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CONSULTANTS IN ENGINEERING,
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ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR) FOR THE PROPOSED BARNADIVANE WIND FARM & SUBSTATION, CO. CORK

VOLUME 2 – MAIN EIAR
CHAPTER 6 – SOILS, GEOLOGY AND HYDROGEOLOGY

Prepared for: Barna Wind Energy (B.W.E.) Ltd. & Arran Windfarm Ltd.

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6. SOILS, GEOLOGY & HYDROGEOOGY

6.1 Introduction

This chapter has been prepared to examine the potential impacts of the Proposed Development, on existing geological and hydrogeological conditions within the Proposed Development study area. The effects of the Proposed Development are considered, taking account of mitigation measures to reduce or eliminate any residual impacts on soils, geology & hydrogeology. The assessment also considers the cumulative impacts associated with other nearby developments.

A detailed description of the Proposed Development and Proposed Project assessed in this EIAR is provided in Chapter 2. In summary, the Proposed Project for EIA purposes is made up of the Proposed Development which includes the Proposed Wind Farm and the Proposed Substation, for which planning consent is sought. Other elements of the Proposed Project for which permission has already been granted includes the Enabling TDR Works and if necessary the AGCR. The AGCR and the Enabling TDR Works will be considered cumulatively with other elements of the Proposed Project.

The Proposed Wind Farm includes the wind turbines, internal access tracks, hard standings, the permanent meteorological mast, internal electrical and communications cabling, temporary construction compound, drainage infrastructure and all associated works related to the construction of the Proposed Wind Farm.

Electricity generated from the proposed 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 the Proposed Substation. The Proposed Substation is proposed to connect to the overhead 110kV electrical infrastructure which traverses the site.

The AGCR will be a tail-fed underground grid connection which has already been consented by Cork County Council and An Bord Pleanála (CCC Pl. Ref. 15/730; ABP Pl04.246353). The underground cable would travel from the wind farm site in a southwest direction and connect to the internal underground Carrigarierk Wind Farm cable. The Carrigarierk Wind Farm connects to the Carrigdangan 110kV substation, which in turn connects to the Dunmanway ESB substation (CCC reference: 17/431; ABP reference: 301563-18).

The Enabling TDR Works includes all aspects of the route from the N22 / R585 junction at Castlemore to the site entrance including proposed temporary accommodation works to facilitate the delivery of wind turbine components. The enabling TDR works have been consented and will be considered cumulatively.

6.2 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 6.2.4.

6.2.1 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).

6.2.2 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. Reference should also be made to the River Basin Management Plan 2018-2021 and the Draft River Basin Management Plan 2022-2027.

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.

6.2.3 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 4 – 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 Soils, Geology & Hydrogeology are presented in Table 6-1:

Table 6-1: Consultation Responses

Consultee	Responses / Issues Raised
Geological Survey Ireland (GSI)	No response to consultation request.
Inland Fisheries Ireland (IFI)	Water quality, protection of watercourses/fisheries due to proposed crossing, peat stability.
Department of Agriculture, Food and the Marine	Raised issues in relation to tree felling, water quality, soils, landscape and visual and ecology and enclosed Forest Service Policy on the granting of Felling Licences for Wind Farm Development.
Cork County Council	Alternatives, Human Beings, Flora and Fauna, Soil Geology and Slope Stability, Air and Noise, Water, Landscape, Material Assets & waste management.

6.2.4 Impact Appraisal Methodology

As outlined in Section 6.1, 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 Soils, Geology and Hydrogeology 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 Soils, Geology and Hydrogeology within the study area:

- Characterisation of the soils, geology and hydrogeology 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. Two site walkovers were also carried out in July 2014 and more recently in October 2022. The study area is defined as the area that could potentially experience impacts from any element of the Proposed Development.

Following the assessment of the existing environment, the unmitigated impacts of the Proposed Development 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 Development was then re-appraised taking into account the recommended measures. The residual impacts from the Proposed Development are presented in Section 6.7.

6.2.5 Evaluation Criteria

During each phase (construction, operation, maintenance and decommissioning) of the Proposed Development, several activities will take place on site, some of which will have the potential to cause impacts on the geological regime at the Proposed Development site and the associated Soils, Geology & Hydrogeology. These potential impacts are discussed throughout this chapter. Mitigation measures where required are presented in Section 6.6.

6.2.6 Assessment of Magnitude and Significance of Impact on Soils, Geology & Hydrogeology

An impact rating has been developed for each of the phases of the Proposed Development 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 6-2 and 6-3.) followed by an estimation of the magnitude of the impacts on geological and hydrogeological features (Tables 6-4 and 6-5).

This determines the significance of the impact prior to application of mitigation measures as set out in Table 6-6.

Table 6-2: 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.	• Contaminated soil on site with previous heavy industrial usage; • Large recent landfill site for mixed wastes;

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

Table 6-3: 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.

Importance	Criteria	Typical Example
Medium	Attribute has a medium quality or value on a local scale.	Locally Important Aquifer Potable water source supplying >50 homes. Outer source protection area for locally important water source.
Low	Attribute has a low quality or value on a local scale.	Poor Bedrock Aquifer. Potable water source supplying <50 homes.

The assessment of the magnitude of an impact incorporates the timing, scale, size and duration of the potential impact. The magnitude criteria for impact on Geological and Hydrogeological features are outlined in Table 6-4 and Table 6-5 respectively.

Table 6-4: 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

Magnitude	Criteria	Typical Example
		• 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 6-5: 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 6-5 determines the significance of the impacts based on the importance and magnitude of the impacts as determined by Tables 6-1 to 6-5.

Table 6-6: 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 Development is discussed in Section 6.4.

6.2.7 Desk Study - Methodology

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

- Geology of South Cork (Sheet 25) [i]
- Geology of West Cork (Sheet 24) [ii]
- County Cork (Southern Division) Groundwater Protection Scheme [iii]
- Aerial imagery from Google and Bing accessed in 2022;
- Current and historical (6 inch and 25 inch) Ordnance Survey maps and aerial imagery [iv]
- Cork County Development Plan 2022-2028 [v]
- DoEHLG Wind Farm Planning Guidelines [vi]
- IWEA Best Practice Guidelines [vii]
- Flood Risk Data [viii]
- Ecological Designations [ix]
- Mapping data of the area produced by the Geological Survey of Ireland (GSI) [x]
    - *Quaternary subsoil geology;*
    - *100k bedrock geology;*
    - *Karst features;*
    - *Geological heritage features;*
    - *Aggregate potential;*
    - *Landslide susceptibility;*
    - *Physiographic Units;*
- Datasets from the EPA [xi]

- European Union open datasets [xii]
- Peat Landslide Hazard and Risk Assessments, Best Practice Guide for Proposed Electricity Generation Developments [xii]

6.2.8 Site Investigations and Field Assessments – Methodology

As part of the geotechnical assessment two site walkovers was undertaken by Fehily Timoney and Company (FT) in July 2014 and October 2022 to determine the baseline characteristics of the Proposed Development site.

The site assessment works undertaken comprised the following:

- Walkover inspections of the Proposed Development site with recording of salient geomorphological features at proposed infrastructure locations.
- 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.

The design layout of the site has been slightly modified since the original July 2014 site walkover. As a result, a second site walkover was undertaken in October 2022 to account for these changes. Although findings from the initial site walkover will be taken into consideration, the October 2022 walkover will be the primary source of field data used to inform this chapter.

6.3 Receiving Environment

6.3.1 General

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 undertaken as part of the baseline assessment works.

6.3.2 Quaternary Geology

GSI 1:50,000 Quaternary Subsoil mapping (Figure 6-1) indicates the Proposed Development site is predominantly underlain by Glacial Till deposits derived from sandstone and siltstone. Frequent areas of ‘bedrock outcrop or subcrop’ are also mapped throughout the site. Isolated albeit relatively large (up to 12 hectares) deposits of Blanket Peat can be found along the western and southern margins of the site, however there is no infrastructure located within these areas of Blanket Peat. It was also confirmed during a site walkover that there is no Blanket Peat located at or near infrastructure locations.

6.3.3 Bedrock Geology

The GSI online 1:100,000 scale bedrock geology mapping (Figure 6-2) indicates the Proposed Development site is underlain by Devonian "Old Red Sandstone" comprising the Toe Head, Castlehaven and Gunpoint Formations.

The majority of the Proposed Development site is underlain by The Toe Head Formation, comprising cross-bedded sandstone and minor mudstone. This formation is mapped across the central portion of the Proposed Development site and underlies all of the proposed turbines with the exception of turbine T6 to the south.

The southern extent and portions of the northern extent of the Proposed Development site is underlain by the Castlehaven Formation, comprising purple mudstone and siltstone. This formation underlies turbine T6.

The Gunpoint Formation can be found underlying the northern margin of the site and comprises green-grey sandstone and purple siltstone.

Rock outcrops are mapped across much of the site. During the site walkover outcrops were observed at several locations, particularly within the southern part of the site between turbines T5 and T6 including the location of the proposed borrow pit. The exposed rock has near vertical bedding and extremely closely spaced vertical fractures and is likely part of the Toe Head and Castlehaven Formations.

6.3.4 Structural Geology

The Proposed Development site lies within a regional scale syncline, whose axis passes from east to west through the central portion of the site.

The core of this syncline comprises the younger rocks of the Toe Head Formation, whereas the northern and southern limbs of the syncline comprise the older rocks of the Castlehaven and Gunpoint Formations. A series of broadly north-south and east-west trending faults cut through the site, displacing the rock formations within this syncline.

The entire Proposed Development site lies within a broader thrust block, juxtaposing younger Gunpoint Formation against older Caha Mountain Formation. The east-west trending faults associated with this block are located approximately 1.5km to the north and south of the Propose Development site.

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community and GSI https://creativecommons.org/licenses/by/4.0/
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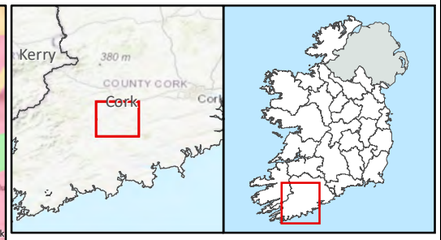
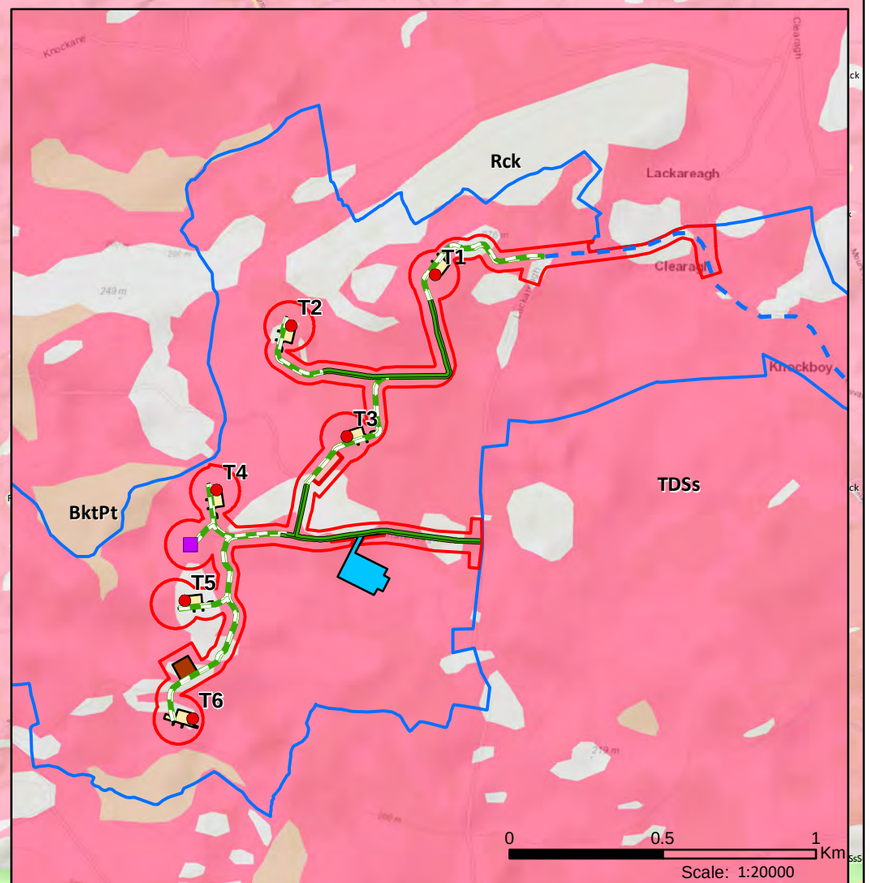


Legend

- Development Planning Boundary
- Study Area
- Proposed Substation
- Turbine Hardstandings
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Met Mast
- Proposed Turbine Layout
- Tracks-Existing
- Tracks-Proposed
- Alternative Grid Connection Route
- Turbine Delivery Route

Quaternary Sediments

- A, Alluvium
- BktPt, Blanket Peat
- GDCSs, Gravels derived from Devonian and Carboniferous sandstones
- GDSs, Gravels derived from Devonian sandstones
- Rck, Bedrock outcrop or subcrop
- TDCSsS, Till derived from Devonian and Carboniferous sandstones and shales
- TDSs, Till derived from Devonian sandstones
- Water



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PROJECT:	Barnadivane Wind Farm and Substation, Co. Cork
FIGURE NO:	6.1
CLIENT:	Barna Wind Energy Ltd. & Arran Windfarm Ltd.
SCALE:	1:50000
REVISION:	0
DATE:	23/02/2023
PAGE SIZE:	A3

