GALETECH
ENERGY SERVICES

Cush Wind Farm Phase II

Environmental Impact Assessment Report

Chapter 6: Land, Soils & Geology

Cush Wind Limited

www.galetechenergyservices.com

Contents

6.1 introduction 1

6.1.1 Background and Objectives 1
6.1.2 Description of the Project 1
6.1.3 Statement of Authority 1
6.1.4 Relevant legislation 2
6.1.5 Relevant Guidance 3

6.2 Methodology 3

6.2.1 Desk Study 3
6.2.2 Baseline monitoring & Site investigations 4
6.2.3 Receptor Importance/Sensitivity Criteria 4
6.2.4 Scoping and Consultation 7
6.2.5 Limitations and Difficulties Encountered 8

6.3 Description of the existing environment 8

6.3.1 Site Location and Description 8
6.3.2 Land & Land Use 9
6.3.3 Superficial Geology 9
6.3.4 Bedrock Geology 12
6.3.5 Peat Stability Analysis Introduction 13
6.3.6 Peat Stability Results 15
6.3.7 Geological Resource Importance 16
6.3.8 Geological Heritage & Designated Sites 17

6.4 Assessment of Likely Effects 18

6.4.1 Characteristics of the Project 18
6.4.2 'Do-Nothing' Impact 20
6.4.3 Construction Phase 20
6.4.4 Operation Phase 24
6.4.5 Decommissioning Phase 24
6.4.6 Assessment of Cumulative Effects 24
6.4.7 Assessment of Likely Health Effects 25
6.4.8 Risk of Major Accidents and Disasters 26

6.5 Mitigation and Monitoring 26

6.5.1 Construction Phase 26
6.5.2 Operation Phase 29
6.5.3 Decommissioning Phase 29
6.5.4 Monitoring Measures 30

6.6 Residual Effects 30

6.6.1 Construction Phase 30
6.6.2 Operation Phase 31
6.6.3 Decommissioning Phase 31

6.7 Summary 31
6.8 References 32

6.1 INTRODUCTION

6.1.1 BACKGROUND AND OBJECTIVES

This chapter provides a baseline assessment of the environmental setting of the project in terms of land, soils and geology and identifies any likely or significant effects (if any) that the construction, operation and decommissioning of the project will have on them, including an assessment of cumulative effects with other existing, permitted and proposed developments.

Where required, appropriate mitigation measures to limit, reduce or avoid any identified likely or significant adverse effects on land, soils and geology are recommended.

6.1.2 DESCRIPTION OF THE PROJECT

The project site is located in rural Co. Offaly, approximately 4km north of the town of Birr and c. 28km south-west of Tullamore, Co. Offaly.

The project assessed within this EIAR comprises a 3 no. wind turbine extension to the permitted Cush Wind Farm Phase I, together with all associated and ancillary infrastructure and works. This includes turbine foundations, crane hardstanding areas, access tracks, internal wind farm underground cabling, site drainage and rehabilitation works, peat/spoil management, a proposed electrical switch room building, and a c.5km underground electricity line required to facilitate connection of the proposed wind farm to the national electricity network.

The final turbine model has not yet been selected and will be selected within the turbine dimension range assessed in this EIAR, as set out in **Chapter 1**. For the purposes of this chapter, the assessment is based on the maximum assumed physical footprint identified for **Chapter 6** in **Table 1.6** of **Chapter 1**.

The turbine component haul route and associated temporary and permanent upgrade works as described in **Chapter 3**, are located within Counties Galway, Roscommon, Westmeath and Offaly. It is envisaged that turbine components will be transported from the Port of Galway to the project site via the N6, M6, N52 and N62, before accessing the project site from the permitted construction phase site entrance from the N62 national road.

Given the limited and localised nature of the turbine haul-route accommodation works, any effects on land, soils and geology are assessed as negligible and not significant. The works are nevertheless considered, where relevant, in the construction-phase assessment below.

A full description of the project is presented in **Chapter 3**.

6.1.3 STATEMENT OF AUTHORITY

Hydro-Environmental Services (HES) are a specialist geological, hydrological, hydrogeological and environmental practice which delivers a range of geological/water and environmental management consultancy services to the private and public sectors across Ireland and Northern Ireland. HES was established in 2005, and our office is located in Dungarvan, County Waterford.

Our core areas of expertise and experience include water and geology. We routinely complete impact assessments for land soils and geology, hydrology and hydrogeology for a large variety of project types, including wind farms and associated

grid connections.

This chapter was prepared by Michael Gill and David Broderick.

Michael Gill (P. Geo., B.A.I., MSc, Dip. Geol., MIEI) is an Environmental Engineer with over 24 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms in Ireland. He has also managed EIAR assessments for infrastructure projects and private residential and commercial developments. In addition, he has substantial experience in wastewater engineering and site suitability assessments, contaminated land investigation and assessment, wetland hydrology /hydrogeology, water resource assessments, surface water drainage design and SUDs design, and surface water/groundwater interactions. For example, Michael has worked on the EIS/EIAR for Seven Hills WF, Cloncreen WF, and Derrinlough WF, and over 100 other wind farm-related projects.

David Broderick (P.Geo, BSc, H. Dip Env Eng, MSc.) is a hydrogeologist with over 19 years' experience in both the public and private sectors. Having spent two years working in the Geological Survey of Ireland, working mainly on groundwater and source protection studies, David moved into the private sector. David has a strong background in groundwater resource assessment and hydrogeological/hydrological investigations in relation to developments such as quarries and wind farms. David has also completed numerous geology and water assessments for inclusion within EIARs for a range of commercial developments. David has worked on the EIS/EIAR for Cush Wind Farm Phase I, Drumlins Park WF, White Hill WF, Bracklyn WF, Pinewoods WF and Yellow River WF, and over 80 other wind farm related projects across the country.

6.1.4 RELEVANT LEGISLATION

This chapter has been 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.

Regard has also been had to the requirements of the following legislation:

- S.I. No. 349/1989: European Communities (Environmental Impact Assessment) Regulations, and subsequent Amendments (S.I. No. 84/1995, S.I. No. 352/1998, S.I. No. 93/1999, S.I. No. 450/2000 and S.I. No. 538/2001), S.I. No. 30/2000, the Planning and Development Act, and S.I. 600/2001 Planning and Development Regulations and subsequent Amendments. These instruments implement EU Directive 85/337/EEC and subsequent amendments, on the assessment of the effects of certain public and private projects on the environment;
- Directives 2011/92/EU and 2014/52/EU on the assessment of the effects of certain public and private projects on the environment, including Circular Letter PL 1/2017: Implementation of Directive 2014/52/EU on the effects of certain public and private projects on the environment ('the EIA Directive');
- Planning and Development Act 2000, as amended (the '2000 Planning Act'); and,
- S.I. No 296/2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 which transposes the provisions of Directive 2014/52/EU into Irish law.

6.1.5 RELEVANT GUIDANCE

This chapter has been prepared having regard, where relevant, to the guidance contained in the following documents:

- *Guidance Document on Wind Energy Developments and EU Nature Legislation* (European Commission, 2020);
- Environmental Protection Agency (2022) *Guidelines on the Information to be Contained in Environmental Impact Assessment Reports*;
- Institute of Geologists Ireland (2013) *Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements*;
- National Roads Authority (2008) *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*;
- Department of the Environment, Heritage, and Local Government (2006) *Wind Energy Development Guidelines for Planning Authorities 2006*;
- Forestry Commission (2004) *Forests and Water Guidelines, Fourth Edition*. Publ. Forestry Commission, Edinburgh;
- COFORD (2004) Forest Road Manual – *Guidelines for the Design, Construction and Management of Forest Roads*;
- Department of Housing, Planning & Local Government (2018) *Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment*;
- European Union (2017) *Guidance on the preparation of the EIA Report* (Directive 2011/92/EU as amended by 2014/52/EU); and
- Institute of Environmental Management (IEMA) (2022) *A New Perspective on Land and Soil in Environmental Impact Assessment*.

6.2 METHODOLOGY

6.2.1 DESK STUDY

A desk study of the project site and study area (described in **Section 6.2.6** below) was completed in advance of undertaking the walkover survey, visual assessments and site investigations. This involved collecting all relevant land, soil and geological information for the overall project area. Data sources included:

- Environmental Protection Agency databases (www.epa.ie);
- Geological Survey of Ireland – Groundwater and Geological Database (www.gsi.ie);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 15 (Geology of Galway - Offaly). Geological Survey of Ireland (GSI, 1999);
- Geological Survey of Ireland – 1:25,000 Field Mapping Sheets;
- Ordnance Survey Ireland (OSI) – 6" and 1:5,000 scale basemaps; and,
- Aerial photography (www.bing.com/maps; www.google.com/maps).

6.2.2 BASELINE MONITORING & SITE INVESTIGATIONS

Site walkovers, geological mapping and site investigations, including soil probing and trial pitting, were previously undertaken by HES on 21 October 2022, 5 December 2022, 23 and 25 January 2023 and 26 March 2023 in respect of the permitted Cush Wind Farm Phase I development.

The information obtained from these investigations has been reviewed and, where relevant, used to inform the baseline understanding of ground conditions within and surrounding the project site. Existing trial pit logs relevant to the project site are attached as **Annex 6.3**.

Additional site walkovers, site investigations and baseline monitoring were carried out on 12 November 2025 and 23 January, 18 June & 13 August 2026.

A Peat Stability Assessment, prepared by Fehily Timoney & Company, has been used to inform the assessment contained within this chapter and is provided at **Annex 6.1**.

A Planning-Stage Peat and Spoil Management Plan has also been prepared and is provided at **Annex 3.4**. This sets out the proposed approach to the handling, management and monitoring of material excavated during the construction phase of the project.

