulative Impact from other Developments

Development	Distance to Proposed project (km)	Status	Interface	Potential Cumulative Impact
Greenoge Wind Farm	0.5km	Constructed	Groundwater	Negligible
Battery Storage (at Kellistown Substation)	0km	Proposed	Subsoils, Bedrock	Negligible
Replant Lands – Stroove, Co. Sligo	185km	Proposed	N/A	N/A
Replant Lands – Crag, Co. Limerick	180km	Proposed	N/A	N/A

The Greenoge Wind Farm is located adjacent to the main wind farm site and is currently operational . There is the potential for groundwater pollution from run-off impacting on the groundwater receptor. The Magnitude of the impact from these works is considered to be Negligible in nature. The importance of the groundwater receptors is considered to be 'Medium'. The magnitude of this potential cumulative impact is considered to be of **Imperceptible significance.**

A Battery storage facility is proposed for a site adjacent to the off-site substation at Kellistown. The construction of this facility will lead to disturbance of soils and subsoils on the proposed site and require the importation of granular materials from local quarries during the construction phase. 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'. Should these works take place at the same time as the construction phase of the proposed project, they will result in a **Negligible** cumulative impact.

Potential replanting sites have been identified at Sroove, Co. Sligo and Crag, Co. Limerick. These lands have been assessed in this EIAR in terms of potential impacts to the existing environment in Appendix 3.3 and 3.4 of this EIAR.

Given the distance to the proposed replant sites at Sroove, Co. Sligo and Crag, Co. Limerick to the proposed project it is considered there is no potential cumulative impact to the underlying geological and hydrogeological environment should the replanting be undertaken in conjunction with the construction phase of the proposed project.

There may be indirect cumulative impacts in terms of demands placed on local quarries for aggregate and concrete required during the construction phase of the proposed project, however this is considered to be Negligible in impact.

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 9.15with 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 Attributes

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 and Borrow Pit Excavations)	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 and Glacial Till deposits. Bedrock	Low	Small Adverse	Imperceptible
Earthworks associated with the construction of the proposed project and associated infrastructure	Slope Failure	Localised organic soils and Glacial Till deposits. Bedrock	Low	Moderate Adverse	Slight
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.	Localised organic soils and Glacial Till deposits. Bedrock Local quarries	Low	Small Adverse	Imperceptible

Activity	Potential Impact	Receptor	Importance	Prior to Mitigation	
				Magnitude	Significance
	Importation of engineering fill				
Internal Cabling and Grid Connection	Removal of overburden material and exposure underlying Clay and Bedrock to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill and concrete products Disposal of surplus excavated material to licenced facility	Localised organic soils and Glacial Till deposits. Bedrock Local quarries Licenced Waste Facilities	Low	Small Adverse	Imperceptible
HDD under existing Road	Overburden collapse due to advancement of HDD bore	Local Glacial Till deposits. Bedrock	Low	Small Adverse	Imperceptible
Accommodation works along TDR	Removal of overburden material and exposure of underlying Clay and Bedrock to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill Disposal of surplus excavated material to licenced facility	Localised organic soils and Glacial Till deposits. Bedrock Local quarries Licenced Waste Facilities	Low	Small Adverse	Imperceptible
Operational Phase					
Maintenance Traffic, Substation	Release of hydrocarbons or fuel spill	Localised organic soils and Glacial Till deposits.	Low	Small Adverse	Imperceptible

Activity	Potential Impact	Receptor	Importance	Prior to Mitigation	
				Magnitude	Significance
		Bedrock			
Maintenance of access tracks	Importation of engineering fill	Local quarries	Low	Small Adverse	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 and Glacial Till deposits. 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	Low	Negligible	Imperceptible
Battery Storage at Kellistown Substation	Importation of engineering fill from local quarries	Local quarries	Low	Negligible	Imperceptible

Table 9.16: Summary of Potential Unmitigated Impact Significance on Hydrogeology

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Construction Phase					
Earthworks (Turbine Base and Borrow Pit Excavation)	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
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	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
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	Locally Important Bedrock Aquifer	Medium	Moderate Adverse	Moderate

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
	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	Groundwater Wells and Springs			
Construction of the Grid Connection, works at Kellistown Substation 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
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	Locally Important Bedrock Aquifer	Medium	Small Adverse	Slight

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
	Potential for contamination to groundwater from spills/leakages during decommissioning phase earthworks.	Groundwater Wells and Springs			
Cumulative Impacts					
Greenog Wind Farm	Potential for groundwater pollution from runoff from wind farm	Potential cumulative impact on: Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Negligible	Imperceptible
Battery storage at Kellistown Substation	Potential for ground water pollution from the removal of overburden deposits.	Locally Important Bedrock Aquifers 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 the CEMP included in Section 4.3.4 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 wind farm in terms of locating the turbines, access roads, borrow pit, material storage areas and other site infrastructure within an area of 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 peat/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:

- Extensive peat probing to identify areas of peat deposits across the site.
- Excavation of trial pit and advancement of boreholes to establish overburden and bedrock characteristics.
- Preparation of Slope Stability Assessments, included in the Geotechnical Assessment Report, Appendix 9.1 of this EIAR
- Relocation and micro-siting of turbines, hardstandings, borrow pit 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

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.