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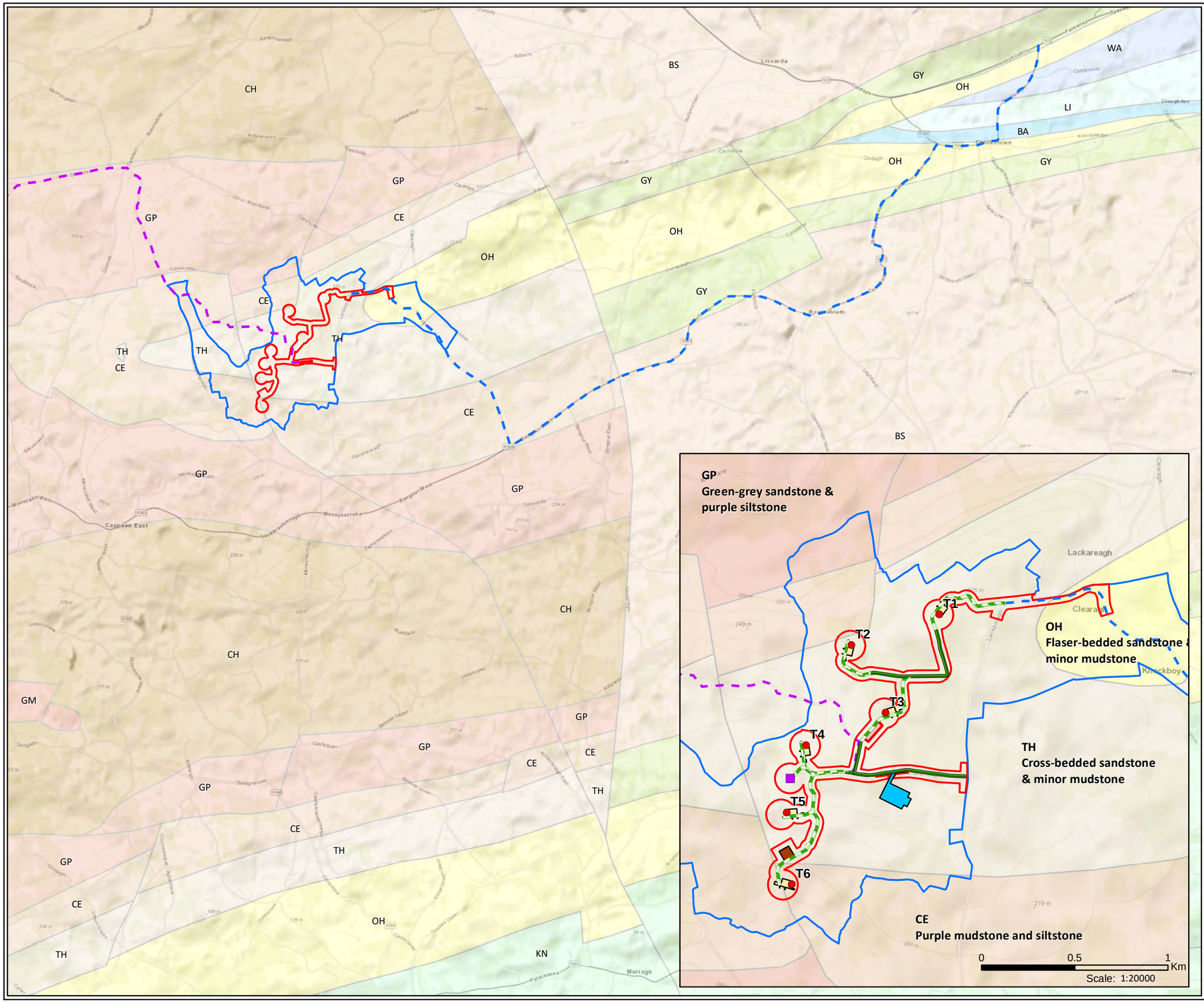

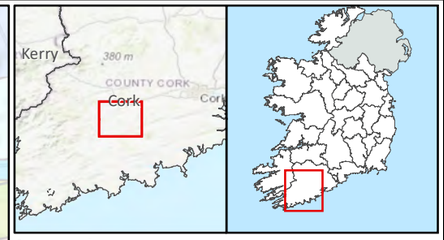

Legend

- Development Planning Boundary
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- Proposed Borrow Pit
- Proposed Met Mast
- Proposed Turbine Layout
- Tracks-Existing
- Tracks-Proposed
- Alternative Grid Connection Route
- Turbine Delivery Route

Bedrock Geology

- Ballysteen Formation
- Kinsale Formation
- Little Island Formation
- Waulsortian Limestones
- Gortanimill Formation
- Ballytrasna Formation
- Castlehaven Formation
- Caha Mountain Formation
- Gun Point Formation
- Gyleen Formation
- Old Head Sandstone Formation
- Toe Head Formation

TITLE:	Bedrock Geology		
PROJECT:	Barnadivane Wind Farm and Substation, Co. Cork		
FIGURE NO:	6.2		
CLIENT:	Barna Wind Energy Ltd. & Arran Windfarm Ltd.		
SCALE:	1:50000	**REVISION:**	0
DATE:	23/02/2023	**PAGE SIZE:**	A3

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6.3.5 Hydrogeology

6.3.5.1 Anticipated Groundwater Regime

The overburden deposits of till and peat have generally low permeability and may therefore act as a confining layer (where present), preventing the free movement of surface water to the underlying aquifer within the bedrock. The topography of the Proposed Development site is generally sloping gently towards the south, locally to the west and north. Groundwater at the Proposed Development site is expected to flow in the general direction of the topography and surface water courses which again flow predominantly from north to south.

6.3.5.2 Groundwater Vulnerability

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

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

The Groundwater Vulnerability within the Proposed Development site is predominantly 'High' with some areas of 'Extreme' vulnerability and 'X - Rock at or near Surface' (Figure 6-3).

Based on the GSI aquifer vulnerability mapping and findings from the site walkovers, overburden deposits are generally <3m deep across the majority of the Proposed Development site.

A summary of the groundwater vulnerability for the Proposed Project is presented in Table 6-7. This table outlines the standard ratings of vulnerability used by the GSI, with the existing site conditions highlighted in grey based on the findings of the site walkovers.

Table 6-7: Groundwater Vulnerability

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

6.3.5.3 Groundwater Bodies (GWB) Description

The Proposed Development site lies within the Ballinhassig East GWB. The description of the GWB within the study area has been taken from the 'Summary of Initial Characterisation' draft reports published by the GSI in accordance with the Groundwater Working Group Publication: Guidance Document GW2 (2003). The GWB Characterisation Report is available from the GSI Public Data Viewer. Site specific data derived from the site walkover and peat probing survey have been used to supplement and validate the published information.

According to interim classification work carried out as part of the Water Framework Directive and published by the EPA, the GWB is classified as having 'Good' status. The overall risk result is under 'Review' for the Ballinhassig East GWB.

A summary of the aquifer classifications are included in Table 6-8 and Figure 6-5.

Table 6-8: Summary of Aquifer Classifications

GWB	European Code	Aquifer Category	Flow Regime
Ballinhassig East	IE_SW_G_004	Predominantly underlain by a **Locally Important Aquifer (Ll)** – Bedrock which is Moderately Productive only in Local Zones. The northern and southern margins of the site are underlain by a **Poor Aquifer (Pl)** - Bedrock which is Generally Unproductive except for Local Zones	Poorly productive bedrock

6.3.5.4 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 Development. These include group water schemes (GWS), source protection zones and private supply wells with information on these features obtained from the GSI Groundwater database.

6.3.5.4.1 Public Water Supplies and Source Protection Zones

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

However there are four Source Protection Areas for Public Water Supply Schemes in the wider study area (within a 20km radius of the site), and these are:

- Crookstown Water Supply Scheme (Bellmount – BH2) – approximately 7km ENE of the site;
- Crookstown Water Supply Scheme (Pound Cross – BH1) - approximately 8km ENE of the site;
- Coachford Water Supply Scheme - approximately 14km NE of the site;
- Carrignadoura Water Supply Scheme – approximately 20km WNW of the site.

6.3.5.4.2 Group Water Schemes and Source Protection Zones

Based on a review of the current EPA and GSI groundwater databases, there are no groundwater source protection zones within the Proposed Development site. The nearest source protection zone is the Faran Source Protection Area located approximately 14.3km ENE of the Proposed Development site.

6.3.5.5 Groundwater Wells and Springs

Based on a review of the GSI Groundwater Wells and Springs database there are four wells recorded near the Proposed Development in the Ballinhassig East GWB. Based on GSI mapping, there is an accuracy of 50 to 1,000m of the well location. There may also be additional wells not included in the GSI dataset.

Table 6-9 below outlines details of groundwater wells and springs held within the GSI dataset within 1 km of the Proposed Project. Well locations are presented in Figure 6-5.

Table 6-9: Summary of Wells with 1km of the Proposed Project

Location ID	Easting	Northing	Type	Total Depth (m BGL)	Well Use	Yield Class	GSI Location Accuracy (m)	Nearest Infrastructure ID
1105NEW038	535953	564833	Borehole	73.20	Unknown	Poor	2000	T1
1105NEW048	535104	564333	Borehole	23.20	Domestic use only	Poor	100	T1
1105NEW037	534514	565413	Borehole	70.10	Unknown	Poor	1000	T1
1105NEW053	534514	565363	Borehole	7.30	Domestic use only	Moderate	1000	T1

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 500m.

6.3.5.6 Karst Features

According to the GSI datasets, there are no karst features recorded within the Proposed Development site or the wider study area. Karst features are not likely to occur within the Proposed Development site or broader study area due to the absence of carbonate bedrock. The closest mapped karst feature is a swallow hole within the Waulsortian Limestones located approximately 19km to the east of the site (GSI ref. number 1405NWK001).

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community and GSI https://creativecommons.org/licenses/by/4.0/
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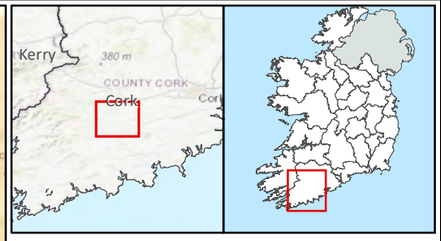
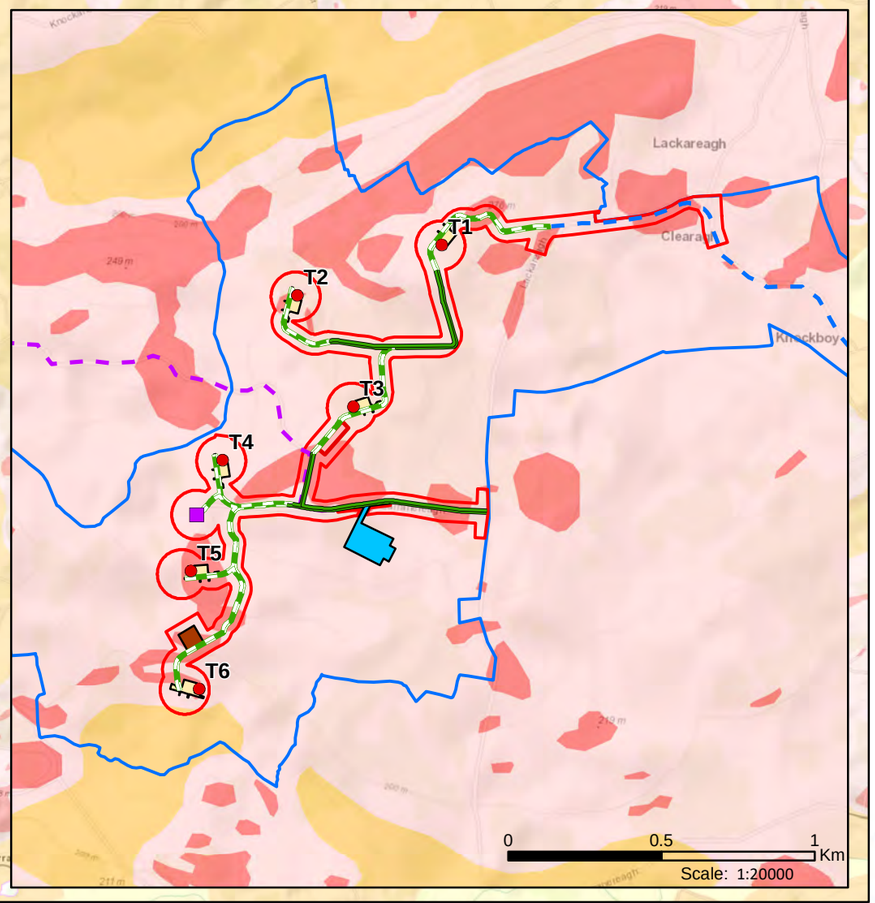


Legend

- Development Planning Boundary
- Study Area Boundary
- Proposed Substation
- Turbine Hardstandings
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Met Mast
- Proposed Turbine Layout
- Tracks-Existing
- Tracks-Proposed
- Alternative Grid Connection Route
- Turbine Delivery Route

Groundwater Vulnerability

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



TITLE: Groundwater Vulnerability	
PROJECT: Barnadivane Wind Farm and Substation, Co. Cork	
FIGURE NO: 6.3	
CLIENT: Barna Wind Energy Ltd. & Arran Windfarm Ltd.	
SCALE: 1:50000	**REVISION:** 0
DATE: 23/02/2023	**PAGE SIZE:** A3

