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PEAT STABILITY RISK ASSESSMENT
For
Tullaghmore Windfarm, Co. Galway

Consultants:
Jennings O'Donovan & Partners Ltd

Author: Andrew Garne PGeo, BSc, MSc, MIGI

Revision 3

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1. Introduction

Garne Geotechnical Services, working in partnership with EcoQuest Environmental, were engaged by Jennings O'Donovan and Partners Limited, Consulting Engineers, to undertake a Peat Stability Risk Assessment (PSRA), for a proposed wind farm located at Tullaghmore, mid County Galway. This chapter describes the pre-existing land, soils and geology and the results of the site reconnaissance surveys along with other data considered relevant to the current and future stability of the proposed development site.

1.1. Statement of Authority

All fieldwork and reporting for this PSRA was undertaken by Andrew Garne B.Sc., M.Sc., P.Geo. Andrew is an independent engineering geologist who specialises in geological, geotechnical and hydrogeological impact assessments. He is a Full Member of the Institute of Geologists of Ireland (IGI) and is a Registered Professional Geologist (P.Geo). He has over 30 years of professional experience including over 20 years in Ireland and has worked as a geotechnical consultant on many geological, hydrogeological and environmental projects including numerous wind farms, road projects, landfills, quarries, water schemes and other infrastructure projects. He has extensive experience in undertaking land, soils and geology assessments for Environmental Impact Assessments along with PSRA's for numerous sites including several proposed upland wind farm sites in Ireland.

1.2. Scope of Assessment

The scope and objectives of this assessment undertaken includes the following:

- Prepare a baseline desk-based study of the land, soils and geology conditions of the existing environment surrounding the proposed development site based on a desk study analysis and site investigations.
- Undertake a programme of fieldwork surveys which includes extensive peat probes, hand shear vane tests, peat gouge cores, slope measurements, drainage and geomorphological observations.
- Undertake a Peat Stability Risk Assessment (PSRA) for the infrastructure on the site (turbine bases, hardstands, access tracks, substation), based on the results of the fieldwork and desk-based surveys.

1.3. Methodology

An investigation of the existing land, soils and geology characteristics of the study area was conducted by undertaking a desk study, consultation with relevant authorities and site-based fieldwork surveys. All data collected has been interpreted to establish the baseline conditions within the study area and the significance of potential adverse effects have been assessed. These elements are discussed in detail in the following sections.

1.4. Applicable Legislation

The PSRA is prepared in accordance with the requirements of European Union Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (the 'EIA Directive') as amended by Directive 2014/52/EU.

1.5. Relevant Guidelines

This PSRA has been prepared with cognisance to the following guidelines:

- Department of Housing, Planning and Local Government – Draft Revised Wind Energy Guidelines, 2019;
- Environmental Protection Agency – Guidelines on the Information to be Contained in Environmental Impact Assessment Reports, 2022;

- Institute of Geologists Ireland – Guidelines for Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements, 2013;
- National Roads Authority (2005): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.
- Peat Landslide Hazard and Risk Assessments. Best Practice Guide for Proposed Electricity Generation Developments. Second Edition, April 2017. Scottish Government.

2. Desk Study

A desk-based study consisting of a review of all available datasets, information, and literature resources relevant to the site was initially undertaken in August and September 2020 and updated in September 2022. The most current datasets and information maintained by the Environment Protection Agency (EPA) and Geological Survey of Ireland (GSI) were reviewed to assist in establishing the land, soil and geological characterisation of the site.

Relevant documents and datasets used to assist in compiling the desk study included EPA land and soils data, topography maps and GSI geological data. The following full list of sources and information were utilised to establish the baseline environment:

- EPA Map Viewer, Land, Soil and Geology features
<https://gis.epa.ie/EPAMaps/Land & Soil>
- Geological Survey of Ireland – 1:25,000 Field Mapping Sheets
- General Soil Map of Ireland 2nd edition
<https://data.gov.ie/dataset/8414396c-93b0-4cb4-b4d5-60776878a54c/resource/bd48edcd-7cdd-4241-b3bb-2a988fcb096f>
- Ordnance Survey Ireland, Map Viewer
<http://map.geohive.ie/mapviewer.html>
- National Parks and Wildlife Service (NPWS), Protected Sites Map-Viewer
<https://www.npws.ie/protected-sites>
- The Geological Survey of Ireland (GSI), public data viewer
<https://dcnr.maps.arcgis.com/apps/MapSeries>
- Myplan.ie; National Planning Application Map Viewer
<https://myplan.ie/national-planning-application-map-viewer>
- Met Éireann Meteorological Data
<https://www.met.ie/climate/available-data/historical-data>
- Department of Housing, Planning and Local Government, EIA Portal
<https://www.housing.gov.ie/planning/environmental-assessment/environmental-impact-assessment-eia/eia-portal>