A Construction and Environmental Management Plan (CEMP) is contained in Appendix 3-1 of Volume 3.

The CEMP sets out the key environmental management measures associated with the construction, operation and decommissioning of the proposed wind farm, 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.

<u>Tree Felling</u>

As outlined in Section 9.4.2.1 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, and is included in Chapter 10.

Details of the proposed Surface Water Management System and associated mitigation measures are summarised in Chapter 10 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 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.

9.6.2.2 Earthworks

The project will be constructed in a phased manner within a 12-18 month period, as described in Chapter 3, 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 (bedrock) as general fill in the construction of access tracks, hardstands and in reinstatement around turbine foundations.
- Surplus overburden will be re-used on site in the form of landscaping and for reinstatement purposes at the proposed borrow pit.

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 should be shaped and sealed to prevent the ingress of water from rainfall.

To mitigate against the compaction of soil at the site, prior to the commencement of any earthworks, the work corridor will be pegged, and machinery will stay within this corridor so that peatland/soils outside the work area are not damaged. Excavations will then be carried out from access tracks 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 proposed grid connection route will be taken to a licenced facility for disposal or recycling where required. If feasible, the upper layers of tarmac and asphalt will be excavated separately to the lower engineered fill layers. The lower engineered fill layers will be reused. 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.

9.6.2.3 Control of Sediment Laden Runoff

The potential impacts from silt laden surface water runoff from increased erosion of exposed overburden deposits has been assessed where earthworks and tree felling are proposed, and are described in Chapter 10.

Details of the proposed Surface Water Management System and mitigation measures are summarised in Chapter 10 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 in Chapter 10.

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.

9.6.2.4 Measures for Spills

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

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

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

9.6.2.5 Slope Stability

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

- The works will be 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.
- Turbines located in areas adjacent to peat deposits will incorporate drainage measures such that surface water will be drained away from the peat and will not be allowed to collect adjacent to the peat mass.
- Excavation will be carried out from access roads or hardstanding areas to avoid tracking of construction plant across areas of soft ground/peat.
- An assessment of the stability at proposed infrastructure locations has been carried out as part of this EIAR based on worst case conditions. 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 is forecast. A rainfall gauge will be installed on site to provide a record of rainfall intensity. An inspection of site stability and drainage by the Geotechnical Engineer will be carried out on site when a daily rainfall of over 25mm is recorded on site, works will only recommence after heavy rain with the prior approval of the Geotechnical Engineer following inspection.
- An emergency plan is included in the CEMP (Appendix 3.1) outlining 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 will be given in the CEMP included in Appendix 3.1 of Volume 3 of this EIAR.

9.6.2.6 Groundwater

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

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

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

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

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

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

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

9.6.3 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 wind farm, over and above those incorporated into the design of the substation transformer, which will be bunded to protect soils against accidental leakages of oils and battery fluids.

9.6.4 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 with the exception of T3 and T6 hard standings which will be removed, and the land reinstated at these locations. Grid connection 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.

9.6.5 Cumulative

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 maintenance works at the existing Greenoge Wind Farm, or at the proposed battery storage adjacent to Kellistown substation there would a cumulative impact in terms of demands placed on local quarries for aggregate.

Given the Greenoge Wind Farm is already constructed and operational it is considered unlikely significant quantities of aggregate would be required. As such, it is considered there will be an **Imperceptible** cumulative impact during the construction phase of the project.

The proposed battery storage facility adjacent to the substation at Kellistown will require the importation of aggregate during construction. However, this is considered to have an **Imperceptible** cumulative impact during the construction phase of the project.

The proposed replant lands at Sroove, Co. Sligo and Crag, Co. Limerick, will not result in any cumulative impacts on the proposed project.

No significant, direct 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.

9.7 Residual Impacts

It can be observed from Table 9.17 and Table 9.18 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 project. Mitigation measures will be monitored throughout the construction and operational 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.