In summary, the site investigations and baseline information used to inform this assessment comprise:

- Detailed site walkovers and visual inspections to assess ground conditions;
- Land and drainage surveys;
- Trial pit investigations undertaken in December 2022 in respect of the permitted Cush Wind Farm Phase I development, comprising 7 no. trial pits;
- 25 no. peat probe locations, together with slope angle measurements, undertaken by FT in March 2026 as part of the Peat Stability Assessment;
- Logging and mapping of peat and subsoil exposures; and
- Logging of mineral subsoils in accordance with BS 5930.

6.2.3 RECEPTOR IMPORTANCE/SENSITIVITY CRITERIA

In addition to the utilisation of sensitivity and receptor importance criteria outlined within the above-mentioned EPA Guidance (EPA, 2022), this assessment, in accordance with National Roads Authority (NRA, 2008) guidance, quantifies the importance of the land, soil and geology environments at the project site by applying the criteria set out in **Table 6.1**, with the impact magnitude and impact rating subsequently assessed using **Table 6.2** and **Table 6.3**.

Importance	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 route is significant on a national or regional scale.	• Geological feature rare on a regional or national scale (NHA/SAC). • Large existing quarry or pit. • Proven economically extractable mineral resource.
High	• Attribute has a high quality, significance or value on a local scale. • Degree or extent of soil contamination is significant on a local scale. • Volume of peat and/or soft organic soil underlying site is significant on a local scale.	• Contaminated soil on site with previous heavy industrial usage. • Large recent landfill site for mixed wastes. • Geological feature of high value on a local scale (County Geological Site). • Well drained and/or high fertility soils. • Moderately sized existing quarry or pit. • Marginally economic extractable mineral resource.
Medium	• Attribute has a medium quality, significance or value on a local scale. • Degree or extent of soil contamination is moderate on a local scale. • Volume of peat and/or soft organic soil underlying 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 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. • Uneconomically extractable mineral resource.

Table 6.1. Estimation of Importance of Soil and Geology Criteria (NRA, 2008)

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

Table 6.2: Estimation of Magnitude of Impact (NRA, 2008)

	Magnitude of Impact			
Importance of Attribute	Negligible	Small Adverse	Moderate Adverse	Large Adverse
Extremely High	Imperceptible	Significant	Profound	Profound
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

Table 6.3: Estimation of Rating of Impact (NRA, 2008)

6.2.4 SCOPING AND CONSULTATION

The scope for this assessment has been informed by consultation with statutory consultees and other bodies with environmental responsibility.

This consultation process is outlined in **Chapter 1** of this EIAR. Matters raised and recommendations highlighted by the responses in relation to land, soils and geology are summarised in **Table 6.4** below. The full response from each of the below consultees are provided in **Annex 1.7**.

Consultee	Summary of Response	Addressed
Geological Survey of Ireland (GSI)	*"Our records show that there is a CGS adjacent and partially within the proposed wind farm development site boundary. Kilcormac Esker, Co. Offaly (GR 215100, 213236), under IGH theme: IGH 7 Quaternary.* *With the current plan, there may be potential impacts on the integrity of current CGS envisaged by the proposed development, should this site not be assessed as a constraint. Ideally, the site should not be damaged or integrity impacted or reduced in any manner due to any proposed construction and/or modification of access roads, from traffic due to access road construction and grid connection works and installation. This would include impacts that may be related to altered drainage patterns, changes in soil profiles and structures etc. However, this is not always possible, and in this situation appropriate mitigation measures should be put in place to minimize or mitigate potential impacts".*	Sections 6.3.8, 6.4.3.6, 6.5.1.6 & 6.6.1.
National Office of Environmental Health Services (EHS)	*"A detailed assessment of the current ground stability of the site for the proposed windfarm development and all proposed mitigation measures should be detailed in the EIAR. The assessment should include the impact construction work may have on the future stability of ground conditions, taking into consideration extreme weather events, site drainage and the potential for soil erosion. Information should be provided on the make and model of the turbines and on construction details for the turbine foundations, including the depth and volume of concrete required. An accurate assessment of the potential impacts of the foundations on water quality and peat stability cannot be undertaken without this information. Reference is made to a peat slide which occurred near Ballybofey in Co. Donegal on 13th November 2020 which may have been linked to construction activity at Meenbog Wind Farm. Potential impacts on water supply associated with contamination following a peat slide include sedimentation and alteration of pH levels. The NEHS recommends that a detailed Peat Stability/Geotechnical Assessment should be undertaken to assess the suitability of the soil for the proposed development. The EIAR should include provision for a peat stability monitoring programme to identify early signs of*	Sections 6.3.3.2, 6.3.3.3, 6.3.5, 6.3.6, 6.4.3.5, 6.5.1.5 & 6.6.1. **Annex 3.4 and 6.1**

	potential bog slides ('pre-failure indicators' see the Scottish Government's 'Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Developments 2017)"	

Table 6.4: Summary of Land, Soils and Geology Scoping Responses

6.2.5 LIMITATIONS AND DIFFICULTIES ENCOUNTERED

No material limitations affecting the assessment were encountered. The investigation methodology was adapted at T9–T11, where gouge coring and peat probing were undertaken in place of trial pitting. The information obtained was supplemented by nearby trial pit data from the permitted Cush Wind Farm Phase I which provided an appropriate basis for the assessment.

6.2.6 PROJECT STUDY AREA

The project study area with regard to Land, Soils and Geology is within at least 2km of the project site as per IGI (2013) guidance. However, only direct effects on land, soils and geology within the project site are expected with regard to the project works (i.e. no indirect effects/off-site effects).

6.3 DESCRIPTION OF THE EXISTING ENVIRONMENT

6.3.1 SITE LOCATION AND DESCRIPTION

The project site is located c. 4km north of Birr, Co. Offaly. The project site incorporates both the proposed wind farm and proposed underground electricity line. The wind farm site has an area of c. 87ha. The permanent above-ground infrastructure footprint within the wind farm site, including the switch room, is approximately 2.33ha.

Temporary working areas associated with the underground electricity line will be reinstated following construction.

The proposed wind farm is located on the western portion of the project site where the setting is primarily cutaway bog. The 3 no. proposed turbine locations (T9, T10 and T11) are located on a Bord na Mona (BnM) bog which is named 'Galros Bog'. Much of Galros Bog is now cutaway and the majority of the original raised bog has now been removed. The bog surface is extensively drained by a north – south trending drain network.

Galros Bog is bordered on its western side by the N62 road between Cloghan and Birr. The bog is situated in a small topographical basin surrounded by esker ridges along the northern and western and south-western sides. Conifer plantation has been developed on cutover bog adjacent to the south side of the bog. The West Galros Stream, a tributary of the Rapemills River, flows along the southwestern boundary of the bog.

Galros Bog topography is typically flat or very gently sloping with ground elevations ranging from approximately 56m OD on the northeast of the bog to 47m OD on the southwest.

The proposed underground electricity line ('UGL') will connect into the proposed Mullanafawnia 110kV substation which is located c. 3.8km to the southeast of the proposed wind farm. The proposed route is c. 5km in length and extends from the proposed electrical switch room building ('switch room') located in grassland on the southeast of the proposed wind farm.

The majority of the underground electricity line will be situated within private lands comprising mainly agricultural grassland. The line will cross beneath the N52 national road and the L7006 local road using Horizontal Directional Drilling (HDD), thereby avoiding open trenching within the public roads.

The underground electricity line will run adjacent to the Rapemills River for approximately 2.5km and will cross beneath the river at two locations using HDD. The topography along the route is relatively flat, with ground elevations ranging from approximately 51m to 65m OD.

The haul route works are predominately located within motorway and national roads. The majority of the works comprise the temporary removal of street furniture to accommodate the delivery of turbine components.

From the junction of the M6 and N52, the haul route follows the N52 to its junction with the N62. Along this section temporary hardcore will be laid on roundabout central islands and road signs, street furniture and street lighting temporarily removed at a number of locations.

A temporary reverse manoeuvre location will be required along the eastern side of the N52/N62 junction and will only be utilised by turbine component delivery vehicles travelling towards the project site. The physical (temporary) works proposed in order to accommodate this reverse manoeuvre were permitted as part of the Cush Wind Farm Phase I planning consent (ACP Reference: ABP-318816-24).

6.3.2 LAND & LAND USE

Based on the Corine (2018) mapping, the project site comprises mainly peat wetlands (peat bogs) and agricultural areas (pastures).

The 3 no. proposed turbines are mapped in peat bogs while the route of underground electricity line and switch room building are mapped within agricultural areas.

Galros Bog was in industrial peat production from the 1950s up until 2019. Industrial peat harvesting has now ceased across the whole of Galros Bog as of 2021. Galros Bog is currently not being used for any particular land-use according to BnM.

A draft bog rehabilitation plan for Galros Bog has been prepared by BnM (2026), see **Annex 6.2**, as part of obligations to carry out peatland rehabilitation via an IPC Licence.

The key objective of peatland rehabilitation is environmental stabilisation. This means developing habitats and vegetation back onto the bare peat (putting a "skin" back onto the peat), and minimising effects to downstream waterbodies. Galros Bog will be rehabilitated to integrate the Cush Wind Farm Phase II development or at a later date.

6.3.3 SUPERFICIAL GEOLOGY

6.3.3.1 Mapped Soils & Subsoils

Based on the GSI/Teagasc soils mapping (www.gsi.ie) the proposed wind farm is mapped largely as cutaway/cutover peat, with basic shallow well-drained mineral soil (BminSW) mapped on the south of the wind farm where there are some agricultural lands.

Soils along the western half of the underground electricity line route are mapped mainly as BminSW along with Alluvium where the proposed route intercepts the

Rapemills River.

According to the GSI/Teagasc, soils mapped along the eastern half of the underground electricity line are more variable and comprise cut peat, shallow peaty poorly drained mineral soils (BminSPPT) and peaty poorly drained mineral soil (BminPDPT). The lands along the underground electricity line have been improved and drained for agriculture. Due to land improvements, any peat present is limited to shallow peat topsoil.

