8 SOILS AND GEOLOGY

8.1 INTRODUCTION

This chapter assesses the impacts of the Project on the land soils and geology environments. The Project refers to all elements of the construction of the Firlough Wind Farm (FWF), Firlough Hydrogen Plant (FHP) and associated cable connection and delivery routes (**Chapter 2: Project Description)**. Where negative effects are predicted, the chapter identifies appropriate mitigation strategies therein. The assessment considers the potential effects during the following phases of the Project:

- Construction
- Operation
- Decommissioning

Common acronyms used throughout this EIAR can be found in **Appendix 1.2.** This chapter of the EIAR is supported by Figures provided in **Volume III** and by the following Appendix documents provided in **Volume IV** of this EIAR:

- **Figure 8.1a – Site Location & Layout Wind Farm**
- **Figure 8.1b – Site Location Hydrogen Plant**
- **Figure 8.1c – Site Layout Hydrogen Plant**
- **Figure 8.2a – Land Use Wind Farm**
- **Figure 8.2b – Land Use Hydrogen Plant**
- **Figure 8.3a - Geology Wind Farm**
- **Figure 8.3b - Geology Hydrogen Plant**
- **Figure 8.4a – Soils Wind Farm**
- **Figure 8.4b – Soils Hydrogen Plant**
- **Figure 8.5a – Subsoils Wind Farm**
- **Figure 8.5b – Subsoils Hydrogen Plant**
- **Figure 8.6a – Landslide Risk & Events Wind Farm**
- **Figure 8.6b – Landslide Risk & Events Hydrogen Plant**
- **Figure 8.7a – Peat Depths Wind Farm**
- **Figure 8.7b – Peat Depths with Slope Wind Farm**
- **Figure 8.8a – Historic Application Consent for Plots and Peat Deposition Areas**
- **Figure 8.8b – Peat Deposition Areas Constraints**

- **Appendix 8.1a – Peat Database**

A live Construction and Environmental Management Plan (CEMP) is appended to the EIAR in **Appendix 2.1**. This document will be a key construction contract document, which will ensure that the mitigation measures, which are considered necessary to protect the environment are implemented during construction, operational phase and decommissioning of the Project. It will include and apply all of the mitigation described within the EIAR where relevant, and by relevant competent engineers at the detailed design, construction, operational and decommissioning of the Project. The CEMP will be subject to ongoing review, refinement and developed throughout the Project but subject at all times to fully implementing the mitigation measures specified in the EIAR.

8.1.1 Project Description

The Project comprises the "Proposed Development" the subject of the planning application and consists of the Wind Farm and associated Infrastructure on the Wind Farm Site, the Hydrogen Plant and associated infrastructure on the Hydrogen Plant Site, the Grid Connection, the Interconnector, the Construction Haulage Route, road widening and re-alignment of sections of the Killybegs Turbine Delivery Route/Galway Turbine Delivery Route as well as associated development outside the Redline Boundary not the subject of the planning application but assessed as part of part of this EIAR, including the demolition of an existing house and sheds and the construction of a new house. Further detail on the Proposed Development is outlined in **Chapter 2 Section 2.1.**

Watercourse Crossings

Wind Farm Site

New watercourse crossings are associated with the proposed new Wind Farm Site access roads. Existing watercourse crossings are associated with existing Wind Farm Site access roads and will require upgrading. In total, during the desk based assessment 3 No. watercourse crossings over mapped rivers were identified within the proposed red line boundary of the Wind Farm Site, an additional 10 no. watercourse crossings were identified over significant drainage features associated with peat harvesting activities.

Hydrogen Plant Site

The receiving river (WFD) sub basin/ EPA Ref. Dooyeaghny_or_Cloonloughan_010 runs parallel, 70 m at the closest point along the south of the Hydrogen Plant Site which forms the Co. Sligo/Mayo County boundary and Carraun (Sligo)/Dooyeaghny (Mayo) townland boundary. While no watercourse crossings are required as part of the Hydrogen Plant Site development, the drainage design takes into account a discharge point for wastewater from the Hydrogen Plant Site via a formed headwall and outfall pipe directly to the receiving river sub basin as presented in **Figure 9.6b**.

Grid Connection Route

The proposed Grid Connection Route will include up to six (6 no.) surface water crossings that were identified as part of the desk based study which will require Horizontal Directional Drilling methodology, as presented in **Appendix 9.7** - Conceptual and Information Graphics. The remaining water crossings will be crossed utilising either under or over crossing methodology (refer to **Appendix 2.2 Outline Construction Methodology – Firlough Windfarm 110kV Loop-In Grid Connection Report Ref No.: 05806-R01-01).**

Interconnector Route

The proposed Interconnector Route will include up to six (6 no.) surface water crossings that were identified as party of the desk based study.