2.1. Existing Environment

The proposed windfarm development site is located near the townland of Tullaghmore, approximately 9 kilometres west of Oughterard in County Galway. The site is located across approximately 583 acres (236 hectares) of land which is predominantly Atlantic blanket bog and mountain blanket bog (>200m in altitude) situated to the west of the Derroua Forest which is managed by Coillte. The site also includes an Ecological Enhancement Area, located on flat bogland at Maam Cross.

To the south of the site is the N59 Road, Lough Boffin and the Connemara Bog Complex Special Area of Conservation (SAC). North of the site there are additional areas of blanket bog, forestry, Curraun Lough, the Western Way long-distance walking trail and the Lough Corrib SAC. To the west/southwest of the site flows the Owenwee River, Loughaunierin and Tawnaghbeg Lough.

The topography of the site is such that it is broadly surrounded by or is partially overlapping three elevated areas. These include Knockbrack to the east of the site (299m) near Lough Beg in the Derroua Forest and Capanalaurabaun (273m) at the northern extent of the site. Further north beyond the site boundary is Curraun Hill at 252m. Across the remainder of the site, elevations typically range from between 100m and 200m.

2.2. Superficial Geology

The desk study on soils includes a detailed review of published literature and datasets on soils, subsoils and minerals pertaining to the site. From information obtained from the Geological Survey of Ireland (GSI) and Environmental Protection Agency (EPA) websites, the following soils are understood to exist on the site.

- Blanket peat covers the majority of the site to variable depths (based on the GSI Quaternary and Groundwater Vulnerability mapping). The peat is absent from some of the upland (northern) areas of the site and parts of the lowland (southern) parts of the site in addition to parts of the grid connection route to Screebe.
- Glacial till derived from the underlying granite bedrock and covering approximately 5% or less of the main site area and minor parts of the grid connection route.
- Approximately 20% or less of the main site and less than 5% of the grid connection route has shallow/exposed bedrock and hence has no superficial geology cover.

An overview of the bedrock geology for the main site is shown in Figure 1. An overview of the quaternary geology for the main site is shown in Figure 2.