GSI subsoils mapping (www.gsi.ie) show that the proposed wind farm is underlain predominantly by cutover raised peat (Cut) along with Gravels derived from Limestones (GLs) mapped on the southeast of the proposed wind farm where agricultural lands are present.

Subsoils along the western half of the underground electricity line route are mapped mainly as Gravels derived from Limestones along with two gravel Esker ridges mapped along the proposed route.

Subsoils mapped along the eastern half of the underground electricity line are more variable and comprise cutover raised peat, Gravels and Limestone Tills (glacial tills).

Alluvium is also mapped along sections of the Rapemills River. However, due to land improvements, any peat present is limited to shallow peat topsoil.

A GSI subsoil geology map is shown in **Figure 6.1** below.

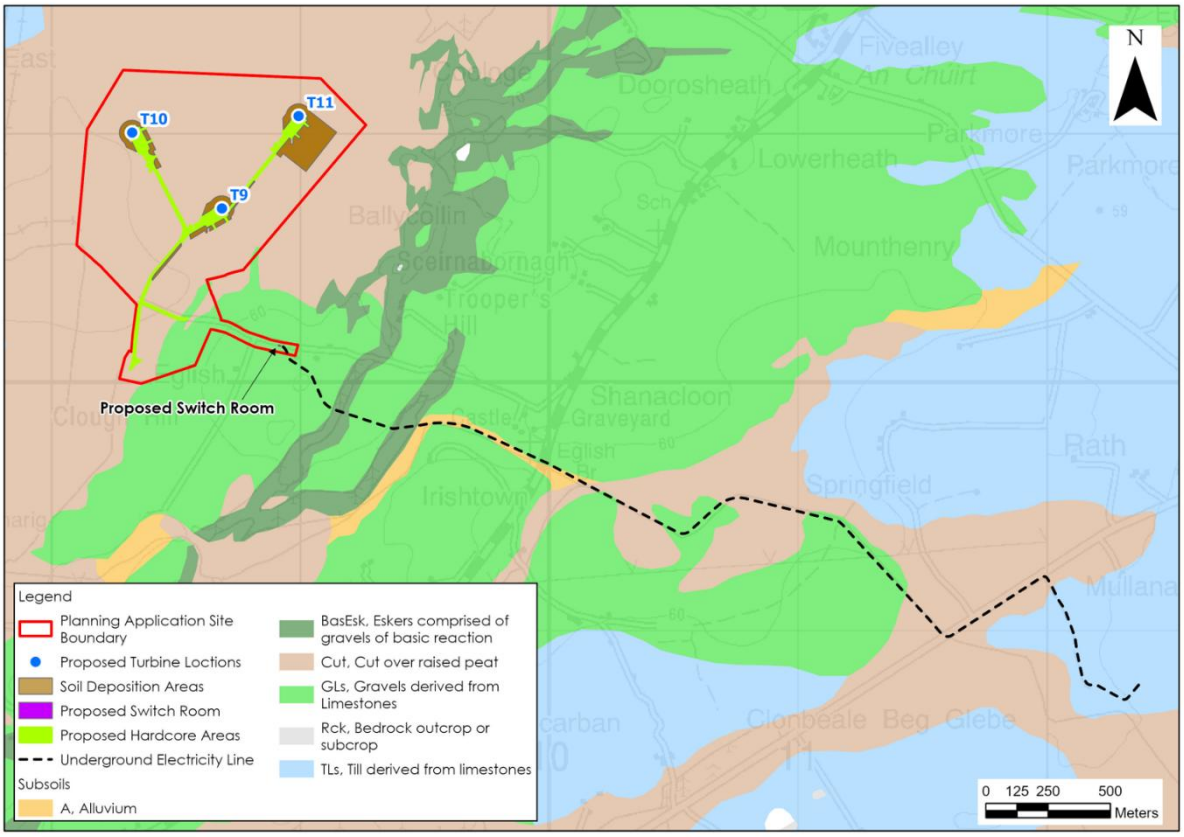

Figure 6.1: GSI Subsoils Geology Mapping

6.3.3.2 Peat Probing

Much of Galros Bog is now cutaway/cutover and the majority of the original raised

bog has now been removed. According to the BnM draft bog rehabilitation plan (2026), the western side of Galros Bog has relatively shallow residual peat (<1m). This residual peat is fen peat found in the lower layers of raised bogs. Sections of deeper residual peat remain on the eastern side, with peat thickness of up to 4.5m recorded.

A total of 25 no. peat probes were carried out by FT at the proposed wind farm on 16 March 2026. Refer to **Figure 6.**2 below for peat depth locations.

Peat depths recorded from peat probing across the wind farm ranged from 0 to 5.2m with an average depth of 4m. The areas of deeper peat were recorded within Galros Bog while the shallower peat (<0.3m) was recorded within grassland areas on the south of the proposed wind farm near the switch room building.

Recorded peat depths within Galros Bog are largest on the northeast of the bog near proposed turbine T11 (4.5 -5m) and reduce to <2m at the south periphery of the bog along the proposed wind farm access road alignment.

Peat depths recorded at the turbine locations varied from 4.0 to 5.2m with an average depth of 4.8m (refer to **Table 6.5** below for summary peat depths and mineral subsoil lithology).

Shallow peat depths/peaty topsoil (0.1 – 0.3m) were recorded along the underground electricity line route and at the switch room building. **Table 6.5** includes a summary of peat depths and the mineral subsoil lithology at wind farm infrastructure locations.

6.3.3.3 Trial Pits

Based on the Cush Wind Farm Phase I site investigations carried out in 2022, the cutover raised bogs typically have the following lithological sequence – peat, shell marl and lacustrine clay. The depth to the base of the lacustrine clay exceeds 5m (depth below ground level) at the previous trial pit locations carried out on cutover bog.

Trial pits were not carried out at proposed turbine locations T9, T10 and T11 due to inaccessibility, but coring confirms the peat at these locations is also underlain by similar shell marl and lacustrine clay.

Trial pits carried out in 2022 within grassland areas to the southeast of the proposed wind farm (i.e. permitted turbines T7 and T8) show glacial deposits (SILT, CLAY and GRAVEL combinations) are likely to be present at the proposed switch room building.

Refer to **Figure 6.2** below for trial pit locations within the wind farm site (refer to **Annex 6.3** for logs).

Infrastructure	Peat Depth Range (m)1	Summary of Subsoil Lithology
T9	4.6 - 5.1	Shell MARL above lacustrine CLAY
T10	4.0 – 4.2	Shell MARL above lacustrine CLAY
T11	4.8 - 5.2	Shell MARL above lacustrine CLAY
Switch Room Building	0 - 0.2	Silt over silt sandy GRAVEL

Table 6.5: Summary of Peat Probes and Gouge Core Investigations

Based on the criteria in **Table 6.1** above, local peat, soils and subsoils are assessed to be of Low-to-Medium importance. This is largely due to the cutaway and heavily drained nature of the peat bogs (Low) and the Medium importance of agricultural land.

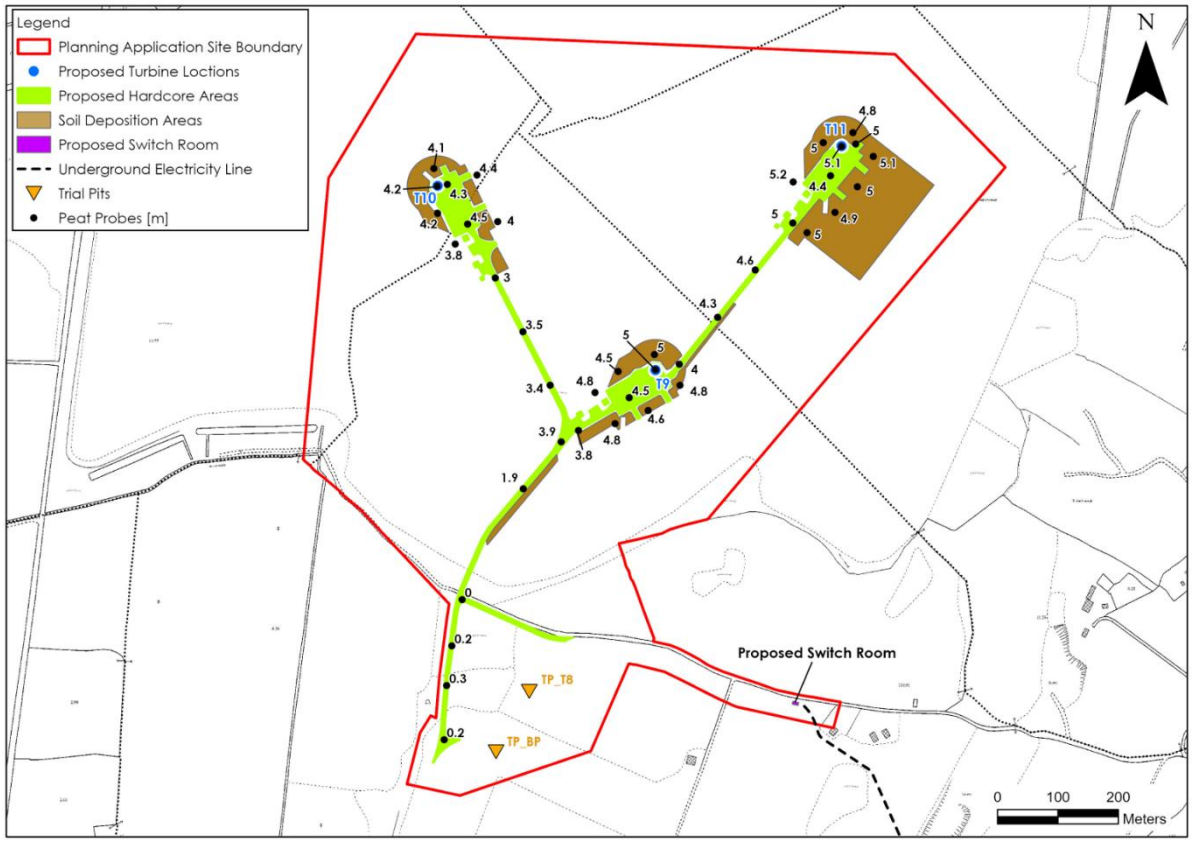

Figure 6.2: Site Investigation Map & Peat Depths

6.3.3.4 Soil Contamination

There are no known areas of soil contamination within the project site or in its immediate environs. During the site walkovers and previous intrusive site investigations, no areas of contamination concern were identified.