Killybegs Turbine Delivery Route & Galway Turbine Delivery Route

The Killybegs Turbine Delivery Route (TDR) will start at the port of Killybegs, County Donegal and utilise the N56, N15, N59, Stockane road (L5137-9) to the Wind Farm Site, traversing a length of c.6.7 km, N59 to the proposed Wind Farm Site, **Figure 8.1a**. Temporary works will be required to accommodate the delivery of the turbine components. These temporary works are included as part of this application and are located in the townlands of Ballymoghany and Cloonkeelaun. No works associated with the upgrade of the route require works to a watercourse.

Where works are required along the Killybegs Turbine Delivery Route and Galway Turbine Delivery Route within a surface water buffer zone; particular attention is required in relation to the design and methodology of bridges and/or culverts along with their associated risks Mitigation measures laid out in this Chapter and in **Section 9.5 of Chapter 9**.

8.1.2 Statement of Authority

Minerex Environmental Ltd. (MEL), is a RSK Group company. RSK (Ireland) Ltd. (RSK), part of RSK Group, is a consultancy providing environmental services in the hydrological, hydrogeological and other environmental disciplines. The company and group provide consultancy to clients in both the public & private sectors. More information can be found at www.rskgroup.com. MEL was commissioned by Jennings O'Donovan on behalf of their Client, Mercury Renewables, to carry out this Assessment Report. The principal members of the EIA team involved in this assessment include the following persons:

- Sven Klinkenbergh – B.Sc. (Environmental Science), P.G.Dip. (Environmental Protection) – Associate, Project Manager and EIA Lead Author with c. 9 years industry experience in the preparation of hydrological and hydrogeological reports.

- Lissa Colleen McClung - B.Sc. Environmental Studies (hons.), M.Sc. Environmental Science (hons.). Current Role: Graduate Project Scientist
- Mairéad Duffy- B.Sc. Environmental Management, M.Sc. Climate Change. Current Role: Graduate Project Scientist
- Jayne Stephens - B.S.c (Environmental Science), PhD (Environmental and Infection Microbiology). Current Role: Environmental Consultant

8.1.3 Assessment Structure

This EIAR chapter is structured as follows:

- This Methodology section discusses and presents how the environmental attributes associated with the Project are qualified in terms of importance and sensitivity, and how the Project effects are qualified and quantified in terms of nature, magnitude, scale, duration etc. This is important to consider and understand when reading the following sections.
- The Baseline Description presents compiled environmental data associated with the Project site/s. This data is used, often in combination with other disciplines (Hydrology, Hydrogeology, Geology and Ecology are often cross referenced) to qualify the importance and sensitivity of the receiving environmental attributes, and where necessary to risk assess hazardous environmental conditions.
- The Assessment of Potential Effects presents and discusses the likely significant effects arising as a product of the Project. The section describes how these effects will arise, and under conservative worst case or an unmitigated scenario, qualifies the effects and impacts in terms of nature, magnitude, scale, duration etc. This section will also comment on whether the effects can be mitigated.
- The Mitigation Measures and Residual Effects section presents and discusses appropriate and practical mitigation measures which will be applied to the Project. Mitigation measures described conceptually in the EIAR chapters, however key design considerations, and most importantly the objective of mitigation measures are included. This is complemented by conceptual and information graphics, which combined with descriptive text, and with reference to sited guidance, will inform the design team and relevant people / engineers in applying the measures to the engineered design and preparing associated management plans. This section also comments on the likely residual effect anticipated on the basis of adequate application of the mitigation measures. The residual effects are then also considered the objectives of mitigation the Project will commit to.
- The Summary of Significant Effects collates and summarises the residual effects arising as a product of the Proposed Development under a mitigated scenario. Included in this

section is a table presenting all of the likely significant effects, their unmitigated qualification, which mitigation measures are applied, and the qualification of residual mitigated effects which are also considered the mitigation objectives the Project is committed to.

This report references appended figures, reports and other data throughout. It is recommended to have the graphics available to view in tandem to reading the report.

8.2 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

The following sections are general to the EIAR process and where specific items are raised, they are assessed and discussed in detail in following sections of the report.