2.3. Bedrock Geology

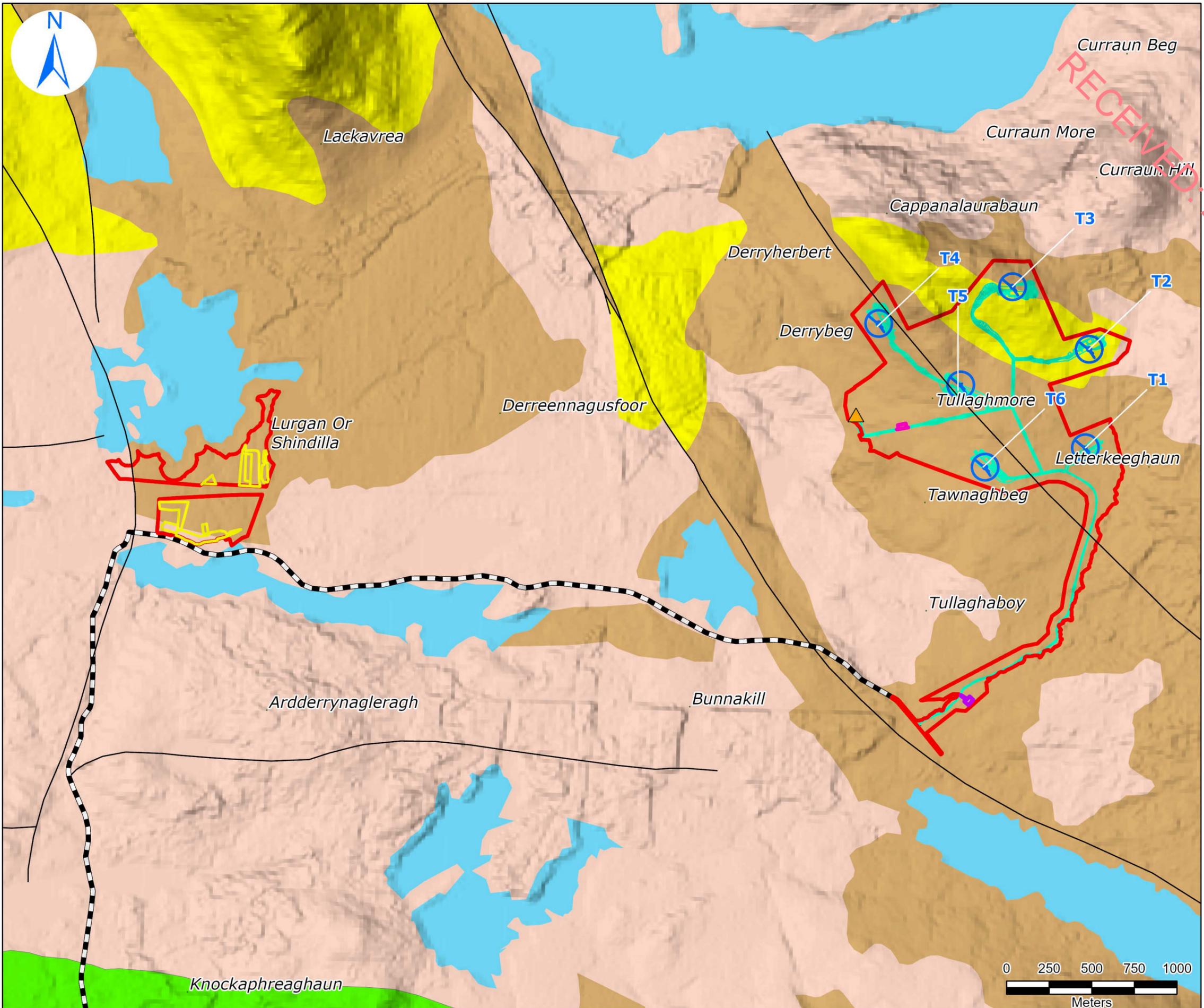
The GSI maps and website for this area shows that the majority of the site is underlain by Ordovician age igneous and metamorphic rocks as shown in Figure 1. It should be noted that some outcrops of bedrock are present throughout the site, particularly within the upland (northern) parts of the site.

The majority of the main site is underlain by the Oughterard Granite formation which consists of two main bodies, the Oughterard mass in the east and the Tullaghmore mass in the west, which are linked by a narrow granite strip. The granite is non-porphyrific and medium to coarse grained, with pink or white K-feldspar but also includes areas of granodiorite, tonalite and dacite. The northern part of the main site (between T2 and T3) is mainly underlain by the Bennabeola Quartzite Formation which comprises Proterozoic age pale quartzite (Argyl Group). A small part of the northeast corner of the site is underlain by Proterozoic age Streamstown Schist Formation which comprises psammitic pelitic and semi-pelitic schists (Argyl Group).

Structurally, the Site is crossed by a northwest-southeast trending fault which runs close to the proposed locations of turbines T4 and T5. This fault is not however expected to impact on any infrastructure locations. An anticlinal fold axis trends east-west across the northern part of the Site which is also not considered significant. Due to the tectonic history of Ireland, these features are common throughout the country and particularly along the west coast.

2.4. Landslide Susceptibility

The Geological Survey of Ireland (GSI) maintains a database of known landslides in Ireland. The database records no landslides on or adjacent to the site. The nearest recorded landslides are shown approximately 7km west of the site where five landslides are recorded to the northwest of Maam Cross as shown in Figure 3. The landslides are of unknown type but are recorded as having bedrock within 1m of the surface.



Legend

- Faults (500k)
- Redline Boundaries
- Turbine Locations
- ▲ Met Mast
- Hardstand and Roads
- Spoil Storage Areas
- Sub Station Location
- Temporary Construction Compound
- Grid Connection Route
- Lakes

Bedrock Geology

- Argyll Group; Quartzite
- Argyll Group; Psammitic & pelitic schist, marble, amphibolite, diamictite
- Orthogneiss suite, mainly quartz diorite (Connemara)
- Granodiorite, tonalite, dacite, granite



Client: Jennings O'Donovan & Partners	
Project: Tullaghmore Windfarm	
Map Title: Bedrock Geology (500K)	
Spatial Reference Name: IREN95 Irish Transverse Mercator	Page Size: A3
Figure No. 1	Scale: 1:22,000
Date: 24/8/2022	Prepared By: DP
Revision Number: 3	Checked By: AG
Tel: +353 (91) 897 583	
Email: info@ecoquest.ie	
Web: www.ecoquest.ie	