According to the EPA online mapping database (http://gis.epa.ie/Envision), there are no licensed waste facilities within or in the immediate environs of the project site.

There are no historic mines within or in the immediate vicinity of the project site which are likely to have contaminated tailings and could give rise to adverse environmental effects.

6.3.4 BEDROCK GEOLOGY

Based on the GSI bedrock mapping (www.gsi.ie), Waulsortion Limestones (Dinantian Pure Unbedded Limestones) are mapped to underlie the majority of the proposed wind farm site including the 3 no. proposed turbine locations.

The eastern portion of the wind farm along with the majority of the underground electricity line route are mapped to be underlain by Visean Limestones which are also Pure Bedded Limestones. The eastern end of the underground electricity line

route, close to the proposed Mullanafawnia 110kV substation, is mapped to be underlain by the Lucan Formation (Dinantian Impure Limestone).

The Waulsortion Limestone is described as dominantly grey, crudely bedded or massive limestones. The Lucan Formation, known as 'calp limestone', is described as dark limestone and shale. The Visean Limestones are undifferentiated.

The bedrock underlying the proposed project site is not exposed due to the presence of peat bogs and sand and gravel deposits. Also, bedrock was not encountered at any of the trial pit locations carried out in 2022.

The Visean Limestones, which are mapped to underlie the eastern side of the proposed wind farm, are potentially prone to karstification. The Visean Limestones are not mapped to underlie any of the proposed wind farm infrastructure.

The Waulsortion Limestone and Lucan formation do not typically exhibit significant karstification as they are generally impure or massive.

No karst features are mapped by the GSI within the project site. The closest mapped karst feature to the project site is a spring located approximately 0.8km to the south of the proposed wind farm.

A bedrock geology map for the area is shown in **Figure 6.3** below.

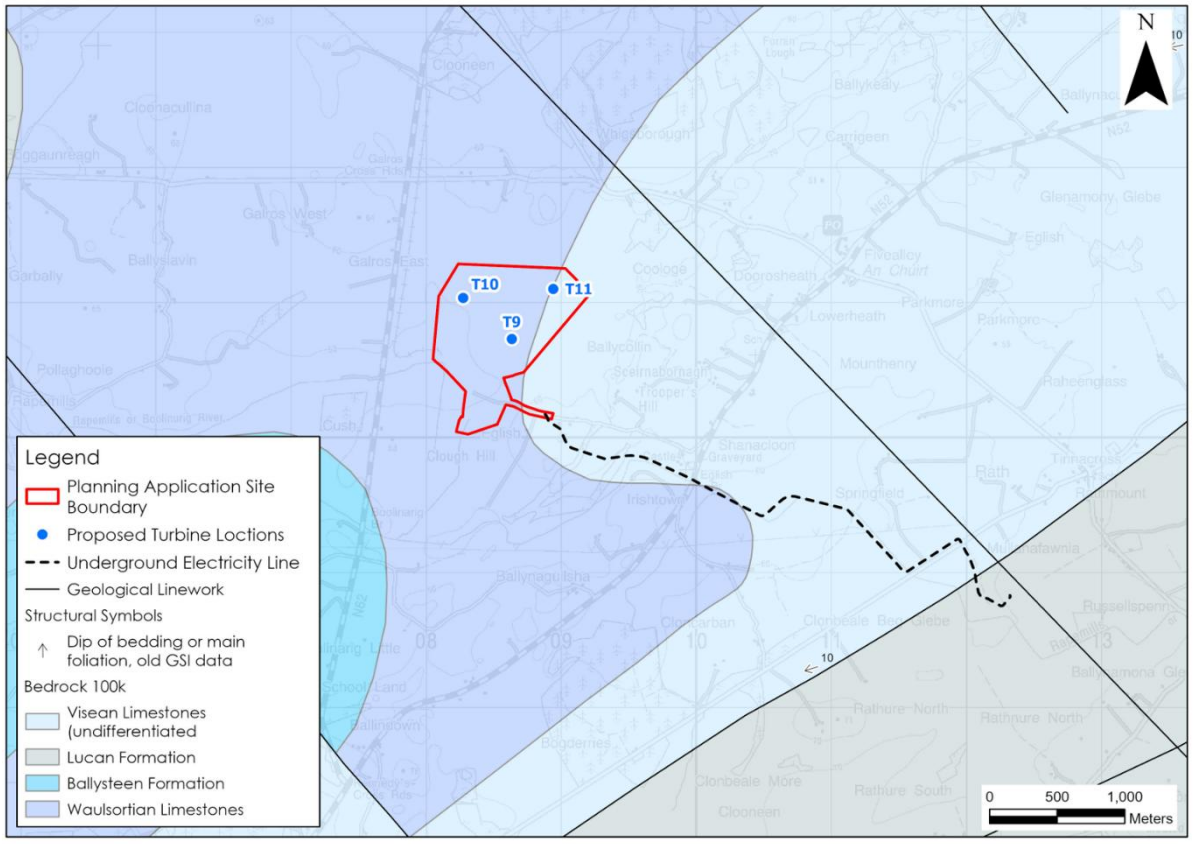

Figure 6.3: Local Bedrock Geology Mapping

6.3.5 PEAT STABILITY ANALYSIS INTRODUCTION

Fehily Timoney and Company (FT) was engaged to undertake a peat stability assessment of the project site.

Hydrological, hydrogeological and ecological factors were also assessed in the Peat Stability Assessment Report (**Annex 6.1**), and interaction between FT, HES and Galetech Energy Services (GES) were undertaken throughout the iterative design process. The assessment was done in accordance with guidance contained in Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (PLHRAG, Scottish Government, 2017).

A constraints study was initially undertaken by the Environmental, Hydrological and Ecological members of the project design team to determine the developable area on the project site, prior to the site reconnaissance by engineering geologists/geotechnical engineers from FT.

The hydrological factors with regard to peat stability were assessed using a combination of desk study data, aerial photography (historical and contemporary), topographic lidar data flow path drainage analysis, site walkovers, field drainage mapping and gouge coring. Detailed drainage maps were prepared along with hydrological constraints mapping for on-site drainage features and wet areas.

Many of the pre-conditions as described by (PLHRAG, Scottish Government, 2017) are hydrological in nature and are listed in the guidance as follows:

- Impeded drainage caused by a peat layer overlying an impervious clay or mineral base (hydrological discontinuity, especially an iron pan at the base of the peat deposit);
- A convex slope or a slope with a break of slope at its head (concentration of
- subsurface flow);
- Proximity to local drainage, either from flushes, pipes or streams (supply of
- water); and
- Connectivity between surface drainage and the peat/impervious interface (mechanism for generation of excess pore pressures).

Identifying any pre-conditions at the project was a key part of the hydrological constraints assessment carried out in conjunction with project design team.

An analysis of peat stability was carried out at all the main infrastructure locations at the proposed wind farm. Either due to the lack of peat or shallow nature of any that is present (<0.3m) along the underground electricity line route, no assessment of peat stability was required.

The purpose of the analysis was to determine the Factor of Safety (FoS) of the peat slopes. The FoS provides a direct measure of the degree of stability of the slope. A FoS of less than 1.0 indicates that a slope is unstable, a FoS of greater than 1.0 indicates a stable slope.

The previous code of practice for earthworks BS 6031:1981 (BSI, 1981), provided advice on design of earthworks slopes. It stated that for a first-time failure with a good standard of site investigation the design FoS should be greater than 1.3. For the purposes of this assessment, a design FoS of 1.3 has been adopted, as a precautionary approach.

Eurocode 7 (EC7) (IS EN 1997-1:2005) now serves as the reference document and the basis for design geotechnical engineering works. The design philosophy used in EC7 applies partial factors to soil parameters, actions and resistances. Unlike the traditional

approach, EC7 does not provide a direct measure of stability, since global Factors of Safety are not used.

As such, and in order to provide a direct measure of the level of safety on a site, EC7 partial factors have not been used in this stability assessment. The results are given in terms of FoS.

The assigned probability of instability associated with a given FoS value is described in **Table 6.6** below. Hydrological and hydrogeological factors were also assessed in the Peat Stability Assessment Report (**Annex 6.1**).

No peat failures/landslides are recorded on the project site which suggests that project site conditions do not pre-dispose themselves to failures/landslides. The landslide susceptibility at the project site was classified by the GSI (2022) as low susceptibility, which is expected given the flat terrain present.

The hand vane results indicate undrained shear strengths in the range 18 to 65kPa, with an average value of about 40kPa. The strengths recorded would be typical of well-drained peat as is present at the project site.

Peat strength at sites of known peat failures (assuming undrained loading failure) are generally very low, for example the undrained shear strength at the Derrybrien failure (AGEC, 2004) as derived from back-analysis, was estimated at 2.5kPa.

The recorded undrained strength at the project site is significantly greater than the lower bound values for Derrybrien indicating that there is no close correlation to the peat conditions at the Derrybrien site and that there is significantly less likelihood of failure on the project site[1].

There is no deep peat present along the underground electricity line route and switch room building and therefore there was no requirement to carry out the detailed analysis as described below for the proposed wind farm.

Scale	Factor of Safety	Stability
1	1.30 or greater	Acceptable
2	1.0 to 1.3	Marginally Stable
3	<1.0	Unstable

Table 6.6: Probability Scale for Factor of Safety.

6.3.6 PEAT STABILITY RESULTS

Stability of a peat slope is dependent on several factors. The main factors that influence peat stability are slope angle, shear strength of peat, depth of peat, pore water pressure and loading conditions.