Table 9.17: Residual Impact Significance for Sensitive Geological Attributes

Activity	Potential Impact	Receptor	Importance	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction Phase							
Earthworks (Turbine Base and Borrow Pit Excavation)	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.	Localised organic soils and Glacial Till deposits. Bedrock	Low	Small Adverse	Imperceptible	Negligible	Imperceptible
Felling Activities	Exposure of underlying overburden leading to increased erosion. Felling machinery resulting soil compaction of soft deposits and an increase in surface water runoff resulting in increased erosion of exposed soils.	Localised organic soils and Glacial Till deposits.	Low	Moderate	Slight	Negligible	Imperceptible
Construction of Internal Site Access Tracks, Hardstands, Temporary Compound and 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 and Glacial Till deposits. Bedrock Local quarries	Low	Small Adverse	Imperceptible	Negligible	Imperceptible
Construction of Turbine and Substation Foundations	Open excavations, increased runoff causing erosion of underlying overburden and bedrock. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill and concrete products.	Localised organic soils and Glacial Till deposits. Bedrock Local quarries	Low	Small Adverse	Imperceptible	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Importance	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction of the Grid Connection and Internal Cabling	Removal of overburden material and exposure underlying Clay and Bedrock to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill and concrete products Disposal of surplus excavated material to licenced facility	Localised organic soils and Glacial Till deposits. Bedrock Local quarries Licenced Waste Facilities	Low	Small Adverse	Imperceptible	Small Adverse	Imperceptible
Earthworks associated with the construction of the proposed project and associated infrastructure	Slope Failure	Localised organic soils and Glacial Till deposits.	Low	Small Adverse	Slight	Negligible	Imperceptible
Accommodation works along TDR	Removal of overburden material and exposure underlying Clay and Bedrock to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill Disposal of surplus excavated material to licenced facility	Localised organic soils and Glacial Till deposits. Bedrock Local quarries Licenced Waste Facilities	Low	Small Adverse	Imperceptible	Negligible	Imperceptible
Operational Phase							
Maintenance Traffic	Release of hydrocarbons or fuel spill	Localised organic soils and Glacial Till deposits. Bedrock.	Low	Small Adverse	Imperceptible	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Importance	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Maintenance of access tracks	Importation of engineering fill from local quarries	Local quarries	Low	Small Adverse	Imperceptible	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	Low	Negligible	Imperceptible	Negligible	Imperceptible
Battery Storage at Kellistown Substation	Importation of engineering fill from local quarries	Local quarries	Low	Negligible	Imperceptible	Negligible	Imperceptible

Table 9.18: Residual Impact Significance for Sensitive Hydrogeological Attributes

Activity	Potential Impact	Receptor	Importance	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction Phase							
Earthworks (Turbine Base and Borrow Pit Excavation)	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	Moderate	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Importance	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
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	Moderate	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 Potential for groundwater pollution from the use of cement-based compounds during the construction phase	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Moderate	Moderate	Negligible	Imperceptible
Construction of Turbine and Substation Foundations	Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer Potential for contamination to groundwater from spills/leakages during construction phase earthworks Potential for groundwater pollution from the use of cement-based compounds during the construction phase	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Medium	Moderate	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Importance	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction of the Grid Connection and Internal Cabling	Potential for groundwater pollution from the removal of overburden deposits Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer Potential for contamination to groundwater from spills/leakages during construction phase earthworks	Locally and Regionally Important Bedrock Aquifers Groundwater Wells and Springs	Medium	Small Adverse	Slight	Negligible	Imperceptible
Operational Phase							
Maintenance Traffic	Some operational traffic will be necessary for maintenance plus normal operational traffic which could result in minor accidental leaks or spills of fuel/oil.	Locally and Regionally Important Bedrock Aquifers Groundwater Wells and Springs	Medium	Small Adverse	Slight	Negligible	Imperceptible
Cumulative Impacts							
Greenog Wind Farm	Potential for groundwater pollution from runoff from wind farm	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Negligible	Imperceptible	Negligible	Imperceptible

9.8 Conclusions

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

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

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

A desk study was undertaken prior to site assessment works which included ground investigation at the proposed turbine pit, access road, and borrow pit location.

The subsoils across the proposed project comprise predominantly glacial till derived from limestone bedrock, cutover peat, and limestone derived sand, gravel and alluvium. This was confirmed during the site assessment works. Bedrock was encountered during the site works and confirmed the GSI mapping of a medium strong Shale.

No slope stability issues were identified for the proposed project. Slopes are generally moderate to steep; however, no peat was recorded on the site, only a peaty Topsoil. As such, no peat stability issues are likely.

A number of potential impacts have been identified associated with the excavation of soil and rock on the main wind farm site as listed in Table 9.1513 and Table 9.1614. The significance of these potential impacts is assessed as being of moderate/slight significance prior to mitigation.

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

With mitigation measures, outlined in Section 9.4, put in place during construction, operational and decommissioning stage the proposed project will have imperceptible significance on the Land, Soils & Geology.

9.9 References

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Ireland
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Dublin Office
J5 Plaza,
North Park Business Park,
North Road, Dublin 11, D11 PXT0,
Ireland
+353 1 658 3500

Carlow Office
Unjt 6, Bagenalstown Industrial
Park, Royal Oak Road,
Muine Bheag,
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