Legend

- Redline Boundaries
- ▲ Met Mast
- Turbine Locations
- Temporary Construction Compound
- Sub Station Location
- Spoil Storage Areas
- Hardstand and Roads
- Grid Connection Route

Subsoil Susceptibility

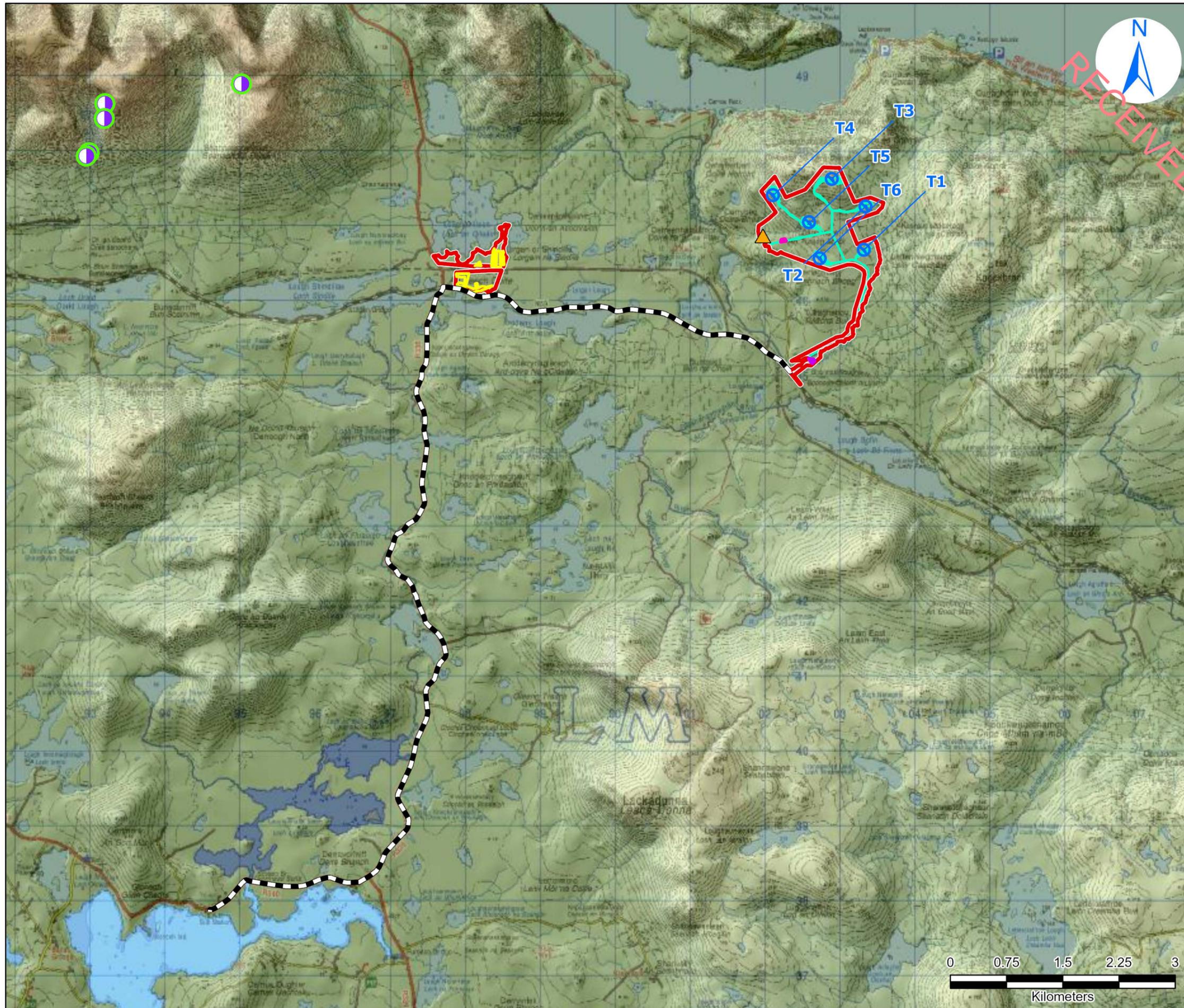
- Blanket peat
- Bedrock at or near surface-Non calcareous
- Granite till
- Metamorphic till
- Lakes



Client: Jennings O'Donovan & Partners	
Project: Tullaghmore Windfarm	
Map Title: Quaternary Geology (Subsoil Susceptibility)	
Spatial Reference Name: IRENET95 Irish Transverse Mercator	Page Size: A3
Figure No. 2	Scale: 1:22,000
Date: 17/8/2022	Prepared By: DP
Revision Number: 3	Checked By: AG
Tel: +353 (91) 897 583	
Email: info@ecoquest.ie	
Web: www.ecoquest.ie	



Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Esri, HERE, Garmin, USGS, NGA Contains Irish Public Sector Data (Geological Survey Ireland) licensed under a Creative Commons Attribution 4.0 International (CC BY 4.0) licence. EMPower and Jennings O'Donovan & Partners, Andrew Carna Geotechnical Services and EcoQuest Environmental



Legend

- Previously Recorded Landslide Events
- Met Mast
- Turbine Locations
- Temporary Construction Compound
- Sub Station Location
- Spoil Storage Areas
- Redline Boundaries
- Hardstand and Roads
- Grid Connection Route

Extent Map



Client: Jennings O'Donovan & Partners	
Project: Tullaghmore Windfarm	
Map Title: Previously Recorded Landslide Events	
Spatial Reference Name: IREN95 Irish Transverse Mercator	Page Size: A3
Figure No. 3	Scale: 1:50,000
Date: 24/8/2022	Prepared By: DP
Revision Number: 3	Checked By: AG
Tel: +353 (91) 897 583	
Email: info@ecoquest.ie	
Web: www.ecoquest.ie	

Credits: EPA, OSI, Esri, HERE, Garmin, FAO, USGS, NGA
 Contains Irish Public Sector Data (Geological Survey Ireland) licensed under a Creative Commons Attribution 4.0 International (CC BY 4.0) licence.
 EMPower and Jennings O'Donovan & Partners, Andrew Garne Geotechnical Services and EcoQuest Environmental

The GSI also maintains a Landslide Susceptibility Map for Ireland. Although some statistical approaches were also explored, the literature research and the requirement for a methodology that could be applied to Ireland as a whole coupled with the uncertainty as to how many additional landslides would be found by extending the inventory lead to a methodology known as the Unique Condition Unit (UCU) approach. As the name suggests, UCUs are parcels of terrain where a set of attributes are combined in a unique way. In the context of landslide susceptibility mapping, the attributes being considered are slope, soil type and an index which is a measure of overland flow concentration from intense rainfall events. The latter parameter has been called the Topographic Flow Index (TFI). As shown in Figure 4, the landslide susceptibility for the site has been categorised by the GSI as Low to High.

2.5. Rainfall

The Met Éireann website was consulted for long-term rainfall averages for the site. The nearest long-term weather station is located at Mace Head. Average Rainfall for 1971-2000 was 1340mm per year. It is likely that the site has a similar average rainfall to this station.

2.6. Desk Study Summary

The soils present on the site comprise predominantly blanket peat overlying granite or quartzite bedrock at generally shallow depths. Due to the presence of peat on the site, it is considered that the potential for a landslide hazard exists at the proposed site in accordance with the Scottish Executive Guidelines.