An adverse combination of factors could potentially result in peat sliding. An adverse condition of one of the above-mentioned factors alone is unlikely to result in peat failure. The infinite slope model (Skempton and DeLory, 1957) is used to combine these factors to determine a factor of safety for peat sliding. This model is based on a translational slide, which is a reasonable representation of the dominant mode of movement for peat failures.

[1] Derrybrien Wind Farm is located in County Galway and was the subject of a significant peat slide in 2003.

To assess the factor of safety for a peat slide, an undrained[2] (short-term stability) and drained (long-term stability) analysis has been undertaken to determine the stability of the peat slopes on site:

- The undrained loading condition applies in the short-term during construction and until construction induced pore water pressures dissipate; and
- The drained loading condition applies in the long-term. The condition examines the effect of in particular, the change in groundwater level as a result of rainfall on the existing stability of the natural peat slopes.

A summary of the 'undrained analysis' is presented in **Table 6.7** and the 'drained analysis' in **Table 6.8**; while full results can be found in **Annex 6.1**.

In summary, the findings demonstrate that the project site has an acceptable margin of safety, is suitable for the proposed project and is considered to be at low risk of peat failure or ground instability. The findings include recommendations and control measures for construction work in peat lands to ensure that all works adhere to an acceptable standard of safety.

Infrastructure ID	Factor of Safety for Load Condition	
	Condition 1	Condition 2
T9	4.59	3.82
T10	5.46	4.41
T11	4.50	3.76

Table 6.7: Factor of Safety Results at Proposed Turbine Locations (Undrained Condition)

Infrastructure ID	Factor of Safety for Load Condition	
	Condition 1	Condition 2
T9	15.65	15.26
T10	16.08	15.56
T11	15.60	15.23

Table 6.8: Factor of Safety Results at Proposed Turbine Locations (Drained Condition)

6.3.7 GEOLOGICAL RESOURCE IMPORTANCE

According to the GSI natural resource mapping, the area of the proposed project has a very low to high crushed rock aggregate potential. The high potential area corresponds to the mapped extent of the Dinantian Pure Limestones. Meanwhile, the majority of the project site has moderate potential with the southwest of the site mapped as having very low potential.

Those areas to the east and southeast of the proposed wind farm, including the western half of the underground electricity line, which are underlain by gravels and eskers, have moderate to very high potential for granular aggregates.

[2] For the stability analysis two load conditions were examined; namely, Condition 1: no surcharge loading, and Condition 2: surcharge of 10 kPa, equivalent to 1 m of stockpiled peat assumed as a worst case.

The very high potential for granular aggregate corresponds to the mapped extent of the esker deposits.

Based on the criteria in **Table 6.1** and the GSI aggregate potential above, the local bedrock, sand and gravels underlying the project site has a Low to High Importance.

6.3.8 GEOLOGICAL HERITAGE & DESIGNATED SITES

Kilcormac Esker Geological Heritage Site (Site Code: OY018), which forms part of the much larger Killimor-Birr-Fivealley-Kilcormac Esker System, is mapped to the east/southeast of the proposed wind farm. Refer to **Figure 6.4** below.

This site is described as a good example of a deglacial, meltwater-deposited complex.

The underground electricity line intercepts Kilcormac Esker at two locations along the proposed route (i.e. two separate esker ridges are crossed by the proposed route). The total length of underground electricity line within the mapped Kilcormac Esker Geological Heritage Site amounts to 160m.

All other Geological Heritage Sites are remote from the project site as shown on **Figure 6.4.**

Based on the criteria in **Table 6.1** above, geological heritage sites have a High Importance.

Designated sites include Natural Heritage Areas (NHAs), proposed Natural Heritage Areas (pNHAs), candidate Special Areas of Conservation (cSAC), Special Areas of Conservation (SAC) and Special Protection Areas (SPAs). There are no designated sites within the project site or adjacent to it, which can be directly affected (from a land, soil and geology perspective) by the construction, operation or decommissioning of the project.

Designated sites within 2km of the proposed project site include Lough Coura pNHA (Site Code:000909) which is located approximately 0.9km to the north of the proposed wind farm. The proposed project has no direct interaction with Lough Coura pNHA.

Further details of the assessment of potential indirect hydrological effects on downstream designated sites can be found in **Chapter 7**. Based on the criteria in **Table 6.1** above, designated sites have a Very High Importance.

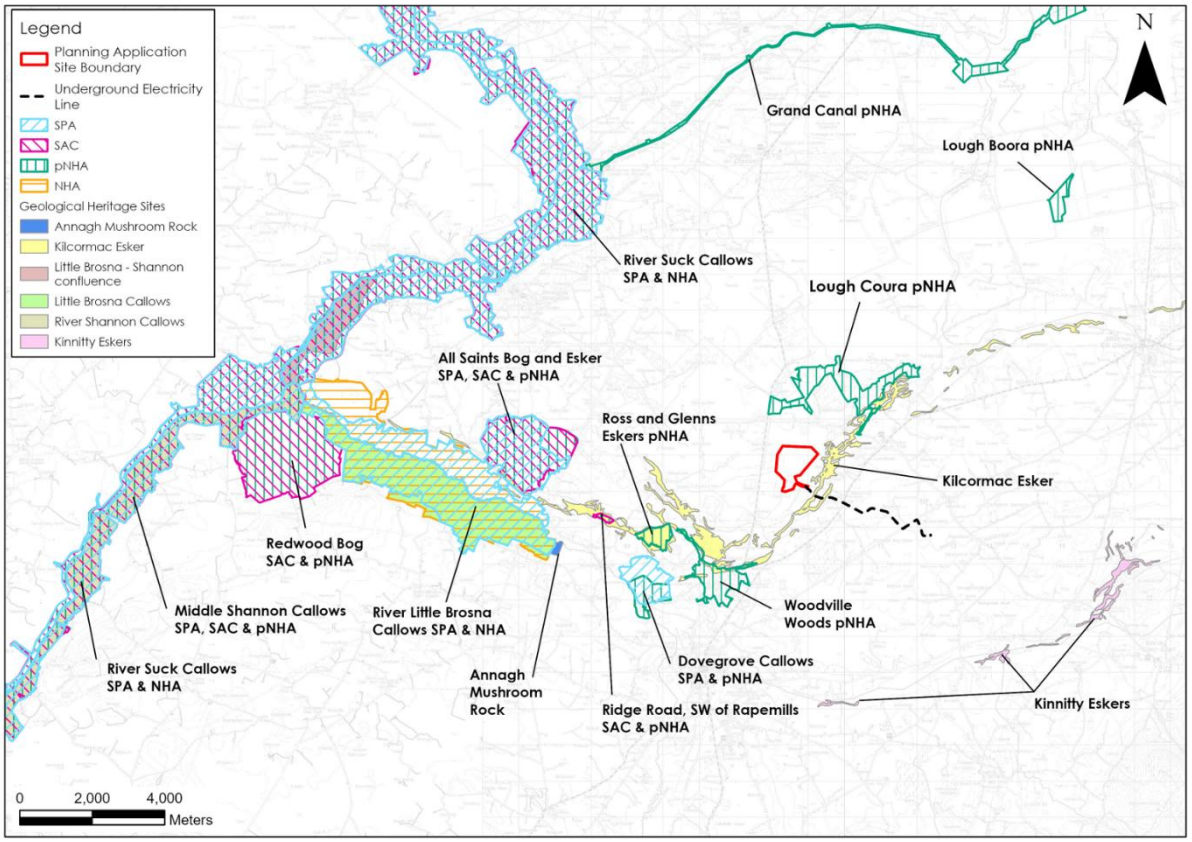

Figure 6.4: Designated Sites & Geological Heritage Sites

6.4 ASSESSMENT OF LIKELY EFFECTS

6.4.1 CHARACTERISTICS OF THE PROJECT

The project will typically involve the removal of peat, soil, subsoil and possibly bedrock (if foundation piling is required) to facilitate the emplacement of access tracks, turbine foundations, crane hardstands, switch room building and underground electrical cabling.

Gravity raft foundations are anticipated and have been adopted as the basis of the excavation and spoil quantities presented in **Table 6.9,** as they give rise to the maximum assumed excavation and spoil volumes. A piled foundation will only be used at an individual turbine location where further site-specific geotechnical investigation demonstrates that it is required by the ground conditions.

Gravity foundation depths are expected to be >5m[3] deep, depending on ground conditions at each turbine location, with an approximate diameter of 29m. For the piled turbine foundations, a typical piling type and configuration could be up to 16 no. 1200mm rotary bored piles down to suitable weight bearing substrate. The hardstands will generally be of a 'floated' construction type, thus avoiding significant excavations; however, localised excavations may be required to avoid excessive placement of granular fill.

Floating access roads are the predominant road construction type proposed for the project site which given the ground conditions and type of terrain present is deemed

[3] In order to accommodate a foundation depth of 3-5m.

an appropriate construction approach. Where shallow peat is present (<1m), excavate and replace (founded) type construction will be used.

Overburden/spoil will be utilised for reinstatement of excavated areas etc. and for landscaping purposes. Excess material, or material which cannot be used for reinstatement, will be stored, permanently, at 1 no. dedicated spoil deposition area located southeast of proposed turbine T11 as well as smaller deposition areas at each of the 3 no. turbine locations.

The designated spoil deposition areas have been sized to accommodate the anticipated c. 48,000m³ of material requiring permanent deposition. The material will be placed in controlled shallow layers across the designated areas, in accordance with the Peat and Spoil Management Plan (within the Planning-Stage Construction Environmental Management Plan [CEMP] at **Annex 3.4**) to ensure that stability is maintained.

To maintain the geological integrity of the project site, it is proposed that generated spoil will firstly be deposited locally to its point of origin or at a location of similar geological characteristics.

Following completion of spoil deposition, the dedicated spoil deposition areas will be graded to match existing profiles and reseeded.