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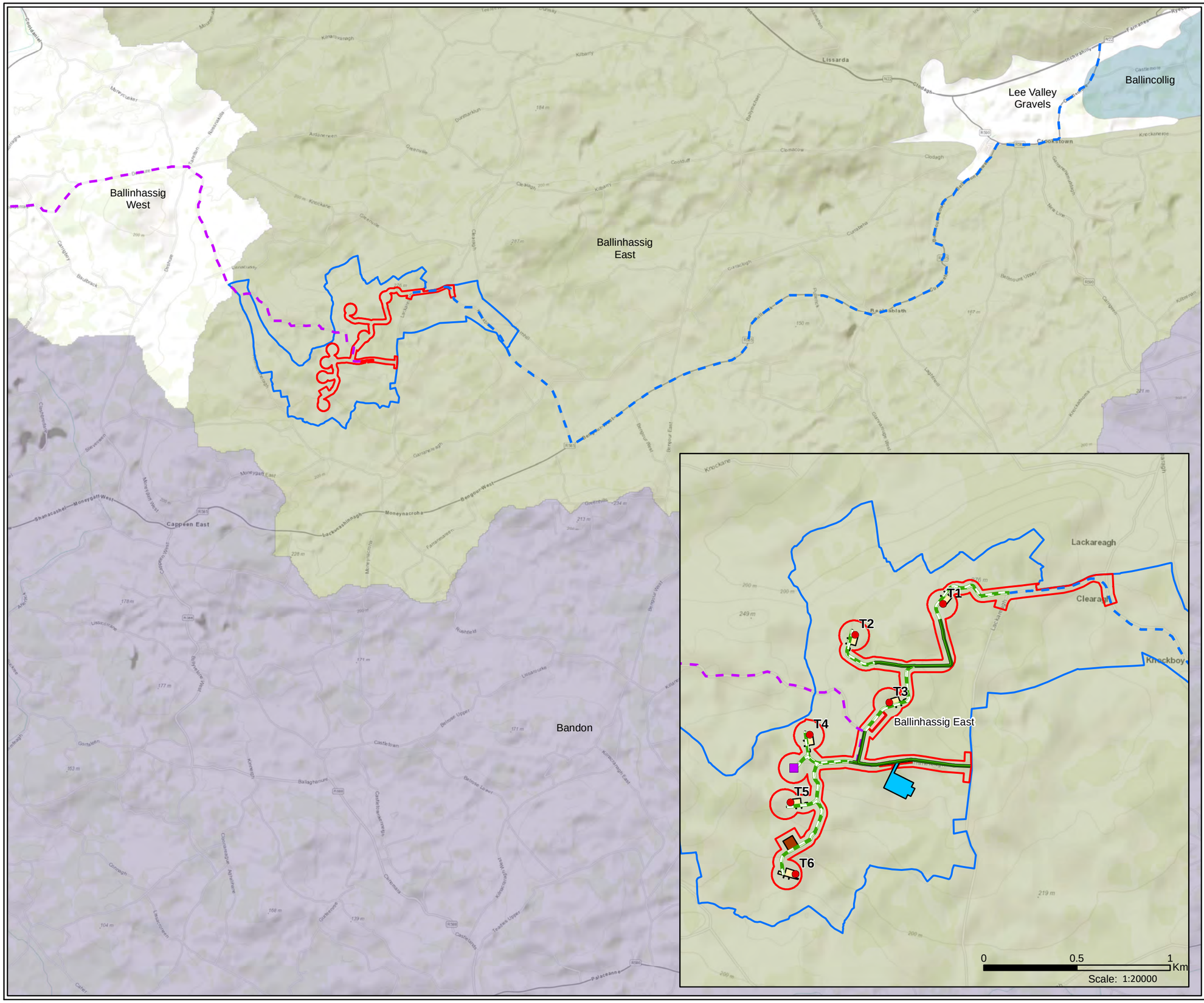

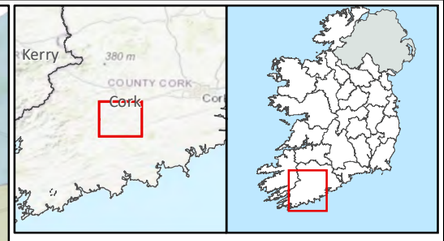

Legend

- Development Planning Boundary
- Study Area Boundary
- Proposed Substation
- Turbine Hardstandings
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Met Mast
- Proposed Turbine Layout
- Tracks-Existing
- Tracks-Proposed
- Alternative Grid Connection Route
- Turbine Delivery Route

WFD Ground Water Bodies

- Ballincollig
- Bandon
- Ballinhassig East

TITLE: Groundwater Bodies

PROJECT: Barnadivane Wind Farm and Substation, Co. Cork

FIGURE NO:	6.4		
CLIENT:	Barna Wind Energy Ltd. & Arran Windfarm Ltd.		
SCALE:	1:50000	**REVISION:**	0
DATE:	23/02/2023	**PAGE SIZE:**	A3

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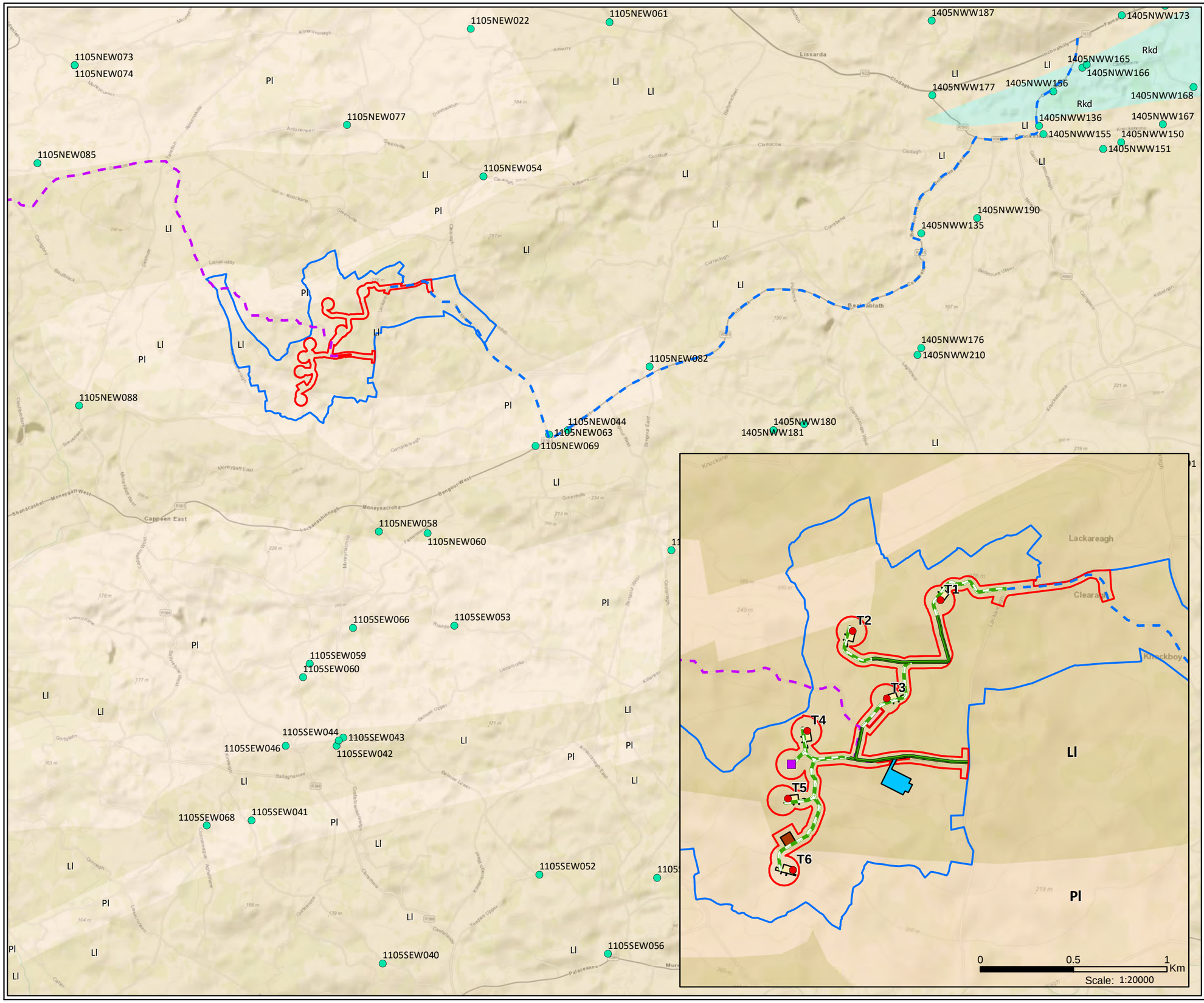

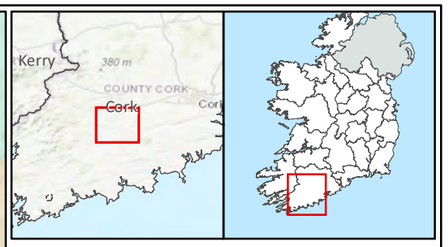

Legend

- Development Planning Boundary
- Study Area Boundary
- Proposed Substation
- Turbine Hardstandings
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Met Mast
- Proposed Turbine Layout
- Tracks-Existing
- Tracks-Proposed
- Alternative Grid Connection Route
- Turbine Delivery Route
- Wells and Springs (10-50m Accuracy)

Bedrock Aquifers

- Ll: Locally Important Aquifer - Bedrock Mod Productive Locally
- Pl: Poor Aquifer Bedrock Generally Unproductive Except Locally
- Rkd: Regionally Important Aquifer - Karstified (diffuse)

TITLE:	Aquifer Classification		
PROJECT:	Barnadivane Wind Farm and Substation, Co. Cork		
FIGURE NO:	6.5		
CLIENT:	Barna Wind Energy Ltd. & Arran Windfarm Ltd.		
SCALE:	1:50000	**REVISION:**	0
DATE:	23/02/2023	**PAGE SIZE:**	A3

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6.3.6 Geological Heritage

The GSI - Irish Geological Heritage Section (IGH) and NPWS (National Parks and Wildlife Service) have undertaken a programme to identify and select important geological and geomorphological sites throughout the country for designation as NHAs (Natural Heritage Areas). This is being addressed under 16 different geological themes. For each theme, a larger number of sites (from which to make the NHA selection) are being examined, to identify the most scientifically significant. The criterion of designating the minimum number of sites to exemplify the theme means that many sites of national importance are not selected as the very best examples. However, a second tier of County Geological Sites (CGS) (as per the National Heritage Plan) means that many of these can be included in County Development Plans and receive a measure of recognition and protection through inclusion in the planning system.

The GSI Online Irish Geological Heritage database indicates that the Proposed Project is not located in an area of specific geological heritage interest. There are no audited or unaudited geological heritage areas within the Proposed Development site boundary. The nearest designated area is the 'The Gearagh, River Lee' unaudited CGS, which is located approximately 5km north of the GCR and 11km NW of the site (ITM Coordinates E 529965, N 570062). The heritage site has been described by GSI as 'a unique part of a formerly much larger floodplain with a forested anastomosing channel system'.

6.3.7 Economic Geology

The GSI Online Minerals database shows no mineral (metallic and non-metallic) occurrences within the Proposed Development site. An iron deposit has been recorded within the Castlehaven Formation approximately 1km west of the site (ITM coordinates E 532335, N 562365). Disseminated malachite has been recorded within the Gun Point Formation approximately 8km west-south-west of the Proposed Development site (ITM coordinates E 525926, N 561214).

The GSI Aggregates database indicates that there is predominantly a low crushed rock aggregate potential across most of the Proposed Development site (Figure 6-8). Localised extents of 'moderate' crushed rock potential can be found throughout the Proposed Development site; their presence directly correlates to areas of mapped 'bedrock outcrop or subcrop' (Figure 6-1). Discrete areas of 'high' to 'very high' crushed rock potential are mapped along the eastern and northernmost extents of the site respectively and correspond to the underlying Gun Point Formation (north) and Old Head Sandstone Formation (east) (Figure 6-2).

There are no areas of granular aggregate potential mapped within or adjacent to the Proposed Development site (Figure 6-9).

6.3.8 Walkover Survey Findings

During the October 2022 site walkover, hand-held probes were undertaken at proposed turbine locations and at other targeted locations around the Proposed Development site in order to determine the presence or absence of peat/soft ground. No peat was recorded across the Proposed Development site. A summary of the probe information is presented in Table 6-10.

Table 6-10: Summary of October 2022 Site Walkover Results

Turbine/ID	ITM Coordinates		Peat Depth (m)	Slope (°)	Notes
	Easting	*Northing*			
T1	534486	563861	0.00	6	Agricultural field
T2	534016	563695	0.00	8	Agricultural field
T3	534198	563333	0.00	6	Agricultural field
T4	533772	563159	0.00	4	Agricultural field
T5	533669	562798	0.00	6	Agricultural field
T6	533695	562414	0.00	6	Agricultural field, sandstone rock outcrop present within close proximity to turbine location
Substation	534254	562891	0.00	10	Agricultural field
Borrow Pit	533685	562575	0.00	6	Agricultural field, sandstone rock outcrop present
Met Mast	533695	562987	0.00	6	Agricultural field

6.3.8.1 Proposed Borrow Pit

A rock outcrop was identified within the southern part of the Proposed Development site, close to turbine T6 and this area has been selected for a proposed borrow pit. The exposed rock is considered suitable for the excavation of material for the construction of the Proposed Wind Farm access tracks and hardstanding areas. The presence of shallow rock and thin soil cover contributes to the suitability of this location. The proposed borrow pit location is shown in the site plans.

The method of extraction of materials at the borrow pit will be by excavator, and if required, a hydraulic hammer mounted on a hydraulic excavator (rock-breaker) will also be used locally. It is not intended to crush rock or screen excavated materials at the borrow pit as the sandstone and siltstone is expected to be suitable for use directly from excavation. Blasting is not required at the site. Due to the elevated topography of the borrow pit site and low permeability of the rock, groundwater is not expected to be encountered within the borrow pit.