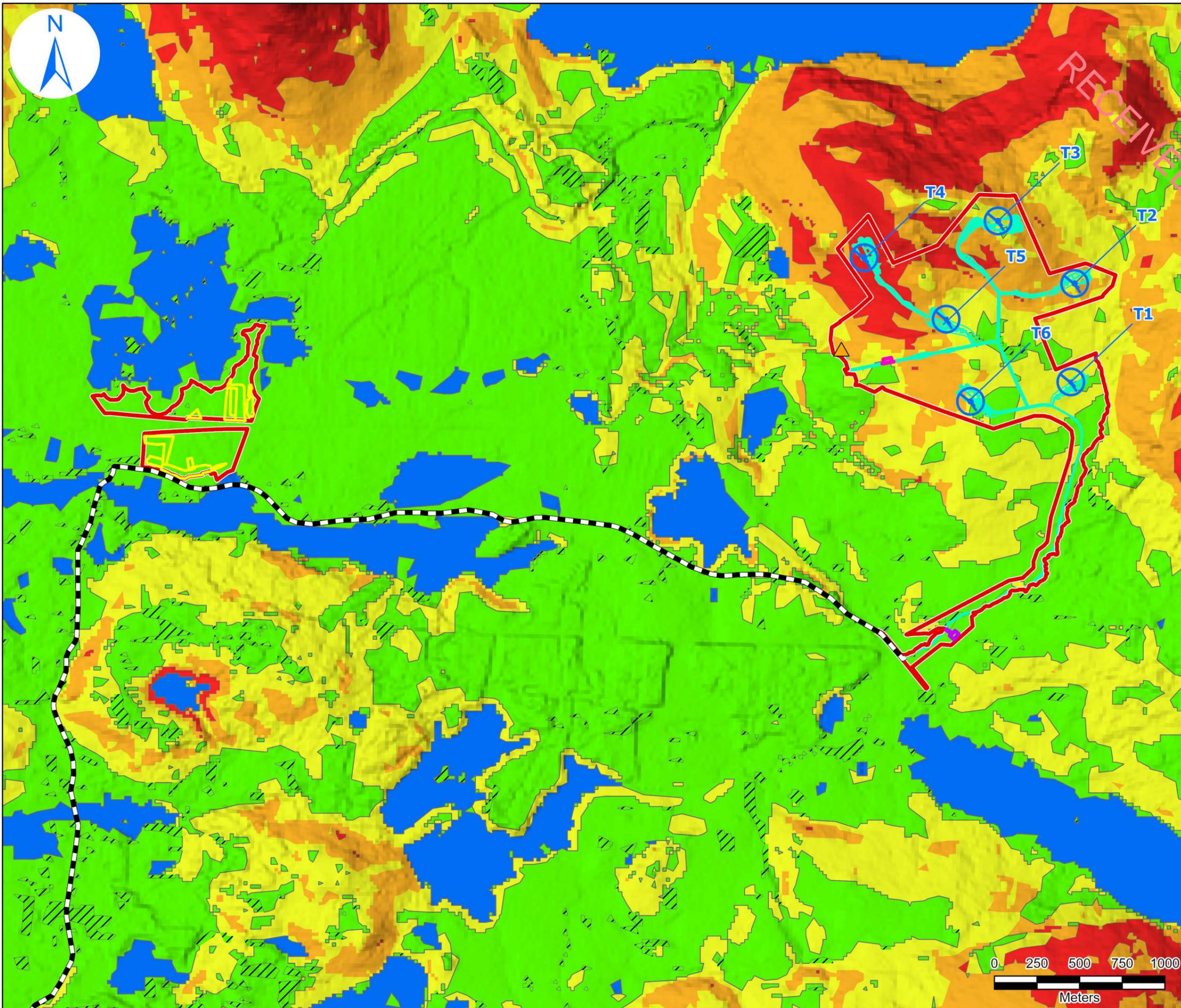
An initial step in the assessment of pre-existing landslide risk is the determination of landslide history in the area. The GSI Irish landslides database as consulted on 2nd November 2021. The GSI online database shows no recorded landslides within or near the site. The nearest recorded landslides are shown approximately 7km west of the main site where five landslides are recorded 4 to 5km northwest of Maam Cross as shown in Figure 3. The landslides are of unknown type but are recorded as having bedrock within 1m of the surface. Aerial photographs of the site and surrounding area also show no evidence of historic landslides.

3. Field Surveys

A field investigation to inform the baseline geological conditions of the site was undertaken by Andrew Garne B.Sc, M.Sc., P.Geo of Garne Geotechnical Services initially between 31st August to 3rd September 2020. Additional walkover surveys were made on 13th and 14th October 2020, 4th and 5th March 2021, 5th and 6th October 2021, 19th November 2021, 25th and 26th January 2022 and 18th August 2022, following layout design changes. The field investigations consisted of the following:

- A walkover survey of the site to identify and record geological features was undertaken to identify rock outcrops, topography/slopes, areas of unstable ground and surface water features.
- Peat probes, hand vanes and gouge cores were undertaken at, and adjacent to, the turbine locations, hardstands, access tracks and substation, to determine peat depths, peat composition, slope angles and peat shear strengths across the site.
- Laboratory testing of peat samples for moisture content and organic carbon content.

Upon completion of the field surveys, the data collected was reviewed and imported into ArcGIS Pro software for further analysis. The field data collected was overlain against the publicly available datasets listed in section 2 such as those from the EPA, GSI and OSI. The results of the field investigations are presented in Appendix 1.



Legend

- Redline Boundaries
- ▲ Met Mast
- Turbine Locations
- Temporary Construction Compound
- Sub Station Location
- Spoil Storage Areas
- Hardstand and Roads
- - - Grid Connection Route

Landslide Susceptibility Classification

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



Client: Jennings O'Donovan & Partners	
Project: Tullaghmore Windfarm	
Map Title: Geological Survey of Ireland (GSI) Landslide Susceptibility Mapping With Hillshade.	
Spatial Reference Name: IREN95 Irish Transverse Mercator	Page Size: A3
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