It is, therefore, predicted that all spoil generated, which is suitable for storage via this method, will be stored permanently within the project site. However, asphalt and other materials unsuitable for reuse or deposition, including material arising from the haul-route accommodation works, will be removed from the site and delivered to an appropriately authorised waste facility. As waste license permits are subject to renewal, it is not currently possible to confirm the precise facility to which any material requiring off-site disposal will be delivered; however, having reviewed the National Waste Collection Permit Office (NWCPO) database, there are a number of facilities within County Offaly which currently accept soil, rock and other materials arising from construction projects.

The underground electricity line trench will be typically 1.0m wide by 1.2m deep. The trench will be located predominately within private lands. It is predicted that c. 5,946m³ of spoil will be generated during trench excavation with the majority being utilised for reinstatement/landscaping.

In the event that material is generated which is unsuitable for storage within the deposition areas or excess material arises which cannot be accommodated on-site, it will be removed from site and disposed of at a licensed waste disposal facility.

The haul route accommodation works will largely involve road furniture alteration and vegetation pruning; however a small section (c. 6m) of wall will be removed at the R339/Connolly Avenue Junction, in Galway City, and replaced with a section of fence.

Estimated volumes of spoil (including topsoil, subsoil, peat, and tar) to be removed for each element of the proposal are indicated in **Table 6.9** below.

Please refer to the Peat & Spoil Management Plan (**Annex 3.4**) prepared by Galetech Energy Services for further details on the management and storage of spoil.

Project Element	Volume of Material to be Excavated (m^3)	Volume of Material to be utilised for reinstatement/landscaping (m^3)	Volume of Material to be disposed of in deposition areas (m^3)	Volume to be Disposed Off-Site (m^3)
Proposed Wind Farm (Incl. foundations, access tracks, hardstands, drainage, and internal cables)	62,509	15,364	47,145	-
Switch Room (incl. Compound area, and site entrance)	60	60	-	-
Underground Electricity Line	5,946	5,946	-	-
Haul Route Upgrade Works	10	-	-	10

Table 6.9: Summary of Estimated Spoil Volumes at Project site

6.4.2 'DO-NOTHING' IMPACT

In the event that the project is not progressed, existing land uses will continue and there will be no alteration to the land, soil or geological environment. The permitted Cush Wind Farm Phase I will be constructed. The opportunity to add 3 no. additional turbines will be lost.

6.4.3 CONSTRUCTION PHASE

6.4.3.1 Soil, subsoil and bedrock excavation

The excavation of peat, soil, subsoil and possibly bedrock (where present) will be required for all groundworks; including site levelling, the installation of infrastructure (e.g. turbine foundations and switch room building) and for access track formation and will, therefore, give rise to direct effects on these receptors. The excavation of soils and subsoils will also be required along the underground electricity line route; while minor levels of excavation are predicted at haul route works locations.

Bedrock is likely only to be encountered if piling is carried out, as evidenced by the results of the preliminary site investigations undertaken.

Due to the shallow and linear nature of the works along the underground electricity line (c. 1.2m) and the fact that most of the spoil can be reinstated, effects on soils, subsoil and bedrock will not likely be significant.

These works will result in a direct, permanent loss of soil, subsoil and bedrock at excavated locations. The estimated excavation volumes are detailed in **Table 6.9** above.

The overall effect is determined not to be significant due to the following:

- The peat, soils and subsoils and bedrock at the project site are generally classified as 'low to medium' importance;

- A minimal volume of peat, soil, subsoil and bedrock; in comparison to the total resource present on the site; will be removed to allow for the construction of the project;
- The peat, soil, subsoil, and bedrock which will be removed during the construction phase will be localised to the footprint of infrastructure only; and,
- No turbines or other wind farm-site infrastructure will be constructed within a designated ecological or geological heritage site. The underground electricity line will cross the Kilcormac Esker County Geological Site at two locations, and the resulting effects are assessed separately in **Section 6.4.3.6**.

The excavation and relocation of material is an inevitable part of the project and no mitigation is required. The excavation of materials will be completed in accordance with best practice for the management and treatment of such materials.

The overall effect of the excavation of peat, soil, subsoil and bedrock is summarised in **Table 6.10** below. The impact magnitude is Small Adverse to Moderate Adverse.

Attribute	Description
Receptor	Peat, soils, subsoils and bedrock
Pathway/Mechanism	Excavations
Overall Effect	Negative, direct, slight-moderate, likely, permanent effect on peat, soil, subsoil and bedrock

Table 6.10: Peat, Soil & Subsoil Excavation Effect

6.4.3.2 Erosion of exposed peat, soil and subsoil at excavation and storage areas

The exposure of peat, soil and subsoils at locations of excavation and of spoil storage can increase the likelihood of soil erosion resulting in a direct physical effect on land and soil. However, given the small footprint of the proposed excavation and spoil storage areas in the context of the overall project site, the pre-mitigation effect will not be significant.

The pre-mitigation effects of peat, soil and subsoil erosion are summarised in **Table 6.11** below. The impact magnitude is Negligible to Small Adverse.

Attribute	Description
Receptor	Peat, Soils and subsoils
Pathway/Mechanism	Vehicle movement, surface water erosion, and wind action.
Pre-Mitigation Effect	Negative, direct, slight, short-term, likely effect on peat, soil and subsoils.

Table 6.11: Peat, Soil & Subsoil Erosion Effect

6.4.3.3 Contamination of peat, soils and subsoils by leakages or spillages of hydrocarbons or other chemicals

The contamination of peat, soils and subsoils presents a direct effect on the geology of the project site. Accidental spillage during refuelling of construction plant with petroleum hydrocarbons is a pollution risk. The accumulation of small spills of fuels and lubricants during routine plant use can also be a significant pollution risk.

Hydrocarbon has a high toxicity to humans and all flora and fauna, including fish, and is persistent in the environment. Large spills or leaks are likely to result in significant

effects, including contamination of soils and subsoils within the geological environment. The likely pre-mitigation effect is assessed to be not significant due to the relatively low volumes of fuels/chemicals that will be kept on-site at any one time.

The pre-mitigation effect of soil contamination is summarised in **Table 6.12** below. The impact magnitude is Negligible to Small Adverse.

Attribute	Description
Receptor	Peat, soil and subsoils
Pathway	Peat, soil and subsoil pore space.
Pre-Mitigation Effect	Negative, direct, slight, short-term, likely effect on, peat, soils and subsoils.

Table 6.12: Peat, Soil & Subsoil Contamination Effect

6.4.3.4 Effects on Land & Land Use

The maximum assumed permanent physical footprint of the wind farm infrastructure within the wind farm site is approximately 2.33 ha. This comprises the turbine foundations, crane hardstands, access tracks, switch room building and compound, and other permanent wind farm infrastructure. The assessment is based on the maximum assumed physical footprint identified for **Chapter 6** in **Table 1.6** of **Chapter 1**.

The permanent physical footprint will result in a change in land use affecting approximately 0.32 ha of agricultural land and 2.01 ha of cutaway bog.

The change in land use affecting approximately 0.32 ha of agricultural land will not be significant, as it represents a very small proportion of the surrounding agricultural landholding. Agricultural activities will continue around the permanent wind farm infrastructure and can readily coexist with the project.

The 2.01 ha of affected bog comprises previously worked, drained and degraded cutaway bog. The permanent infrastructure will occupy only a small proportion of Galros Bog and has been designed to remain compatible with the wider rehabilitation of the bog.

The underground electricity line will be entirely below ground and, following reinstatement of the trench and temporary working areas, will not result in a permanent alteration to land use. The haul-route accommodation works will similarly not result in any material change in land use.

The pre-mitigation effect on land and land use is summarised in **Table 6.13** below. The impact magnitude is Small Adverse.

Attribute	Description
Receptor	Land & Land Use
Pathway	Excavation and infrastructure construction
Pre-Mitigation Effect	Negative, slight, direct, likely, permanent effect on land and land use.

Table 6.13: Land & Land Use Effect

6.4.3.5 Peat Instability and Failure

A peat stability assessment was carried out for the main infrastructure elements at the proposed wind farm. This approach takes into account guidelines for geotechnical/peat stability risk assessments as given in PLHRA (2017) and MacCulloch (2005).

Peat instability or failure refers to a significant mass movement of a body of peat that would have an adverse impact on the proposed wind farm development and the surrounding environment. The potential significant effects of peat failure at the study area may result in:

- Death or injury to site personnel;
- Damage to machinery;
- Damage or loss of infrastructure;
- Drainage disruption by blockage of drainage pathway by relocated peat and spoil;
- Site works damaged or unstable;
- Contamination of watercourses, water supplies by particulates; and,
- Degradation of the peat environment by relocation of peat and spoil.

However, the findings of the peat stability assessment, which involved analysis of 40 no. locations, showed that the proposed wind farm has an acceptable margin of safety and that the site is suitable for the project. Notwithstanding the above, the management of peat stability and appropriate construction practices will be inherent in the construction phase to ensure peat failures do not occur on site.

The pre-mitigation effect on peat stability is summarised in **Table 6.14** below. The impact magnitude is Small Adverse.

Attribute	Description
Receptor	Peat Stability
Pathway	Excavation and infrastructure construction
Pre-Mitigation Effect	Negative, slight, direct, unlikely effect on peat stability

Table 6.14: Peat Stability and Failure

6.4.3.6 Effects on Kilcormac Esker Geological Heritage Site

The underground electricity line will cross the mapped Kilcormac Esker County Geological Site at two locations, comprising two separate esker ridges. In total, approximately 160m of the underground electricity line will be located within the mapped geological heritage site.

The works will involve the excavation of a trench approximately 1m wide and 1.2m deep. Given the shallow, narrow and linear nature of the works, the physical disturbance will be confined to a small proportion of the overall esker system and will not materially alter its wider topography or morphology. However, the excavation will result in localised disturbance of the soils, subsoils and geological material within the trench footprint.

The magnitude of the effect is assessed as Small Adverse. As Kilcormac Esker County Geological Site is a receptor of High importance, the resulting pre-mitigation effect is assessed, in accordance with **Table 6.3**, as Moderate/Slight. The effect will be negative, direct, likely and permanent, but will be localised and will not be significant.