6.3.9 Existing Slope Stability

The recent site walkover indicated that peat was not present at any of the proposed infrastructure locations across the Proposed Development site.

A summary of the general topography and slopes at the Proposed Development site are summarised below.

6.3.9.1 Site Topography

The Proposed Development site sits on an area of raised ground forming a northeast-southwest trending ridge that dominates the site and wider study area.

GSI physiographic mapping indicates this upland ridge is part of a broader 'mountain to hill' topography that encompasses the Proposed Development site. In general, site slopes can be categorised as gentle to moderate generally sloping down the south. However, slope gradients increase along the northern and north-eastern margins of the Proposed Development site where they become steep to extremely steep sloping down towards the north and northwest. Slope angles measured during the October 2022 site walkover range from 2 to 10 degrees with a mean value of 6 degrees. Elevations range from 180m AOD in the south to 270m AOD in the north.

6.3.9.2 Slope Stability Assessment

From a review of the GSI Landslide Susceptibility database, the Proposed Development and proposed infrastructure locations are generally located within areas of 'Low' to 'Moderately Low' susceptibility.

Turbine locations T5 and T6 and portions of the access road linking the two turbines are located within an area of 'Moderately High' susceptibility. These areas directly correlate with mapped 'bedrock outcrop or subcrop' (Figure 6-1) with no other significant factor adding to the susceptibility rating. Field observations at both turbine locations indicate gentle to moderate slopes (6° slope angle) with no evidence of historic slope instability. In addition, desktop review of available aerial photography did not identify evidence of slope instability. It is therefore considered that the risk of landslide at turbine locations T5 and T6 is considered to be negligible and that the GSI Landslide Susceptibility Classification rating at these locations does not accurately reflect actual ground conditions encountered on site.

An isolated area of 'High' landslide susceptibility is located to the north of the Proposed Development site and relates to steepened topography; however, there is no infrastructure proposed here. A summary of the GSI landslide susceptibility with respect to the Proposed Development is provided in Figure 6-10.

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

6.3.9.3 Summary and Type of Geological/Hydrogeological Environment

Based on regional and site-specific information available the type of geological/hydrogeological environment as per the IGI Guidelines is **Type A – Passive Geological/Hydrogeological Environments**.

A summary of the Proposed Development sites' geology and hydrogeology is outlined below:

- The overburden deposits of till and peat have generally low permeability and may therefore act as a confining layer (where present), preventing the free movement of surface water to the underlying aquifer within the bedrock.
- The average subsoil recharge rate across the Proposed Development site and broader study area is low, ranging from 100 to 200mm/year.
- The Proposed Development site is predominantly underlain by a locally important aquifer, which is flanked by poor aquifers along the northern and southern extents of the Proposed Development site. The groundwater flow regime of these underlying bedrock aquifers can be described as poorly productive.
- There are no wells or springs mapped within the Proposed Development site and a limited number of wells and springs mapped within the broader study area.

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community and GSI https://creativecommons.org/licenses/by/4.0/
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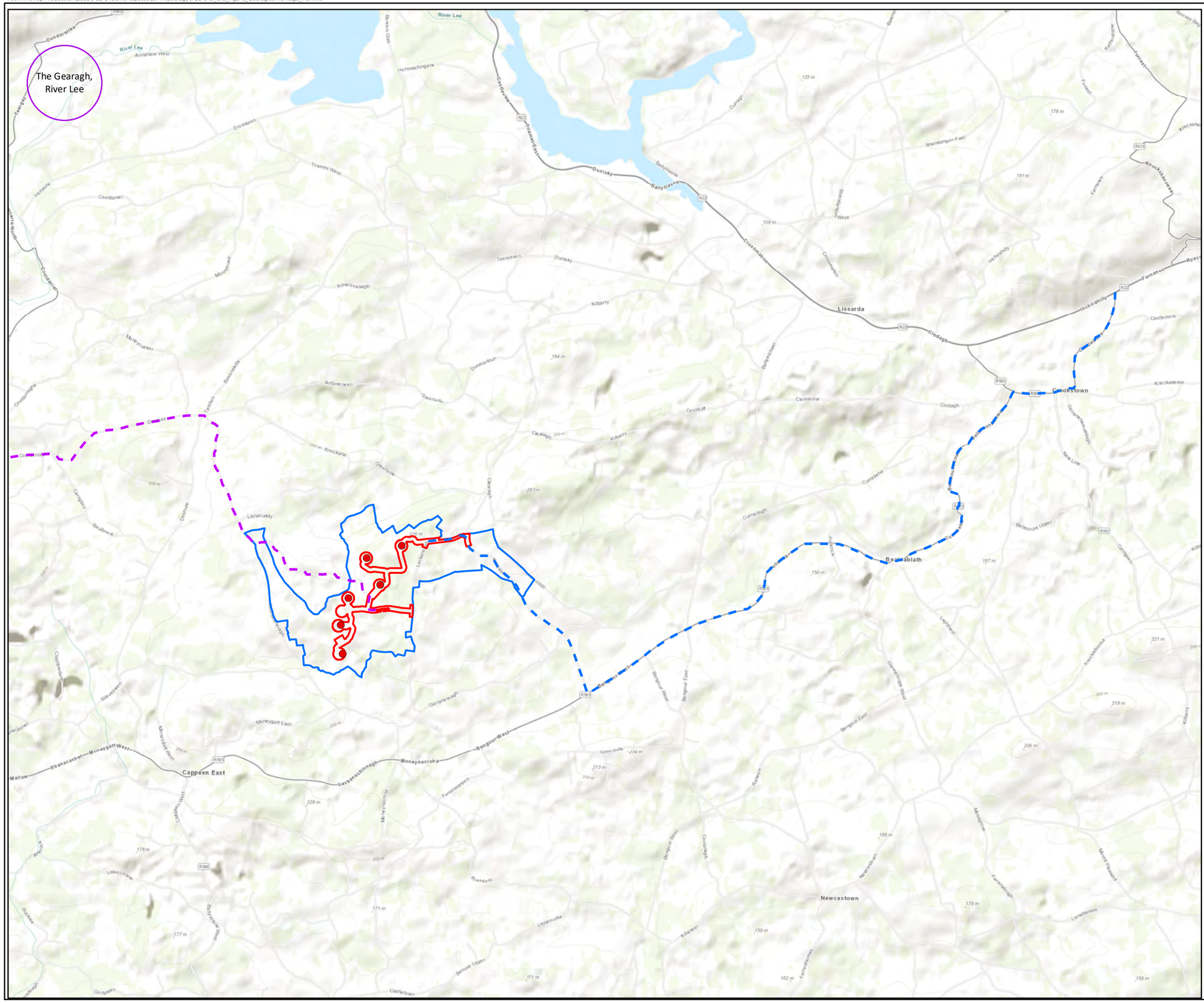

Legend

- Development Planning Boundary
- Study Area Boundary
- Proposed Substation
- Turbine Hardstandings
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Met Mast
- Proposed Turbine Layout
- Tracks-Existing
- Tracks-Proposed
- Alternative Grid Connection Route
- Turbine Delivery Route
- Geological Heritage Sites (Unaudited)

TITLE: Geological Heritage			
PROJECT: Barnadivane Wind Farm and Substation, Co. Cork			
FIGURE NO:	6.6		
CLIENT:	Barna Wind Energy Ltd. & Arran Windfarm Ltd.		
SCALE:	1:50000	**REVISION:**	0
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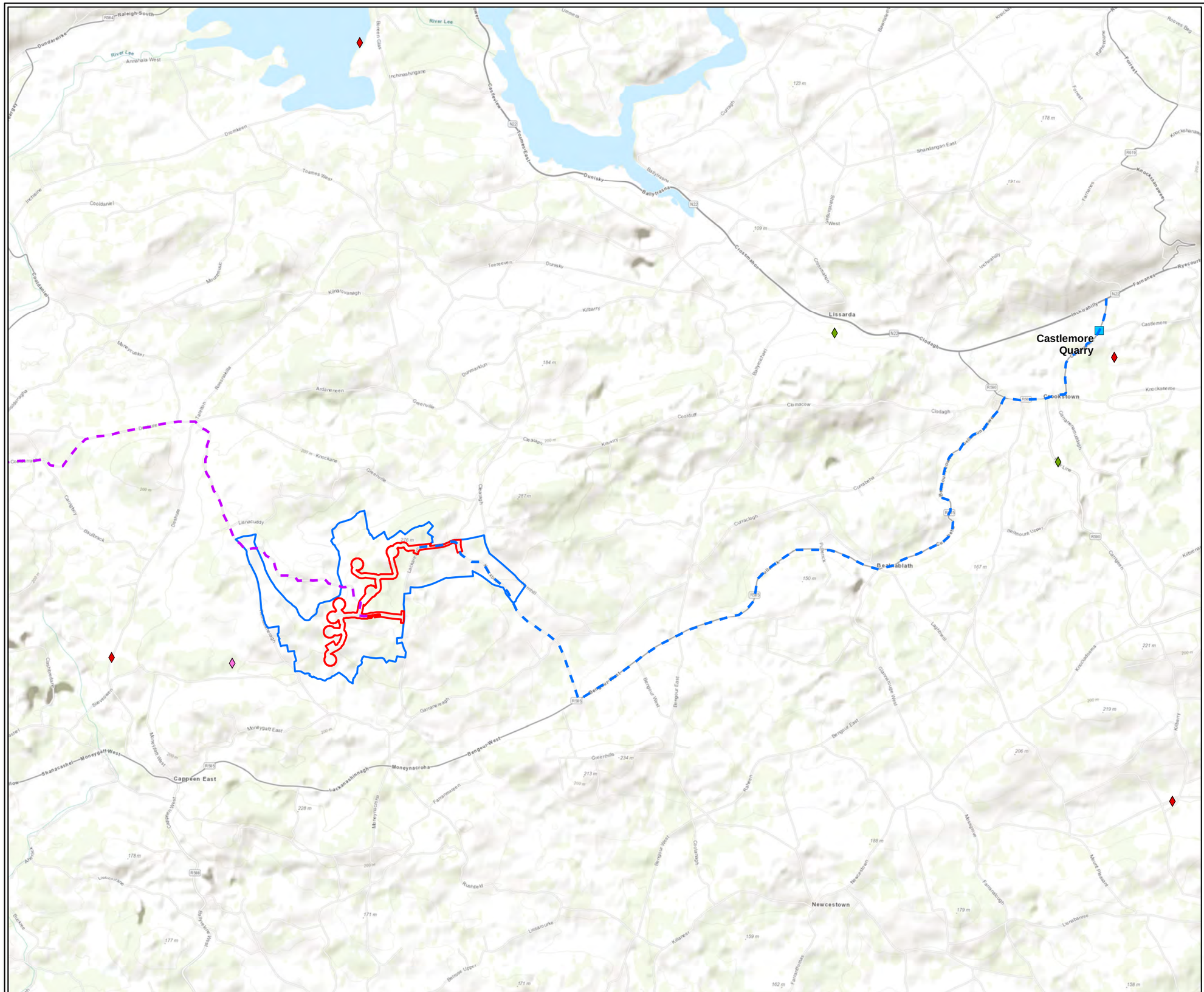

Legend

- Development Planning Boundary
- Study Area Boundary
- Alternative Grid Connection Route
- Turbine Delivery Route

Active Quarries

- Crushed Rock

Mineral Localities

- Both
- Metallic
- Non-metallic

0 1 2 4 Kilometers

TITLE: Economic Geolgy			
PROJECT: Barnadivane Wind Farm and Substation, Co. Cork			
FIGURE NO:	6.7		
CLIENT:	Barna Wind Energy Ltd. & Arran Windfarm Ltd.		
SCALE:	1:50000	**REVISION:**	0
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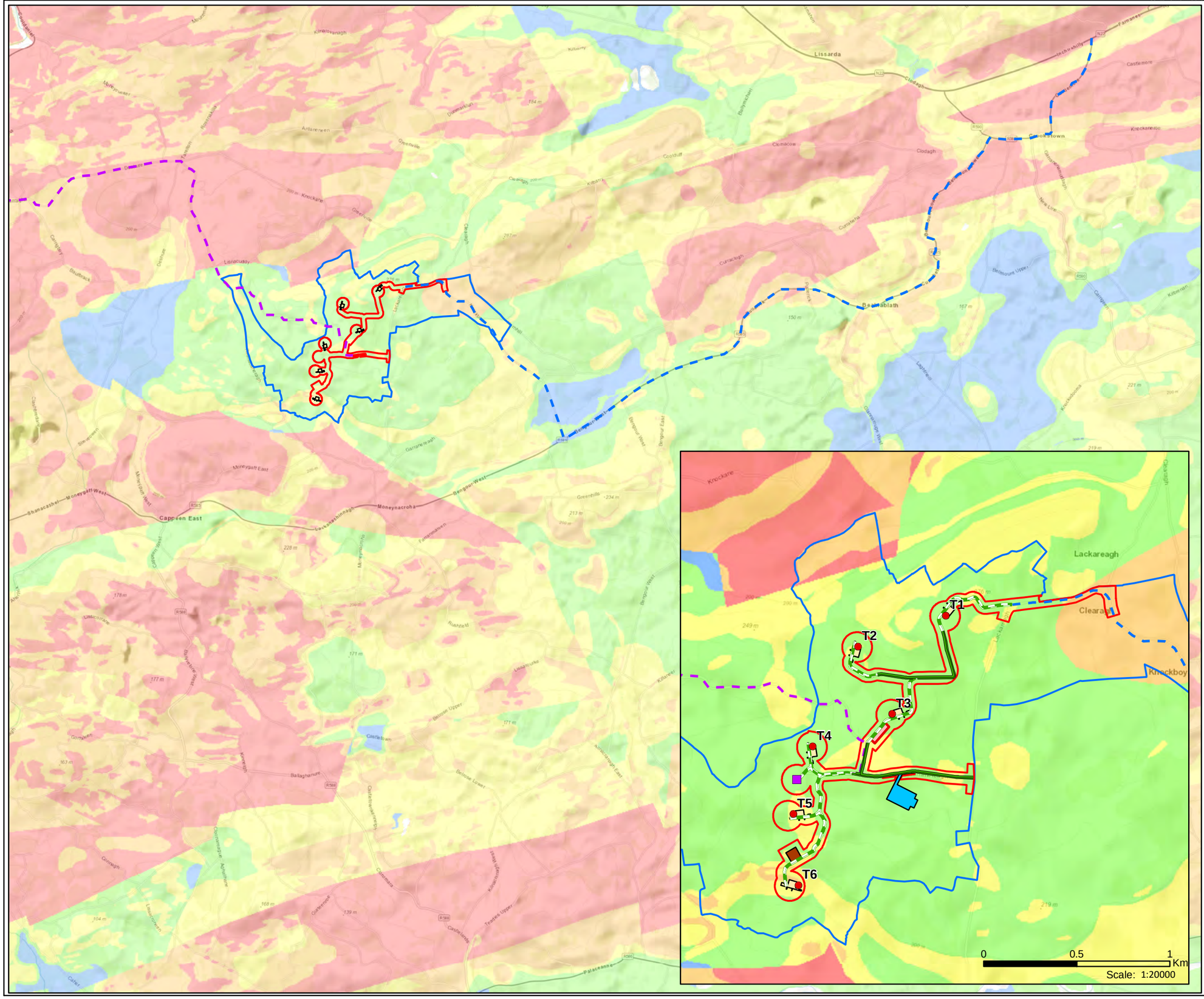