The pre-mitigation effect on Kilcormac Esker CGS is summarised in **Table 6.15** below. The impact magnitude is Small Adverse.

Attribute	Description
Receptor	Kilcormac Esker CGS
Pathway/Mechanism	Trench Excavations
Overall Effect	Negative, direct, Moderate/Slight, likely and permanent effect on the localised soils, subsoils and geological material within the underground electricity line trench footprint.

Table 6.15: Effects on Kilcormac Esker Geological Heritage Site

6.4.4 Operation Phase

Following the completion of the construction phase, including the appropriate reinstatement and landscaping of the project site which will avoid the likelihood of erosion effects, very few (if any) effects on land and soils are likely during the operation phase of the project. These may include:

- Minor accidental leaks or spills of fuel/oil from vehicles associated with the occasional maintenance of the wind farm; and,
- Where oil-filled transformers are installed, an accidental oil leak could result in localised contamination of soils or subsoils.

6.4.5 Decommissioning Phase

The likely effects associated with decommissioning of the project will be similar to those associated with construction but of a substantially reduced magnitude (i.e. imperceptible to slight). Activities which are likely to affect land & soil include the removal and reinstatement of turbine hardstand areas and access tracks (where not retained); while some sub-surface elements such as the underground electricity line ducting will be left in situ to reduce effects.

6.4.6 Assessment of Cumulative Effects

All elements of the project, including the proposed wind farm, electrical switch room building, underground electricity line and turbine haul route works, have been assessed together within this EIAR.

The permitted Cush Wind Farm Phase I development is located adjacent to the proposed wind farm and represents the principal development with the potential to give rise to cumulative effects on land, soils and geology. For the purposes of the cumulative assessment, the potential for construction activities associated with the permitted Phase I development and the project to occur concurrently has been considered. This approach ensures that the potential combined effects associated with excavation, construction traffic, plant movements and peat and spoil handling are fully assessed.

The likely effects associated with both developments will be direct and largely confined to the immediate vicinity of their respective construction activities. Peat and

spoil arising from the project will be managed in accordance with the Peat and Spoil Management Plan (within the Planning Stage CEMP at **Annex 3.4**). The erosion, drainage, contamination and peat-stability control measures set out in this chapter and the Planning-Stage CEMP will also be implemented throughout the construction phase of the project. The permitted Phase I development will be constructed in accordance with the mitigation and environmental management measures forming part of its consent.

Under the concurrent construction scenario assessed, the overall level of construction activity would temporarily increase, however it will not materially alter the nature, magnitude or geographical extent of the effects identified in respect of land, soils and geology. Accordingly, no significant cumulative effects on land, soils or geology are likely to arise from the concurrent construction of the permitted Phase I development and the project.

The proposed Mullanafawnia 110kV substation is being progressed separately and does not form part of the project or the planning application. The c.5km underground electricity line, which forms part of the project, will connect the proposed electrical switch room building to the proposed Mullanafawnia 110kV substation. The cumulative assessment has been undertaken on the basis that construction of the proposed substation and the underground electricity line will occur concurrently.

Construction of the proposed substation will involve separate and localised earthworks within its own development footprint. Concurrent construction will temporarily increase the level of construction activity in the vicinity of the eastern end of the underground electricity line. However, the associated effects on land, soils and geology will remain localised and will be subject to the mitigation and construction-management measures applicable to each development. Consequently, no significant cumulative effects on land, soils or geology are likely to arise from the concurrent construction of the project and the proposed Mullanafawnia 110kV substation.

The potential for cumulative effects with the other existing, permitted and proposed developments identified in **Chapter 1** has also been considered. Given the localised nature of the effects identified in this chapter, together with the scale, location and separation distances of the other developments, no additional significant cumulative effects on land, soils or geology are likely.

Accordingly, the project, in combination with the permitted Cush Wind Farm Phase I development, the proposed Mullanafawnia 110kV substation and the other existing, permitted and proposed developments identified in **Chapter 1**, will not give rise to significant cumulative effects on land, soils or geology during the construction, operation or decommissioning phases.

6.4.7 Assessment of Likely Health Effects

The possibility of health effects, albeit unlikely, arises mainly from the potential for soil and ground contamination during construction. A type of development, such as the project proposed, is not a recognised source of land or soil pollution and therefore the potential for effects during the construction, operation or decommissioning phases is unlikely.

Hydrocarbons will be used onsite during construction; however, the volumes will be small and will be handled and stored in accordance with best practice mitigation

measures. As a result, it is assessed that the likely residual effects associated with soil or ground contamination and subsequent health effects will be imperceptible.

6.4.8 RISK OF MAJOR ACCIDENTS AND DISASTERS

The presence of soft peat deposits gives rise to a potential risk of peat instability or failure, which could constitute a major accident if it resulted in the uncontrolled movement of peat. However, the proposed wind farm is located on generally flat and low-lying ground.

A comprehensive Peat Stability Assessment has been undertaken for all proposed wind farm infrastructure locations and is provided at **Annex 6.1**. The assessment concludes that the proposed infrastructure locations have an acceptable margin of safety and that the risk of peat instability or failure is low.

With the implementation of the peat-stability control measures set out in **Section 6.5.1.5** and the Peat Stability Assessment, the residual risk rating at each infrastructure element will be negligible. Accordingly, the project will not give rise to significant effects on land, soils or geology as a result of peat instability or failure.

6.5 MITIGATION AND MONITORING

6.5.1 CONSTRUCTION PHASE

6.5.1.1 Peat, Soil, subsoil and bedrock excavation

The excavation of peat, soil, subsoil and bedrock will have a direct effect on the geological environment and no specific mitigation measures are proposed. The excavation and long term storage of materials will be completed in accordance with best practice for the management and treatment of such materials.

6.5.1.2 Erosion of Exposed Peat, Soil and Subsoil at Excavation and Storage Areas

The following avoidance and design measures are proposed to reduce erosion effects at excavation and spoil storage areas:

- Mats will be used, as necessary, to support construction plant and machinery on soft ground, thus reducing the likelihood of soil and subsoil erosion and avoiding the formation of rutted areas. This will substantially reduce the likelihood for surface water ponding to occur;
- Excavated material required for reinstatement or landscaping will be temporarily stored only in locations identified as suitable in the Peat Stability Assessment and Peat and Spoil Management Plan, outside identified peat-stability exclusion areas and applicable surface-water buffers. Material not required for reinstatement or landscaping will be transported directly to the designated spoil deposition areas;
- Silt fences, and all necessary surface water management measures (including upslope interceptor drains), will be installed around all temporary stockpiles to limit movement of entrained sediment in surface water runoff. All slopes will be sealed with the bucket of an excavator;
- In order to minimise erosion during the construction phase, works will not take place during periods of intense or prolonged rainfall (to prevent increased silt laden runoff). Drainage systems, as outlined in Chapter 7, will be implemented to limit runoff effects during the construction phase;

- At the designated spoil deposition areas, material will be placed in layers to ensure stability is maintained and works will be undertaken in accordance with best practice construction methodologies. Works at the spoil deposition areas will be monitored, on a weekly basis during the construction phase and monthly for a 6 no. month period thereafter, by an appropriately qualified Geotechnical Engineer. In the event that any ground stability issues arise, the Engineer will have the power to cease works until such time as remedial works have been completed to his/her satisfaction;
- Permanently mounded spoil; for example, berms surrounding turbines and hardstands, berms located along access tracks and at the spoil deposition areas; will be seeded and grassed over at the earliest opportunity to prevent erosion; and,
- The underground electricity line trench will be reinstated to the required specification and in accordance with landowner requirements and will be reseeded or allowed to vegetate naturally (on agricultural land) or topped with tarmacadam (or similar along public roads) at the earliest opportunity to prevent erosion.

6.5.1.3 Contamination of Soils and Subsoils by leakages, spillages of hydrocarbons or other chemicals

The following measures are proposed to specifically prevent contamination of soils and subsoils:

- The volume of fuel and oil stored on site will be minimised. Fuel and oil will be stored within appropriately bunded areas at the temporary construction compounds permitted as part of Cush Wind Farm Phase I and used during construction of the project. The bunded areas will be roofed to prevent rainfall ingress and will have a capacity of at least 110% of the volume stored;
- Refuelling of plant and machinery will be undertaken using a mobile double-skinned fuel bowser operated by trained and competent personnel. The bowser will be filled and stored at the construction compounds when not in use. Drip trays, absorbent mats and spill-response materials will be used during refuelling. Fuel and chemicals will not be stored or handled, and refuelling will not take place, within 50m of a surface-water feature;
- All plant and machinery used during construction will be regularly inspected for leaks and fitness for purpose;
- Spill kits will be available to deal with any accidental spillages within the temporary construction compound and during re-fuelling;
- All asphalt or other road-cutting material arising from the haul-route accommodation works will be removed from the site and delivered to an appropriately authorised waste facility. This material will not be used for reinstatement or deposited within the spoil deposition areas; and
- An emergency plan for the construction phase to deal with accidental spillages is contained within the Planning-Stage Construction and Environmental Management Plan (Annex 3.4). This emergency plan will be further developed by the contractor prior to the commencement of construction.

6.5.1.4 Land and Land Use

The permanent wind farm infrastructure will occupy approximately 0.32 ha of agricultural land. This represents a small area in the context of the agricultural land within and surrounding the project site, and agricultural activities will continue around the permanent infrastructure. The effect on agricultural land use will therefore not be significant, and no specific mitigation is required.

Approximately 2.01 ha of the permanent wind farm infrastructure will be located on previously worked, drained and degraded cutaway bog. Given the existing condition of this land and the limited extent of the permanent footprint, the effect on land use will not be significant. The infrastructure has also been designed to remain compatible with the wider rehabilitation objectives for Galros Bog. No specific land-use mitigation is therefore required.

Areas of temporarily disturbed or levelled soil will be reinstated and allowed to revegetate. Silt fencing will be installed, where required, to prevent the mobilisation of soil into surrounding drains while vegetation becomes established.

6.5.1.5 Peat Stability and Failure

Firstly, the key mitigation with regard peat stability risk at the project site was the carrying out of a robust, multidisciplinary site investigation and peat stability risk assessment carried out in accordance with best practice guidance (PLHRAG, Scottish Government, 2017).

The findings of the peat stability assessment, which included factor-of-safety analysis at 40 locations, demonstrate that the project site has an acceptable margin of safety and is suitable for the proposed wind farm.

The peat stability assessment report provides a number of mitigation/control measures to reduce the potential risk of peat failure at each infrastructure location. Sections of access roads to the nearest infrastructure element will be subject to the same mitigation/control measures that apply to the nearest infrastructure element. The required mitigation/control measures are shown below:

The following control measures incorporated into the construction phase of the project will ensure the management of the risks for this site:

- Appointment of experienced and competent contractors;
- The site will be supervised by experienced and qualified personnel;
- Allocate sufficient time for the project (be aware that decreasing the construction time has the potential to increase the risk of initiating a localised peat movement);
- Prevent undercutting of slopes and unsupported excavations;
- Maintain a managed robust drainage system;
- Prevent placement of loads/overburden on marginal ground;
- Implementation of safety buffers around deep peat areas;
- Adhere to the spoil and peat storage restriction areas detailed in the Peat Stability Assessment (FT, 2026);
- Set up, maintain and report findings from monitoring systems as outlined in the Peat Stability Assessment (FT, 2026);

- Ensure construction method statements are developed and agreed before commencement of construction and are followed by the contractor; and,
- Revise and amend the Construction Risk Register as construction progresses to ensure that risks are managed and controlled for the duration of construction.

6.5.1.6 Effects on Kilcormac Esker Geological Heritage Site

The following measures will be implemented where the underground electricity line crosses the mapped Kilcormac Esker County Geological Site:

- The extent of the working area will be clearly demarcated before construction and will be kept to the minimum area required to safely complete the works;
- Excavation will be confined to the underground electricity line trench and associated working area, and unnecessary disturbance of the adjoining esker slopes and landform will be avoided;
- Topsoil, subsoil and underlying geological material will be excavated and stored separately to prevent mixing;
- Excavated material will be reused within the trench, where technically suitable, and reinstated in its original sequence so far as practicable. Imported material will be limited to any bedding and surround required for the laying of the underground electricity line;
- Excavated material will not be permanently deposited within the mapped geological heritage site;
- Following installation of the underground electricity line, the trench and working area will be reinstated to the original ground levels, contours and surface condition as soon as practicable;
- The works will be carried out in accordance with a site specific method statement reviewed by a suitably qualified geotechnical engineer or engineering geologist before construction; and
- A photographic record of the crossing locations will be prepared before, during and following completion of the works to confirm that the landform and surface profile have been appropriately reinstated.

6.5.2 OPERATION PHASE

Following the completion of construction activities and the reseeding of exposed soil as a result of excavations and spoil storage, it is assessed that due to the absence of likely soil erosion effects, no mitigation measures are required.

Any oil-filled turbine or switch-room transformers will be provided with secondary containment capable of retaining at least 110% of the stored oil volume. Where solid cast-resin transformers are selected, bunding will not be required. Oils and lubricants stored at the switch room will be contained within an appropriately bunded area.

6.5.3 DECOMMISSIONING PHASE

During decommissioning, it may be possible to reverse or at least reduce some of the likely effects caused during construction by rehabilitating construction areas such as turbine foundations and hardstanding areas. This will be done by removing wind farm

infrastructure and restoring disturbed ground with previously excavated material where possible.

Decommissioning of the underground electricity line will involve the removal of the cabling from the ducting; however, the ducting will remain in situ to avoid further excavations and prevent environmental effects.

Other effects such as possible soil compaction and any contamination by fuel leaks will remain but will be of a substantially reduced magnitude. However, as noted in the Scottish Natural Heritage report (SNH) Research and Guidance on Restoration and Decommissioning of Onshore Wind Farms (SNH, 2013) reinstatement proposals for a wind farm are made approximately 30-years in advance and within the lifespan of the wind farm, technological advances and preferred approaches to reinstatement are likely to change. According to the SNH guidance, 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".*

Mitigation measures applied during decommissioning activities will be similar to those applied during construction where relevant. Some of the effects will be avoided by retaining some elements of the project in place where appropriate; for example, access tracks within the site may be retained for agricultural uses.

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

No significant effects on the land, soils and geology environment are likely during the decommissioning stage of the project.

6.5.4 MONITORING MEASURES

Monitoring of land, soils and peat stability will be undertaken during the construction phase and for a six-month period following completion of construction. All excavated or raised areas, including cut-and-fill areas, reinstated or landscaped ground and the spoil deposition areas, will be inspected for signs of erosion or instability by an appropriately qualified Geotechnical Engineer appointed by the Developer. Inspections will be undertaken weekly during the construction phase and monthly for six months following completion of construction. The monitoring systems specified in the Peat Stability Assessment (**Annex 6.1**) will also be installed and maintained, with the findings recorded and reported in accordance with the requirements of that assessment. Where signs of erosion or instability are identified, appropriate remedial measures will be implemented under the direction of the Geotechnical Engineer.

Following completion of decommissioning and restoration works, reinstated areas will be monitored for a period of two years. Any erosion, instability or defects in reinstatement identified during this period will be appropriately remediated.

6.6 RESIDUAL EFFECTS

6.6.1 CONSTRUCTION PHASE

The loss of land/land-use from agricultural production, and the excavation and relocation of soil, subsoil and bedrock is an inevitable part of the development works and therefore no mitigation measures, other than standard construction best

practices, are proposed. As a result, the likely residual effect with respect to soil, subsoil, and bedrock excavation is assessed to be the same as the pre-mitigation effects, which is Slight to Moderate significance. The land-use residual effect significance will remain as Slight.

The residual effects with respect to soil/subsoil erosion and contamination effects are assessed to be imperceptible.

A detailed peat stability assessment (FT, 2026) has been completed for the development proposal. The findings of that assessment have demonstrated that there is a low risk of peat failure at the site as a result of the proposed project. With the implementation of the control measures outlined above the residual effect is negative, imperceptible, direct, permanent, unlikely effect on peat stability.

Following installation of the underground electricity line, the trench and associated working areas within the Kilcormac Esker County Geological Site will be reinstated to their original ground levels, contours and surface condition. The measures set out in **Section 6.5.1.6** will minimise the extent of disturbance and retain the overall topography and morphology of the esker. While localised disturbance of the geological material within the trench footprint will remain, the residual effect will be negative, direct, Slight, likely and permanent and will not be significant.

6.6.2 Operation Phase

No significant residual effects are assessed as likely to occur during the operation phase.

6.6.3 Decommissioning Phase

No significant residual effects are assessed as likely to occur during the decommissioning phase.

6.7 SUMMARY

Excavations will be required for site levelling and for the installation of turbine foundations, crane hardstands, access tracks, electrical cabling, switch room building and underground electricity line infrastructure. This will result in the permanent removal of soil, subsoil and bedrock (where present) at excavation locations. Excavated soil and subsoil will be used for reinstatement and landscaping, where appropriate; while excavated bedrock will be used in the construction of crane hardstandings and access tracks (where possible); and where excess material arises, this will be disposed of at the designated spoil deposition areas.

All elements of the project, including the proposed wind farm, electrical switch room building, underground electricity line and turbine haul route works, have been assessed together and are not treated as separate developments for the purposes of the cumulative assessment. The potential for cumulative effects with the permitted Cush Wind Farm Phase I development, the separately proposed Mullanafawnia 110kV substation and the other existing, permitted and proposed developments identified in **Chapter 1** has been assessed, including on the basis of concurrent construction. It is concluded that no significant cumulative effects on land, soils or geology are likely.

In conclusion, this assessment has determined that the project (including proposed wind farm, underground electricity line and haul route works), will not result in any likely significant effects on land, soils and the geological environment.

Where effects are likely to occur, such as soil erosion or contamination, the implementation of best-practice construction techniques and appropriate mitigation measures will ensure that any residual effects are imperceptible. Where it is not possible to implement mitigation measures, such as in respect of the direct excavation of soil and subsoil, the level of effect is considered to be slight to moderate significance and will not be significant.

6.8 REFERENCES

Applied Ground Engineering Consultants (AGEC) (2004). Derrybrien Wind Farm Final Report on Landslide of October 2003.

British Standards Institution (BSI). (2015) BS5930 - Code of Practice for Site Investigations.

British Standards Institute (1981). BS 6031:1981 Code of practice for earthworks

Department of Housing, Planning and local Government, 2018: Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment.

Environmental Protection Agency (2022): Guidelines on the Information to be contained in Environmental Impact Assessment Reports.

Environmental Protection Agency (2003): Advice Notes on Current Practice (in the Preparation on Environmental Impact Statements).

European Union, 2017: Guidance on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU).

Geological Survey of Ireland (GSI)1:100,000 scale Bedrock Geology Series, Sheet 15.

Institute of Geologists Ireland (2013): Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements.

National Roads Authority (2008): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.

MacCulloch, F. (2005). Guidelines for the Risk Management of Peat Slips on the Con struction of Low Volume/Low-Cost Roads over Peat. RoadEx 11 Northern Periphery.

PLHRAG (2017). Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments. Prepared for Energy Consents Unit S cottish Government, 2nd Edition. Dated April 2017.

Scottish Natural Heritage report (SNH) Research and Guidance on Restoration and Decommissioning of Onshore Wind Farms (SNH, 2013).

Skempton, A. W. and DeLory, F. A. (1957). Stability of natural slopes in London Clay. Proc 4th Int. Conf. On Soil Mechanics and Foundation Engineering, Rotterdam, vol. 2, pp.72-78