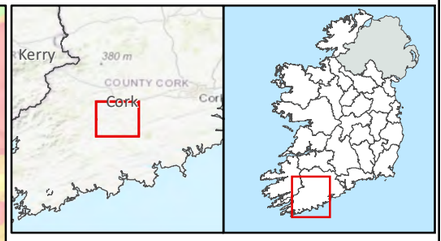

Legend

- Development Planning Boundary
- Study Area Boundary
- Proposed Substation
- Turbine Hardstandings
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- Proposed Borrow Pit
- Proposed Met Mast
- Proposed Turbine Layout
- Tracks-Existing
- Tracks-Proposed
- Alternative Grid Connection Route
- Turbine Delivery Route

Crushed Rock Aggregate Potential

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

TITLE: Crushed Rock Potential			
PROJECT: Barnadivane Wind Farm and Substation, Co. Cork			
FIGURE NO:	6.8		
CLIENT:	Barna Wind Energy Ltd. & Arran Windfarm Ltd.		
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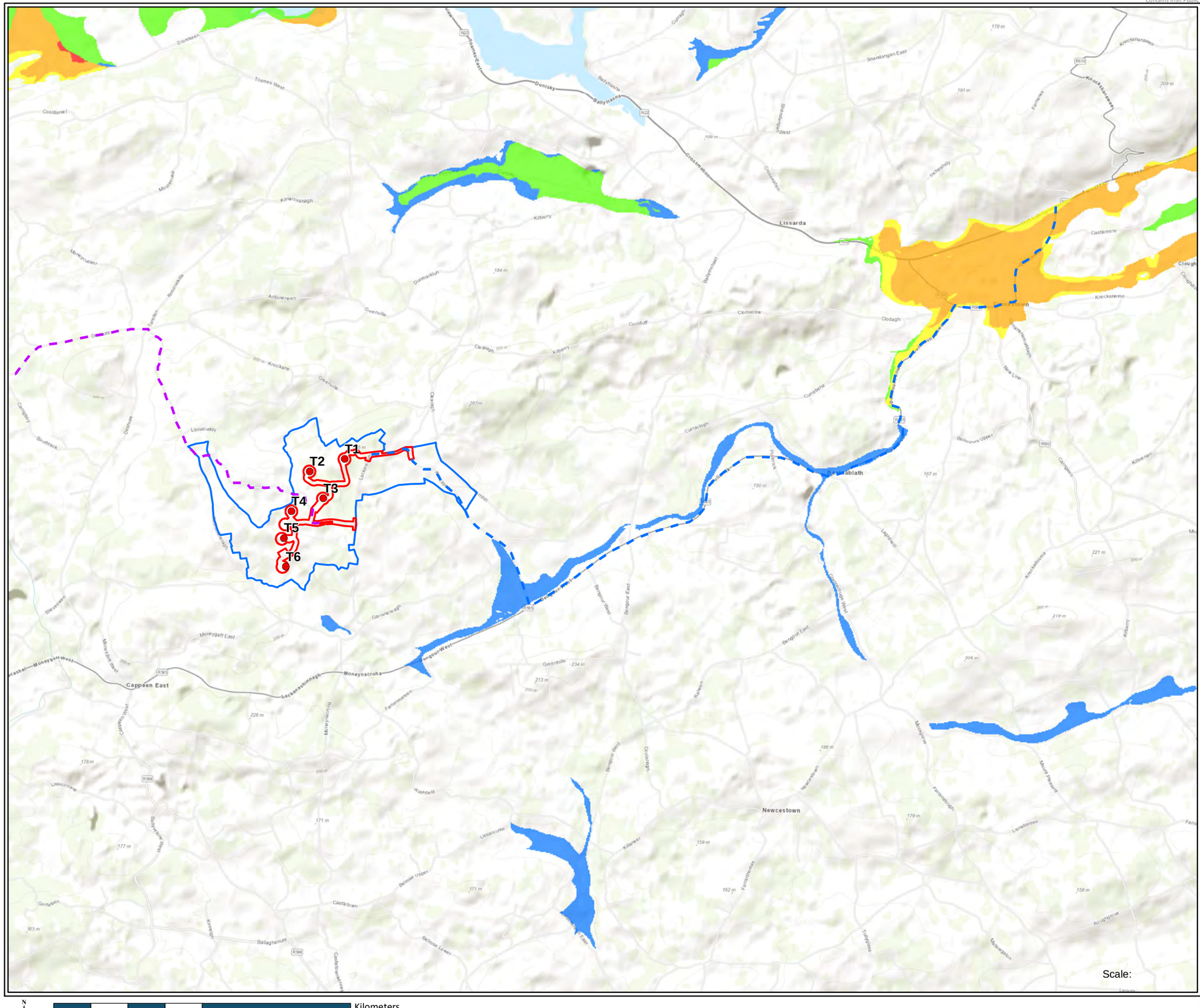

Legend

- Development Planning Boundary
- Study Area Boundary
- Proposed Turbine Layout
- Alternative Grid Connection Route
- Turbine Delivery Route

Granular Aggregate Potential

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

Scale:

0 1 2 4 Kilometers

TITLE: Granular Aggregate Potential			
PROJECT: Barnadivane Wind Farm and Substation, Co. Cork			
FIGURE NO:	6.9		
CLIENT:	Barna Wind Energy Ltd. & Arran Windfarm Ltd.		
SCALE:	1:50000	**REVISION:**	0
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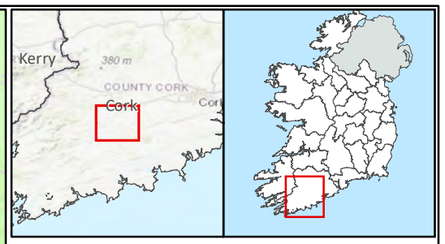
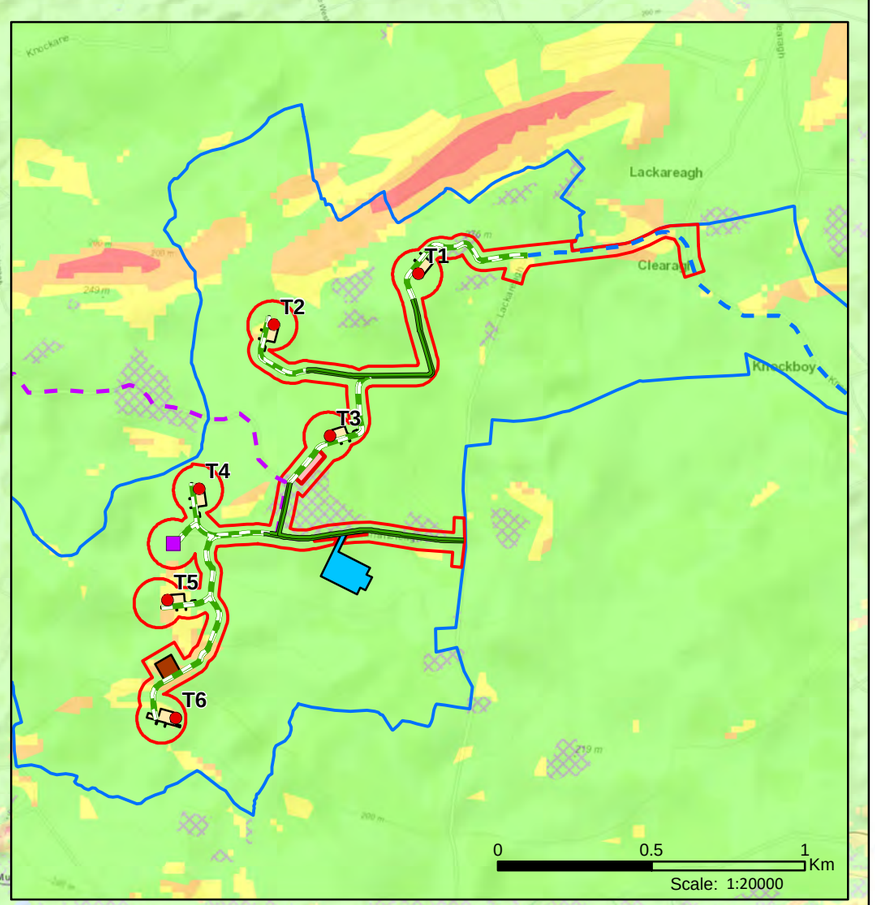


Legend

- Development Planning Boundary
- Study Area Boundary
- Proposed Substation
- Turbine Hardstandings
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Met Mast
- Proposed Turbine Layout
- Tracks-Existing
- Tracks-Proposed
- Alternative Grid Connection Route
- Turbine Delivery Route
- Landslide Events

Landslide Susceptibility

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



TITLE:	Landslide Susceptibilty
PROJECT:	Barnadivane Wind Farm and Substation, Co. Cork
FIGURE NO:	6.10
CLIENT:	Barna Wind Energy Ltd. & Arran Windfarm Ltd.
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0 1 2 4 Kilometers

6.4 Characteristics of the Proposed Development

6.4.1 Proposed Wind Farm

The proposed works require construction of six wind turbines, internal access tracks, hard standings, permanent meteorological mast, internal electrical and communications cabling, temporary construction compound, drainage infrastructure and all associated works related to the construction of the Proposed Development. Refer to Chapter 2 Figure 2-3 of this EIAR for the general arrangement of the Proposed Wind Farm.

Aggregate for construction will be sourced from an onsite borrow pit. The Spoil Management Plan (see Appendix 6.1) estimates that 9,696m^3 of usable rock can be excavated from the borrow pit. Additional crushed rock for construction will be imported from local, authorised quarries.

Estimated volumes of overburden (topsoil and mineral soil) to be removed are shown in Table 6-11.

Estimated stone volumes of approximately 28,622m^3 (Table 6-12) will be required for the construction of access roads, hardstands and turbine bases. Assuming 9,696m^3 of this material can be site won, there will be a requirement to import approximately 18,926m^3 of crushed stone.

Excavated material will be used for reinstatement of the borrow pit and landscaping works around the Proposed Wind Farm site, as well as being side cast and landscaped alongside the access roads. Rock excavated from infrastructure elements will be reused within the access tracks and hardstands.

Table 6-11: Estimated Excavation Volumes

Infrastructure Element	Typical Dimensions	Volume of excavated material (m^3)	Comment
6 no. Turbines & Hardstands	22m diameter and 3m depth excavation footprint for turbine foundation with hardstand area (approx. 2620m^2 footprint per hardstand area).	28,762	Hardstanding area and foundation footprint.
Access Roads	Assumed 5m running surface with 6m wide development footprint.	44,222	New and existing roads.
Temporary Construction Compound	Approximate area of 3,600m^2 and an excavation depth of 0.30m.	1,296	-
Met Mast	Foundation area of 100m^2 with an excavation depth of 1.5m. Hardstand area of 900m^2 with an excavation depth of 0.30m.	504	Foundation and Hardstanding areas.
Borrow Pit	1 No. borrow pit.	11,489	Of which, 9,696m^3 is anticipated to be rock for use as Class 1 fill.

Infrastructure Element	Typical Dimensions	Volume of excavated material (m^3)	Comment
Internal Cable Trenches	Trench cross-sectional area is 0.72m^2. The anticipated overall trench length is 3.26km.	2,817	Assumes a typical 0.6m wide and 1.20m deep trench construction.
	Total	**89,090**	

Note (1) A factor of 20% (bulking factor of 15% and contingency factor of 5%) has been applied to the excavated soil volumes to allow for expected increase in volume upon excavation and to allow for a variation in ground conditions across the site.

Note (2) It should be noted that the soil volumes given in Table 6-11 are indicative and for information purposes only, and subject to detailed design.

Table 6-12: Anticipated Stone Volumes necessary for construction

Infrastructure Element	Typical Dimensions	Stone Volume (m^3)	Average Stone Depth (m)
6 no. Turbines	22m diameter excavation footprint for turbine foundation	1,425	3
6 no. Hardstands	Hardstand area (2,620m^2)	9,825	0.5
Access Roads	Assumed 5m running surface with 6m wide development footprint	14,438	Varies
Temporary Construction Compound	Footprint of 3,600m^2	2,430	0.3
Met Mast	Hardstanding area of 16m^2	504	1.5
	Total	**28,622**	

Note: A contingency factor of 25% stone volumes to allow for a variation in ground conditions across the site.

Out of the total stone volume required (Table 6-12), it is estimated the 9,864m^3 will be made up of Cl804 with the remaining 18,758m^3 comprising Class 1 General Fill.

6.4.2 Proposed Substation.

The Proposed Substation is proposed under a separate planning application under consideration by An Bord Pleanála (reference PL04.308208). Refer to Chapter 2 Figure 2-3 of this EIAR for the general arrangement of the Proposed Development Site.

Estimated volumes of material to be excavated and stone volumes required for construction of the Proposed Substation are presented in Table 6-13.

Excavated material from the Proposed Substation will be used for reinstatement of the borrow pit and landscaping works around the site, as well as being side cast alongside the access roads. Rock excavated from the Proposed Substation will be reused within the access tracks and hardstands.

Table 6-13: Proposed Substation Estimated Excavation and Stone Fill Volumes

Infrastructure Element	Typical Dimensions	Excavation Volume (m^3)
Substation	Assumed 9,288m^2 footprint	19,837
Infrastructure Element	**Typical Dimensions**	**Stone Fill Volume (m^3)**
Substation	Assumed 9,288m^2 footprint	13,932

Note (1) A factor of 20% (bulking factor of 15% and contingency factor of 5%) has been applied to the excavated soil volumes to allow for expected increase in volume upon excavation and to allow for a variation in ground conditions across the site.

Note (2) It should be noted that the soil volumes given in Table 6-13 are indicative and for information purposes only, and subject to detailed design.

Note (3) A contingency factor of 25% stone volumes to allow for a variation in ground conditions across the site.

Out of the total stone volume required (Table 6-13), it is estimated the 1,742m^3 will be made up of Cl804 with the remaining 12,191m^3 comprising Class 1 General Fill.

6.4.3 Total Stone Volumes for the Construction of the Proposed Development

Table 6-14 summarises the total stone volumes necessary for the construction of the Proposed Development (to include both the wind farm and substation).

Table 6-14: Total Crushed Stone Volumes

Material Type	Total Volumes (m^3)	Comments
Cl804	9,864	Typical depth of fill 0.15m.
Class 1 General Fill	32,690	Depth of fill varies.
Total Crushed Stone Volume (m^3)	42,554	

Note (1) A factor of 20% (bulking factor of 15% and contingency factor of 5%) has been applied to the excavated soil volumes to allow for expected increase in volume upon excavation and to allow for a variation in ground conditions across the site.

6.5 Potential Effects

The potential effects on the underlying soils, geology and hydrogeology at the Proposed Development site are assessed in the following sections for the activities associated within each phase (Construction, Operation and Decommissioning) for the Proposed Development as described in Chapter 2.

The potential impacts are assessed in accordance with the evaluation criteria outlined in Section 6.2 The unmitigated potential impacts are summarised in Tables 6-17 and 6-18. The proposed mitigation measures are then considered to reduce or eliminate potential impacts.

6.5.1 Do Nothing Impact

If the Proposed Development were not constructed, it is likely that the current land uses will continue for the foreseeable future. The impact on the Soils, Geology & Hydrogeology would remain unaltered as a result.

6.5.2 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 Wind Farm:

6.5.2.1 Earthworks

The Proposed Wind Farm will require construction phase earthworks associated with the excavation of turbine bases, removal of overburden deposits for the construction of turbine foundations, temporary site compound, substation , turbine hard standings, borrow pit, internal access roads and permanent met mast.

As such there is the potential for impact to Soils, Geology and Hydrogeology from the excavation and movement of existing Glacial Till deposits and bedrock during the construction phase of the Proposed Wind Farm.

The following earthworks excavations will be required:

- Excavation of Topsoil deposits;
- Excavation of Glacial Till to bedrock (as required);
- Excavation of bedrock at Turbine and Met Mast bases, and at the 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, borrow pit and along access roads. Material placed alongside access roads will generally not exceed 1m in height and will be shaped and sealed to prevent the ingress of water.
- Importation and filling of site won and imported General Fill and Engineering Aggregates.

Following the completion of preliminary site investigations and consideration of wind turbine manufacturer specifications for wind turbines of the size proposed at the site, it is expected that wind turbine foundations shall be reinforced concrete gravity foundations with depths of 3m and diameters of approx. 22m. Ideally, a suitable bearing stratum is encountered within 3m from ground surface so that the turbine foundation can be finished at / near existing ground level. Where deeper excavations (3-5m) are required to reach a suitable bearing stratum, soil replacement (engineered fill) is used to bring up the excavation so that the turbine foundation is finished at / near existing ground level.

The proposed borrow pit location has been identified as a source of site won general fill for construction activities. The location was selected as potential sources 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.

Surplus Topsoil and Glacial Till recovered from excavations will be used for the reinstatement proposed around turbine bases, hardstands and the temporary construction compound. All associated quantities have been calculated in Section 6.4 and no excavated material will leave the Proposed Wind Farm site.

Direct impacts to the existing geological regime associated with the construction phase of the Proposed Wind Farm are:

- Soil compaction may occur due to movement of construction traffic. This will occur particularly within areas of highly compressible soft deposits which are left in-situ during the construction phase. This could lead to an increase in surface water runoff due to reduced infiltration of rainfall and subsequently to an increase in erosion of overburden deposits left in-situ.
- The use of plant and machinery during construction will require the storage and use of fuels and oils. Their storage and use present potential for spills and leaks which could contaminate underlying exposed soils.
- During construction, imported engineering fill and excavated soils will be exposed in excavations and in temporary stockpiles. These soils will be subject to erosion by wind and rain which could deposit silt in streams with an indirect impact on surface water quality.
- The extraction of rock from off-site quarries will represent a reduction in the availability of an exhaustible resource. Imported crushed rock will be required for material such as 6F2 (capping), 6N1 (Fill to structures) and 6N2 (fill below structures).

The Magnitude of the impact from these works on the soils and geology receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Slight significance.** The Impact Classification is negative, permanent, direct and will have likely effects.

Direct impacts to the existing hydrogeological regime associated with earthworks with respect to the construction phase of the Proposed Wind Farm are:

- Potential for groundwater pollution from the removal of overburden deposits particularly at proposed turbine locations. The aquifer underlying the Proposed Development site is classified by the GSI as ranging from 'High' to 'Extreme' with areas of exposed bedrock also present. It is proposed to remove the overlying soft ground and Glacial Till deposits as outlined in the proposed design.
- The vulnerability of the aquifer to groundwater pollution particularly during construction stage will be increased as overburden is removed thus reducing the level of protection from groundwater pollution.
- Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Soil erosion as a result of exposure of soils in open excavations and temporary storage of excavated materials represents a potential impact to the underlying groundwater aquifer.
- Reduction in groundwater levels from dewatering of excavations as required during the construction stage if high groundwater is encountered. This impact is most likely during the excavation of turbine foundations and at the proposed borrow pit location. There are no groundwater supply wells recorded in the immediate vicinity of proposed turbine locations. It is considered that other excavations

associated with the Proposed Substation will not extend into the underlying bedrock aquifers. It is possible however that perched groundwater may exist locally within overburden deposits or weathered bedrock. Upon completion of the construction phase, it is considered that groundwater levels will revert to the pre-construction situation when there is no longer a requirement to control groundwater levels.

The Magnitude of the impact from these works on groundwater receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Slight significance.** The Impact Classification is negative, permanent, direct and will have likely effects.

6.5.2.2 Slope Stability

According to the GSI Landslide Susceptibility database, the Proposed Wind Farm site is generally located within areas of 'Low' to 'Moderately Low' landslide susceptibility. Turbines T5 and T6 are within an area of 'Moderately High' susceptibility; however, GSI Quaternary mapping and site observations indicate that these locations are underlain by shallow bedrock with gentle to moderate slopes and no evidence of historic ground instability. This area of 'Moderately High' susceptibility does not accurately reflect actual ground conditions identified through desk study review and site observations and will therefore be discounted. Localised areas of 'High' landslide susceptibility are mapped but these are limited to relatively small areas and are outside the proposed infrastructure locations. GSI landslide mapping indicates the closest recorded landslide is located approximately 15km to the southeast of the Proposed Development site. As such, it is considered construction activities will pose little risk to sensitive receptors from potential landslide/slope failures. Results from the site walkover surveys show no evidence of recent or historic landslides.

Given the absence of peat deposits across the Proposed Development 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 on the soils and geology receptors is considered to be 'Moderate Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Moderate significance.** The Impact Classification is negative, short term, direct and will have unlikely effects.

The Magnitude of the impact from these works on groundwater receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Slight significance.** The Impact Classification is negative, short term, direct and will have unlikely effects.

6.5.2.3 Internal Access Roads, Hardstands and Temporary Construction Compound

There will be approximately 3.85km of internal access tracks associated with the Proposed Development site. This will be a combination of existing track upgrade and construction of new tracks; approximately 2.35km of new track construction and approximately 1.5km of existing track upgrade. Hardstand areas will be provided at each turbine location.

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

The following filling and material deposition operations will be required:

- Deposition of surplus topsoil 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 approximately 23% (9,696m^3) of the stone required for the construction of the internal access roads, hardstands, temporary construction compound and the Proposed Substation will be sourced from the on-site borrow pit. The remaining 77% (32,858m^3) will be imported. If suitable site won material is not available for the finishing layer on the access roads, hardstands and upfill for turbine bases, this material will be imported from quarries in the vicinity.

The likely off-site, source quarries for the supply of imported crushed rock aggregate during the construction phase of the Proposed Development are presented in Table 6-14 over.

Table 6-15: Source Quarries for Imported Aggregate (Crushed Rock)

Name	Distance from site	Products	Rock type
Kilmichael Quarry	5km (W)	Series 600 crushed rock aggregate and Clause 803/4/5/6.	Sandstone
Castlemore Quarry	10km (E)	Series 600 crushed rock aggregate and Clause 803/4/5/6	Limestone

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

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

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

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

The Magnitude of the impact from these works on the soils and geology receptors is considered to be 'Moderate Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Moderate significance.** The Impact Classification is negative, permanent, direct and will have likely effects.

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

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

The Magnitude of the impact from these works on the groundwater receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Slight significance.** The Impact Classification is negative, permanent, direct and will have likely effects.

6.5.2.4 Internal Cabling

The internal cabling is outlined in Section 6.1 and in Chapter 2 (Section 2.3.10) of this EIAR and will comprise a medium voltage (20/33kV) internal circuit of buried cables following on-site access tracks.

Connection works will involve the installation of ducting, joint bays, drainage and ancillary infrastructure and the subsequent running of cables along site access tracks. For cable trenches located along access tracks 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). Cable-ducts will generally be laid when the track is being constructed and will follow the edge of the site access tracks. The trenches within these locations will generally be backfilled using the excavated material.

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

- Trench excavations and ducting may present a preferential pathway for the movement of groundwater and/or contamination in the subsurface. However, the subsoil at the Proposed Development is predominantly Glacial Till, which has a low permeability.
- The excavations for the cable 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 internal cabling excavations are not suitable for reuse as backfill or deposition on site this material will be disposed of at a facility licenced (subject to environmental testing and classification) to accept this waste type.

The Magnitude of the impact from these works on the soils and geology receptors is considered to be 'Small Adverse' in nature.
The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Slight significance.** The Impact Classification is negative, permanent, direct and will have likely effects.

The Magnitude of the impact from these works on the groundwater receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Slight significance.** The Impact Classification is negative, permanent, direct and will have likely effects.

6.5.2.5 Proposed Substation

The Proposed Substation is outlined in Section 6.1 and in Chapter 2 (Section 2.3.10) of this EIAR and will comprise a loop in loop out substation, which is proposed to connect to an existing overhead 110kV powerline.

Direct impacts to the existing environment associated with the Proposed Substation include:

- The excavations for foundations, hardstands, cable 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.
- Excavations and ducting may present a preferential pathway for the movement of groundwater and/or contamination in the subsurface. However, the subsoil at the Proposed Development is predominantly Glacial Till, which has a low permeability.
- Where the material excavated at the Proposed Substation are not suitable for reuse as backfill or deposition on site this material will be disposed of at a facility licenced (subject to environmental testing and classification) to accept this waste type.

The Magnitude of the impact from these works on the soils and geology receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Slight significance.** The Impact Classification is negative, permanent, direct and will have likely effects.

The Magnitude of the impact from these works on the groundwater receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Slight significance.** The Impact Classification is negative, permanent, direct and will have likely effects.

6.5.3 Operational Phase

The potential impacts on soils, geology & hydrogeology from the operation of the Proposed Development are outlined below.

6.5.3.1 Potential Direct Impacts

Very few potential direct impacts are envisaged during the operational phase of the Proposed Development. 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 Proposed Substation and transformers in each proposed wind turbine will be oil cooled. 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 on the soils and geology receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Slight significance.** The Impact Classification is negative, shot-term, direct and has unlikely effects.

The Magnitude of the impact from these works on the groundwater receptors is considered to be 'Negligible' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Imperceptible significance.** The Impact Classification is negative, shot-term, direct and has unlikely effects.

6.5.3.2 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 6.5.2.4.

The Magnitude of the impact from these works on the soils and geology receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Slight Significance.** The Impact Classification is negative, shot-term, direct and has unlikely effects.

The Magnitude of the impact from these works on the groundwater receptors is considered to be 'Negligible' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Imperceptible significance.** The Impact Classification is negative, shot-term, direct and has unlikely effects.

6.5.4 Potential Impacts during Decommissioning

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

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

Other impacts such as possible soil compaction and contamination by fuel leaks will remain but will be of reduced magnitude. Nevertheless, as noted in the Scottish Natural Heritage guidance on restoration and decommissioning of onshore wind farms (SNH, 2013) reinstatement proposals for a wind farm are made approximately 30 years in advance, so within the lifespan of the wind farm, technological advances and preferred approaches to reinstatement are likely to change.

It is therefore '*best practice not to limit options too far in advance of actual decommissioning but to maintain informed flexibility until close to the end-of-life of the wind farm*'.

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

The Magnitude of the impact from these works on the soils and geology receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Slight significance.** The Impact Classification is negative, shot-term, direct and has unlikely effects.

The Magnitude of the impact from these works on the groundwater receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Slight significance.** The Impact Classification is negative, shot-term, direct and has unlikely effects.

6.5.5 Potential Cumulative Impacts

6.5.5.1 Large Scale Developments within 20km of the Site

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

- Cork County Council;
- Kerry County Council;
- An Bord Pleanála.

Relevant projects, that are likely to have an impact on the Soils, Geology and Hydrogeology, in proximity to the Proposed Project including the AGCR and the enabling TDR works are listed in Table 6-15:

Table 6-16: Potential Cumulative Impact from other Developments

Development (Named Developer)	Distance from the Site (km)	Status	Interface	Potential Cumulative Impact
Construction of 96 no. residential units, a creche and all ancillary works (CEPL Ltd.)	8.5km N	Further Information	Groundwater Subsoils and Bedrock	Negligible Small Adverse
Construction of 106 no. residential buildings and creche (Massey Development Ltd.)	8.5km N	Application Finalised	Groundwater Subsoils and Bedrock	Negligible Small Adverse
Wastewater treatment scheme (Irish Water)	11.5km WNW	Conditional	Groundwater Subsoils and Bedrock	Negligible Small Adverse
Carrigarierk Wind Farm – planning application does not include construction of turbines (Keel Energy Ltd.)	13km WSW	Conditional	Groundwater Subsoils and Bedrock	Negligible Small Adverse
Cleanrath Windfarm (Cleanrath Windfarm Ltd.)	14.5km WNW	Conditional	Groundwater Subsoils and Bedrock	Negligible Small Adverse
Cahernafulla Wind Farm (Michael Murnane)	15km NNE	Conditional	Groundwater Subsoils and Bedrock	Negligible Small Adverse
Cahernafulla Wind Farm (Burren Energy Ltd.)	15km NNE	Application Finalised	Groundwater Subsoils and Bedrock	Negligible Small Adverse

The Proposed Developments summarised in Table 6-15 have been consented with the exception of CEPL Ltd.'s application where a request for further information has been made. If construction for these projects overlap or run concurrently with the Proposed Development there may be a supply issue with local quarries providing imported aggregate.

The magnitude of the impact from these works on the soils and bedrock receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'. The rating of this potential cumulative impact is considered to be of **Slight significance.** The Impact Classification is negative, shot-term, indirect and has unlikely effects.

There is the potential for groundwater pollution from run-off impacting on the groundwater receptor from the development sites. The Magnitude of the impact from these works on the groundwater receptors is considered to be 'Negligible' in nature. The importance is considered to be 'Medium'. The rating of this potential cumulative impact is considered to be of **Imperceptible significance.** The Impact Classification is negative, shot-term, indirect and has unlikely effects.

6.5.5.2 Alternative Grid Connection Route (AGCR)

As discussed in Section 6.1, in the event that the Proposed Substation is not permitted or developed, the AGCR may be developed. This, if constructed, will travel from the Proposed Development Site and connect to the underground Carrigarierk Wind Farm cable. The Carrigarierk Wind Farm connects to the Carrigdangan 110kV substation, which in turn connects to the Dunmanway ESB substation.

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

Direct impacts to the existing environment associated with the AGCR works include:

- associated excavations and ducting may present a preferential pathway for the movement of groundwater and/or contamination in the subsurface. However, the subsoil at the Proposed Development is predominantly Glacial Till which has a low permeability throughout the majority of the AGCR.
- The excavations for the AGCR 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.
- The GSI holds records of groundwater wells in the vicinity of the AGCR. However, trenches are shallow (1.2m deep) and will only be open for a couple of days at most.

The Magnitude of the impact from these works on the soils and geology receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Slight significance.** The Impact Classification is negative, permanent, direct and will have likely effects.

The Magnitude of the impact from these works on groundwater receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Slight significance.** The Impact Classification is negative, permanent, direct and will have likely effects.

6.5.5.2.1 Off-Site Vegetation Clearance

The AGCR will require clearance of approximately 280 linear metres of vegetation within the Carrigarierk Wind Farm site boundary.

The vegetation clearance area proposed is the minimum necessary to construct the AGCR.

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.

Further assessment of potential impacts to surface water discharges from vegetation clearance activities are discussed in Chapter 7 of the EIAR.

The Magnitude of the impact from these works on the soils and geology receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts on geological receptors, prior to mitigation, is considered to be of **Slight significance.** The impact classification is negative, short term, direct and will have unlikely effects.

The Magnitude of the impact from these works on groundwater receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Slight significance.**. The Impact Classification is negative, short term, direct and will have unlikely effects.

6.5.5.2.2 Horizontal Directional Drilling (HDD)

A total of 15 no. watercourse crossings have been identified along the AGCR.

It is not anticipated that HDD will be employed within the Site or along the AGCR. However, the option will be made available if required and the methodology is detailed below.

The directional drilling method of duct installation will be carried out using Vermeer D36 x 50 Directional Drill (approximately 22 tonnes), or similar plant, for the horizontal directional drilling at watercourse/culvert crossings. The launch and reception pits will be approximately 0.55m wide, 2.5m long and 1.5m deep. The pits will be excavated with a suitably sized excavator. The drilling rig will be securely anchored to the ground by means of anchor pins which will be attached to the front of the machine. The drill head will then be secured to the first drill rod and the operator shall commence to drill into the launch pit to a suitable angle which will enable them to obtain the depths and pitch required to the line and level of the required profile. Drilling of the pilot bore shall continue with the addition of 3.0 m long drill rods, mechanically loaded and connected into position.

During the drilling process, a mixture of a natural, inert and fully biodegradable drilling fluid such as Clear Bore™ and water is pumped through the centre of the drill rods to the reamer head and is forced into void and enables the annulus which has been created to support the surrounding sub soil and thus prevent collapse of the reamed length.

Depending on the prevalent ground conditions, it may be necessary to repeat the drilling process by incrementally increasing the size of the reamers. When the reamer enters the launch pit, it is removed from the drill rods which are then passed back up the bore to the reception pit and the next size reamer is attached to the drill rods and the process is repeated until the required bore with the allowable tolerance is achieved.

The use of a natural, inert and biodegradable drilling fluid such as Clear Bore™ is intended to negate any adverse impacts arising from the use of other, traditional polymer-based drilling fluids and will be used sparingly as part of the drilling operations. It will be appropriately stored prior to use and deployed in the required amounts to avoid surplus. Should any excess drilling fluid accumulate in the reception or drilling pits, it will be contained and removed from the site in the same manner as other subsoil materials associated with the drilling process to an approved disposal site.

Backfilling of launch and reception pits will be conducted in accordance with the normal specification for backfilling excavated trenches.

A detailed method statement with site specific mitigation measures for this activity is included in the CEMP (Appendix 2.2).

Direct impacts to the existing environment associated with 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 on the soils and geology receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'.
The rating of these potential impacts, prior to mitigation, is considered to be of **Slight significance.** The Impact Classification is negative, permanent, direct and have likely effects.

The Magnitude of the impact from these works on the groundwater receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Slight significance.** The Impact Classification is negative, permanent, direct and have likely effects.

6.5.5.3 Enabling TDR Works

The proposed turbine delivery route (TDR) will be from N22 / R585 junction at Castlemore, as described in more detail in Chapter 11. Key elements of the Enabling TDR Works are summarised below

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

The Magnitude of the impact from these works on the soils and geology receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Slight significance**. The Impact Classification is negative, temporary, direct and has likely effects.

The Magnitude of the impact from these works on the groundwater receptors is considered to be 'Small Adverse' in nature. The importance is considered to be 'Medium'. The rating of these potential impacts, prior to mitigation, is considered to be of **Slight significance.** The Impact Classification is negative, temporary, direct and has likely effects.

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 6.6 of this Chapter.

6.5.5.4 Summary of Potential Cumulative Impacts

During the construction of the Proposed Development there will be the requirement for:

- The importation of engineered fill from licenced quarries. Should these coincide with demand for imported aggregate for construction works at other development locations there would a cumulative impact in terms of demands placed on local quarries for aggregate.
- The excavation of cable trenches along the AGCR. Excavations are shallow and are proposed predominantly along existing roads. In addition, tree felling will be required over a relatively small swath of forestry to the far western extent of the AGCR. These activities will have an impact, albeit limited, on the underlying geological and hydrogeological receptors.

As such , it is considered there may be a **Slight** cumulative impact during construction stage.

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

6.5.6 Summary of Potential Impacts

A summary of unmitigated potential impacts on soils, geology & hydrogeology attributes from the Proposed Project is provided in Table 6-18 with the potential impacts on hydrogeological attributes provided in Table 6-18.

Table 6-17: Summary of Potential Unmitigated Impact Significance on Geological Receptors

Activity	Potential Impact	Receptor	Importance	Prior to Mitigation	
				Magnitude	Significance
Construction Phase					
Earthworks associated with the construction of the proposed turbines and associated infrastructure.	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, Glacial Till deposits and bedrock.	Medium	Small Adverse	Slight
Earthworks associated with the construction of the proposed turbines and associated infrastructure.	Slope Failure.	Localised organic soils, Glacial Till deposits and bedrock.	Medium	Moderate Adverse	Moderate
Earthworks associated with the construction of the Proposed Substation.	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, Glacial Till deposits and bedrock.	Medium	Small Adverse	Slight

Activity	Potential Impact	Receptor	Importance	Prior to Mitigation	
				Magnitude	Significance
Construction of Internal Site Access Tracks, Hardstands and Temporary Compound.	Open excavations, increased runoff causing erosion of underlying overburden and bedrock. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill.	Localised organic soils and Glacial Till deposits. Bedrock Local quarries.	Medium	Moderate Adverse	Moderate
Construction of Proposed 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.	Medium	Moderate Adverse	Moderate
Construction of Internal Cabling.	Removal of overburden material and exposure of underlying subsoil and bedrock to erosion. Importation of engineering fill and concrete products. Disposal of surplus excavated material to licenced facility.	Localised organic soils Glaciofluvial deposits, Glacial Till deposits and bedrock. Local quarries. Licenced Waste Facilities.	Medium	Small Adverse	Slight
Construction of the Proposed Substation.	Removal of overburden material and exposure of underlying subsoil and bedrock to erosion. Importation of engineering fill and concrete products. Disposal of surplus excavated material to licenced facility.	Localised organic soils Glaciofluvial deposits, Glacial Till deposits and bedrock. Local quarries. Licenced Waste Facilities.	Medium	Small Adverse	Slight

Activity	Potential Impact	Receptor	Importance	Prior to Mitigation	
				Magnitude	Significance
Operational Phase					
Construction traffic for maintenance of turbines, hardstands and access tracks. Operation of substation and turbines.	Release of hydrocarbons or fuel spill.	Localised organic soils, Glacial Till deposits and bedrock.	Medium	Small Adverse	Slight
Maintenance of access tracks.	Importation of engineering fill.	Local quarries	Medium	Small Adverse	Slight
Decommissioning Phase					
Removal of Turbines and Hardstands.	Construction traffic resulting in soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils.	Localised organic soils Glaciofluvial deposits, Glacial Till deposits and bedrock.	Medium	Small Adverse	Slight
Cumulative Impacts					
Large-scale developments within 20km of the Site occurring concurrently with construction of the Site/GCR.	Cumulative impacts on local quarries from extraction of fill for Proposed Project.	Local quarries	Medium	Small Adverse	Slight
Vegetation Clearance	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.	Medium	Small Adverse	Slight

Activity	Potential Impact	Receptor	Importance	Prior to Mitigation	
				Magnitude	Significance
Construction of Alternative Grid Connection Route (AGCR).	Removal of overburden material and exposure of underlying subsoil and bedrock to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill and concrete products. Disposal of surplus excavated material to licenced facility.	Localised organic soils Glaciofluvial deposits, Glacial Till deposits and bedrock. Local quarries. Licenced Waste Facilities.	Medium	Small Adverse	Slight
Accommodation works along TDR.	Removal of overburden material and exposure of underlying subsoil and bedrock to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill. Disposal of surplus excavated material to licenced facility.	Subsoils. Bedrock. Local quarries. Licenced waste facilities.	Medium	Small Adverse	Slight
HDD at crossing point(s).	Overburden collapse due to advancement of HDD bore	Local Glacial Till deposits. Bedrock.	Medium	Small Adverse	Slight

Table 6-18: Summary of Potential Unmitigated Impact Significance on Hydrogeological Receptors

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Construction Phase					
Earthworks associated with the construction of the proposed turbines and associated infrastructure.	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	Small Adverse	Slight
Earthworks associated with the construction of the proposed turbines and associated infrastructure.	Slope Failure.	Locally Important Bedrock Aquifer. Groundwater Wells and Springs.	Medium	Small Adverse	Slight

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

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Construction of the Proposed 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	Small Adverse	Slight
Construction of Turbine Foundations.	Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during construction phase earthworks. Potential for ground water pollution from the use of cement-based compounds during the construction phase. Reduction in groundwater levels from dewatering of excavation as required during the construction phase.	Locally Important Bedrock Aquifer. Groundwater Wells and Springs.	Medium	Small Adverse	Slight

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Construction of Proposed Substation Foundations.	Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during construction phase earthworks. Potential for ground water pollution from the use of cement-based compounds during the construction phase. Reduction in groundwater levels from dewatering of excavation as required during the construction phase.	Locally Important Bedrock Aquifer. Groundwater Wells and Springs.	Medium	Small Adverse	Slight
Construction of 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
Construction of cabling for the Proposed Substation.	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

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Operational Phase					
Operational traffic, refuelling of vehicles.	Some operational traffic will be necessary for maintenance plus normal operational traffic which could result in minor accidental leaks or spills of fuel/oil.	Locally Important Bedrock Aquifer. Groundwater Wells and Springs.	Medium	Negligible	Imperceptible
Decommissioning Phase					
Removal of Turbines and Hardstands.	Potential for groundwater pollution from the disturbance of overburden deposits Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer Potential for contamination to groundwater from spills/leakages during decommissioning phase earthworks.	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Small Adverse	Slight
Cumulative Impacts					
Large-scale developments within 20km of the Proposed Development Site occurring concurrently with construction of the Site/AGCR.	Potential for groundwater pollution from runoff.	Potential cumulative impact on: Locally Important Bedrock Aquifer. Groundwater Wells and Springs.	Medium	Negligible	Imperceptible
Vegetation Clearance	Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages from felling machinery.	Locally Important Bedrock Aquifer. Groundwater Wells and Springs.	Medium	Small Adverse	Slight

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Construction of the Grid Connection Route (AGCR).	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
Accommodation works along TDR.	Removal of overburden material and exposure of underlying subsoil and bedrock to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill. Disposal of surplus excavated material to licenced facility.	Locally Important Bedrock Aquifers. Groundwater Wells and Springs.	Medium	Small Adverse	Slight
Horizontal Directional Drilling.	Potential for ground water pollution from boring activities. Potential for contamination to groundwater from spills/leakages during construction phase drilling operations.	Locally Important Bedrock Aquifers. Groundwater Wells and Springs.	Medium	Small Adverse	Slight

6.6 Mitigation Measures

The following section outlines appropriate mitigation measures by design and best practice to avoid or reduce the potential impact of the Proposed Project. Further details are given in Section 4.3 of the CEMP, which is contained in Appendix 2.2 of Volume 2.

6.6.1 Mitigation by Design and Best Practice

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

The primary mitigation measure employed has been the design of the Proposed Development site in terms of locating the turbines, access roads, material storage areas and other site infrastructure within an area comprising predominantly agricultural pastoral land where the soils are generally described as 'well drained' (from GSI Teagasc soils mapping).

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

- Peat probing and site walkover surveys to identify geotechnical constraints (e.g. peat deposits and evidence of historic landslip) likely to adversely affect the design of the Proposed Development site.
- Relocation and micro-siting of turbines, hardstanding's and access roads based on the site assessments and geotechnical assessments in order to reduce ground risk associated with the Proposed Project.
- The works have been designed and checked by geotechnical and civil engineers, who are suitably qualified and experienced in excavation and earthworks design and construction methodologies. Details of experience and competence is included in Chapter 1.

The following will also be implemented:

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

6.6.2 Construction Phase

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

6.6.2.1 Construction Environmental Management Plan (CEMP)

A Construction Environmental Management Plan (CEMP) has been prepared for the Proposed Project and is included in Volume 2, Appendix 2.2. The CEMP defines the work practices, environmental management procedures and management responsibilities relating to the construction phase of the Proposed Development.

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

Reference to relevant sections of the CEMP with respect to the mitigation of potential impacts to Soils, Geology and Hydrogeology from the Proposed Development are outlined below.

6.6.2.2 Earthworks

The Proposed Development will be constructed in a phased manner to reduce the potential impacts of the Proposed Project on the Soils, Geology and Hydrogeology. 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 3.3.1 of the CEMP in Appendix 2.2 of Volume 2.

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 (crushed rock) as general fill in the construction of access tracks, hardstands and in reinstatement around turbine foundations.
- Surplus overburden will be re-used on site in the form of landscaping.

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

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

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

To mitigate against erosion of the exposed soil or rock, all excavations will be constructed and backfilled as quickly as possible. Excavations will stop during or prior to heavy rainfall events (>10mm/hour). To mitigate against possible contamination of the exposed soils and bedrock, refuelling of machinery and plant will only occur at designated refuelling areas.

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.

6.6.2.3 Control of Sediment Laden Runoff

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

Details of the proposed Surface Water Management System and mitigation measures is summarised below and are also outlined in Section 4.3.5 of the CEMP in Appendix 2.2 of Volume 2.

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

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

Final drainage will be constructed following the completion of these activities with silt fencing maintained until such time as a vegetation cover has become established. Chapter 7 of this EIAR discusses surface water issues in more detail.

6.6.2.4 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 2.2 of Volume 2.

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 Proposed Development 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.

6.6.2.5 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.
- Excavation will be carried out from access roads or hardstanding areas to avoid tracking of construction plant across areas of soft ground.
- Blasting of rock will not be permitted.
- Excavations which could have the potential to undermine the up-slope component of an existing slope will be sufficiently supported to resist lateral slippage and careful attention will be given to the existing drainage.
- Earthworks will not be commenced when heavy or sustained rainfall (orange or red weather warnings) is forecast. A series of rainfall gauges will be installed across the Proposed Development site to provide a record of rainfall intensity. An inspection of site stability and drainage by the Geotechnical Engineer will be carried out on site when a daily rainfall of over 10mm/hr or 25mm/day is recorded on site, works will only recommence after heavy rain with the prior approval of the Geotechnical Engineer following their inspection.
- An emergency plan will be updated at pre-construction stage detailing the action plan which would be implemented in the unlikely event of a landslide/slope failure. Should a landslide/slope failure occur or if signs of instability/ground movement are observed, work will cease immediately.

Further details are given in the CEMP included in Appendix 2.2 of Volume 2 of this EIAR.

6.6.2.6 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 and presumed wells, relatively shallow depths of excavation and temporary short-term nature of dewatering, if required. To monitor groundwater during the construction phase groundwater monitoring wells will be installed between areas of deeper excavations and sensitive groundwater receptors. The wells will be used to monitor groundwater levels and quality to assess any potential impacts during the construction works.

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

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

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

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

6.6.3 Mitigation Measures during Operation

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

There is a low risk to the geology receptors from compaction of soils due to the movement of HGVs and maintenance vehicles. All site traffic will be limited to access tracks, thereby reducing the area over which compaction of the underlying natural soils can occur.

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

6.6.4 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) (2012) 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 disturbanc*e". 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 Proposed Development site. It is proposed that the internal site access tracks and hard standings will be left in place and the land reinstated at these locations. The electrical 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.

6.7 Residual Impacts

It can be observed from Table 6-19 and Table 6-20 that, following the implementation of mitigation measures, the residual impact significance to the receiving environment would be imperceptible during the construction period and imperceptible during the operation of the Proposed Development. Mitigation measures will be monitored throughout the construction, operational and decommissioning phases.

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

Table 6-19: Residual Impact Significance for Sensitive Geological Attributes

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Prior to Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction Phase							
Earthworks associated with the construction of the proposed turbines and associated development	Removal of overburden material, open excavations and subsequent exposure underlying overburden and bedrock leading to increased erosion. Construction traffic resulting in soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill and concrete.	Localised organic soils, Glacial Till deposits and bedrock.	Medium	Small Adverse	Slight	Negligible	Imperceptible
Earthworks associated with the construction of the proposed turbines and associated development.	Slope Failure.	Localised organic soils, Glacial Till deposits and bedrock.	Medium	Moderate Adverse	Moderate	Negligible	Imperceptible
Earthworks associated with the construction of the Proposed Substation.	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, Glacial Till deposits and bedrock.	Medium	Small Adverse	Slight	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Prior to Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction of Internal Site Access Tracks, Hardstands and Temporary Compound.	Open excavations, increased runoff causing erosion of underlying overburden and bedrock. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill.	Localised organic soils, Glacial Till deposits and bedrock. Local quarries.	Medium	Moderate Adverse	Moderate	Negligible	Imperceptible
Construction of the Proposed 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.	Medium	Moderate Adverse	Moderate	Negligible	Imperceptible
Construction of Internal Cabling.	Removal of overburden material and exposure of underlying subsoil and bedrock to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill and concrete products. Disposal of surplus excavated material to licenced facility.	Localised organic soils, Glacial Till deposits and bedrock. Local quarries. Licenced Waste Facilities.	Medium	Small Adverse	Slight	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Prior to Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction of cabling for the Proposed Substation.	Removal of overburden material and exposure of underlying subsoil and bedrock to erosion. Importation of engineering fill and concrete products. Disposal of surplus excavated material to licenced facility.	Localised organic soils Glaciofluvial deposits, Glacial Till deposits and bedrock. Local quarries. Licenced Waste Facilities.	Medium	Small Adverse	Slight	Negligible	Imperceptible
Operational Phase							
Construction traffic for maintenance of turbines, hardstands and access tracks. Operation of the Proposed Substation and turbines.	Release of hydrocarbons or fuel spill.	Localised organic soils, Glacial Till deposits and bedrock.	Medium	Small Adverse	Slight	Negligible	Imperceptible
Maintenance of access tracks.	Importation of engineering fill.	Local quarries	Medium	Small Adverse	Slight	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Prior to Mitigation	
				Magnitude	Significance	Magnitude	Significance
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, Glacial Till deposits and bedrock.	Medium	Small Adverse	Slight	Negligible	Imperceptible
Cumulative Impacts							
Large-scale development within 20km of the Proposed Development Site occurring concurrently with construction of the Proposed Development/AGCR/TDR.	Cumulative impacts on local quarries from extraction of fill for Proposed Project.	Local quarries	Medium	Small Adverse	Slight	-	-
Vegetation Clearance	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.	Medium	Small Adverse	Slight	-	-

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Prior to Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction of Alternative Grid Connection Route (AGCR)	Removal of overburden material and exposure of underlying subsoil and bedrock to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill and concrete products. Disposal of surplus excavated material to licenced facility.	Localised organic soils, Glacial Till deposits and bedrock. Local quarries Licenced Waste Facilities	Medium	Small Adverse	Slight	-	-
Accommodation works along TDR	Removal of overburden material and exposure of underlying subsoil and bedrock to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill. Disposal of surplus excavated material to licenced facility.	Subsoils. Bedrock. Local quarries. Licenced waste facilities.	Medium	Small Adverse	Slight	-	-
HDD at crossing points	Overburden collapse due to advancement of HDD bore.	Glacial Till deposits. Bedrock.	Medium	Small Adverse	Slight	-	-

Table 6-20: Residual Impact Significance for Sensitive Hydrogeological Attributes

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Prior to Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction Phase							
Earthworks associated with the construction of the proposed turbines and associated infrastructure	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	Small Adverse	Slight	Negligible	Imperceptible
Earthworks associated with the construction of the proposed turbines and associated infrastructure	Slope Failure	Locally Important Bedrock Aquifer. Groundwater Wells and Springs.	Medium	Small Adverse	Slight	Negligible	Imperceptible

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

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Prior to Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction of the Proposed 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	Small Adverse	Slight	Negligible	Imperceptible
Construction of Turbine Foundations.	Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during construction phase earthworks. Potential for ground water pollution from the use of cement-based compounds during the construction phase. Reduction in groundwater levels from dewatering of excavation as required during the construction phase.	Locally Important Bedrock Aquifer. Groundwater Wells and Springs	Medium	Small Adverse	Slight	Negligible	Imperceptible

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

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Prior to Mitigation	
				Magnitude	Significance	Magnitude	Significance
Operational Phase							
Operational traffic, refuelling of vehicles	Some operational traffic will be necessary for maintenance plus normal operational traffic which could result in minor accidental leaks or spills of fuel/oil.	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Small Adverse	Slight	Negligible	Imperceptible
Decommissioning Phase							
Removal of Turbines and Hardstands	Potential for groundwater pollution from the disturbance of overburden deposits Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer Potential for contamination to groundwater from spills/leakages during decommissioning phase earthworks.	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Small Adverse	Slight	Negligible	Imperceptible
Cumulative Impacts							
Large-scale developments within 20km of the Proposed Development Site occurring concurrently with construction of the Proposed Development/AGCR/TDR.	Potential for groundwater pollution from runoff from Proposed Wind Farm	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Negligible	Imperceptible	-	-

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Prior to Mitigation	
				Magnitude	Significance	Magnitude	Significance
Vegetation Clearance	Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer Potential for contamination to groundwater from spills/leakages from felling machinery	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Small Adverse	Slight	-	-
Construction of the Alternative Grid Connection Route (AGCR)	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	-	-
Enabling TDR Works	Removal of overburden material and exposure of underlying subsoil and bedrock to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill Disposal of surplus excavated material to licenced facility	Locally Important Bedrock Aquifers Groundwater Wells and Springs.	Medium	Small Adverse	Slight	-	-

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Prior to Mitigation	
				Magnitude	Significance	Magnitude	Significance
HDD at crossing points	Potential for ground water pollution from boring activities. Potential for contamination to groundwater from spills/leakages during construction phase drilling operations.	Locally Important Bedrock Aquifer Groundwater Wells and Springs	Medium	Small Adverse	Slight	-	-

6.8 Conclusions

The assessment of Soil, Geology and Hydrogeology 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 soil, geology and hydrogeology, and poses a low risk for landslide.

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

Findings from the site walkover surveys indicates no visual evidence of historic or contemporary landslides or ground instability at or adjacent to the proposed infrastructure locations. No peat or organic soils were encountered.

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

With mitigation measures, outlined in Section 6.6, put in place during construction, operational and decommissioning stage the Proposed Development will have imperceptible significance on the soils, geology and hydrogeology.

6.9 References

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