8.2.1 Assessment Methodology

The following calculations and assessments were undertaken in order to evaluate the potential impacts of the Project on the soils, geology and ground stability aspects of the environment:

- Characterise the topographical, geological and geomorphological regime of the Proposed Development from the data acquired through desk study and onsite surveys.
- Consider ground stability issues as a result of the Proposed Development, its design and methodology of construction.
- Assess the combined data acquired and evaluate any likely impacts on the soils, geology and ground stability aspects of the environment.
- If impacts are identified, consider measures that would mitigate or reduce the identified impact.
- Present and report these findings in a clear and logical format that complies with EIAR reporting requirements.

8.2.2 Relevant Legislation and Guidance

This assessment complies with the Environmental Impact Assessment Directive 2011/92/EU as revised by Directive 2014/52/EU as amended, which requires Environmental Impact Assessment for certain types of development before development consent is granted. This assessment was undertaken in accordance with the following Irish legislation:

- Planning and Development Act 2000, as amended
- Planning and Development Regulations 2001, as amended
- Wildlife Act 1976, as amended
- EC (Birds and Natural Habitats) Regulations 2011, as amended
- Heritage Act 1995, as amended

This assessment has been prepared using, inter alia, the following guidance documents, which take account of the aforementioned legislation and policy:

- BSI (1999) Code of Practice for Site Investigations - BS 5930
- CIRIA (2006) Control of Water Pollution from Linear Construction Projects – Technical Guidance (C649)
- Creighton, R. et al. (2006) Landslides of Ireland: A Report of the Irish Landslide Working
- Group. Geological Survey of Ireland, Dublin
- Department of the Environment, Heritage and Local Government (DEHLG) (2020) DRAFT Revised Wind Energy Development Guidelines
- Department of Housing, Planning, Community and Local Government (DHPLG) (2017) Interim Guidelines for Planning Authorities on Statutory Plans, Renewable Energy and Climate Change
- Environmental Protection Agency (EPA) (2015) Advice Notes for Preparing Environmental Impact Statements – DRAFT September 2015 (will supersede 2003 version once finalised)
- Environmental Protection Agency (EPA) (2022) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (supersedes 1997 and 2002 versions)
- Environmental Protection Agency (EPA) (2022) EPA Map Viewer
- Feehan, J. and O'Donovan, G. (1996) The bogs of Ireland
- Geological Survey of Ireland (GSI) (2022) Geological Survey Ireland Spatial Resources
- Gharedaghloo, B. (2018) Characterizing the transport of hydrocarbon contaminants in peat soils and peatlands
- Institute of Geologists of Ireland (IGI) (2002) Geology in Environmental Impact Statements – A guide
- IGI (2013) Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements
- Irish National Seismic Network (INSN) (ND) Recent Earthquakes
- Irish Wind Energy Association (IWEA) (2012) Best Practice Guidelines for the Irish Wind Energy Industry
- Johnston, W. (2022) Physical Landforms of Ireland
- National Roads Authority (NRA) (2008) Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes
- NRA (2008) Environmental Impact Assessment of National Road Schemes – A Practical Guide – Rev 1
- NPWS (2015) National Peatlands Strategy

- NPWS (2017) Best practice in raised bog restoration in Ireland
- Scottish Forestry Commission (2006) "Guidelines for the Risk Management of Peat Slips on the Construction of Low Volume / Low Cost Roads Over Peat"
- Scottish Government (2017) Peat Landslide Hazard and Risk Assessment: Best Practice Guide for Proposed Electricity Generation Developments
- Scottish National Heritage (SNH) (2013) A Handbook on Environmental Impact Assessment
- Teagasc (2022) Soil Map Viewer

8.2.3 Desk Study

MEL undertook desk study assessments of the soils and geology aspects of the Proposed Development site before and after field investigations. This involved the following components:

- Acquired and compiled all available maps of the Project.
- Studied and assessed the proposed locations of turbines and access roads, Wind Farm Substation, Hydrogen Plant Substation, Killybegs Turbine Delivery Route, Galway Turbine Delivery Route, Grid Connection Route, Interconnector Route, Construction Haulage Route, Wind Farm and Hydrogen Plant, associated infrastructure relative to available data on site topography and slope gradients.
- Studied and assessed the proposed locations of turbines, access roads, , Wind Farm Substation, Hydrogen Plant Substation, Killybegs Turbine Delivery Route, Galway Turbine Delivery Route, Grid Connection Route, Interconnector Route, Construction Haulage Route, Wind Farm and Hydrogen Plant, associated infrastructure to all aspects outlined above (e.g. potential borrow pit locations, typical drainage infrastructure) relative to available data on site soils, subsoil and bedrock geology.
- Overlayed Ordnance Survey of Ireland (OSI) 1:250,000, 1:50,000 and 1:10,560 (6") maps with AutoCAD plan drawings.
- Overlayed Geological Survey of Ireland (GSI) Geology maps (1:100,000) to determine site bedrock geology and the presence of any major faults or other anomalies.
- Overlayed Geological Survey of Ireland (GSI) Groundwater Resources (Aquifers), Groundwater Vulnerability, and Groundwater Recharge maps to determine site sensitivity in terms of groundwater.
- Overlayed Geological Survey of Ireland (GSI) Landslide Susceptibility maps to determine site landslide susceptibility risk classification.
- Overlayed Environmental Protection Agency (EPA) and Teagasc (Agricultural Agriculture & Food Authority) Soils and Subsoil maps (1:50,000) to determine categories of soils and subsoil and indirectly the geochemical origin for the study area.

- Searched GSI databases and publications in relation to geological extractive resources and mineral localities in the region.
- Searched GSI landslide database for records of landslide mass movement events at and near the study area.
- Searched GSI karst database for records of karst features at and near the study area.
- Searched GSI wells and springs database for records of wells or springs at and near the study area.
- Searched National Parks and Wildlife Service designated sites in the region. The Geology & Soils assessments from the previous EIS/planning applications were also considered, for example Carrowleagh Wind Farm, Co. Mayo.

8.2.4 Field Work

RSK personnel (Sven Klinkenbergh – Project Manager) carried out field investigations at the Wind Farm Site and Hydrogen Plant Site between May and December 2021 as well as December 2022. These works consisted of the following:

- Bedrock and mineral subsoil outcrop logging and characterisation.
- Confirm if peat is present at or near any Proposed Development locations.
- Peat depth probing if peat is present (depth to bedrock and/or competent subsoil).
- Gouge coring if peat is present (peat and subsoil characterisation to BS 5930 and Von Post Humification scale.
- Trial holes in mineral soil to validate desk study findings.
- Boreholes in bedrock to validate to desk study findings.
- Slope measurements at proposed turbine locations to determine slope gradient.
- Recording of GPS co-ordinates for all investigation and monitoring points in the study.
- Digital photography of significant features.

Initial Wind Farm and Hydrogen Plant Site walk overs were carried out to assess general ground conditions including topographical characteristics, including visual assessment of the receiving environment in terms of impacts arising from the existing infrastructure and practices at the sites.

The Grid Connection Route, Interconnector Route, Construction Haulage Route, Killybegs Turbine Delivery Route and Galway Turbine Delivery were all desk based assessments.

8.2.5 Peat & Slope Stability Risk Assessment Methodology

8.2.5.1 Key assessment principals

The site assessment is carried out following key principals in line with relevant guidance, namely:

- BS 5930:2015+A1:2020 Code of Practice for Site Investigations.
- Scottish Government (2017) Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments

These guidance documents are accepted best practice and widely recognised as the industry standard.

Some key insights to application and interpretation are provided from numerous documents, in particular:

- N. Boylan, P. Jennings & M. Long (2008) Peat slope failure in Ireland. Quarterly Journal of Engineering Geology and Hydrogeology.

8.2.5.2 BS 5930 – Code of Practice for Site Investigations

This document explains the important steps to be taken in preparing for, scoping, and executing site investigations of various nature. The standard covers the following aspects:

- Planning: This section provides guidance on the planning of site investigations, including the purpose of the investigation, the scope of work, and the selection of appropriate investigation techniques.
- Desk Study: This section provides guidance on the collection and review of existing information, such as geological maps, site records, and historical data, that can aid in the planning and execution of site investigations.
- Site reconnaissance: This section provides guidance on the preliminary site visit to collect data on site characteristics and conditions.
- Investigation methods: This section provides guidance on the selection of appropriate investigation methods, such as drilling, sampling, and testing techniques, based on the site characteristics and the purpose of the investigation.
- Field testing: This section provides guidance on the execution of field testing, such as in-situ testing, geophysical surveys, and environmental testing.
- Laboratory testing: This section provides guidance on the selection and execution of laboratory testing, such as soil and rock testing, and the interpretation of laboratory results.
- Reporting: This section provides guidance on the reporting of site investigations, including the presentation of data, the interpretation of results, and the conclusions and recommendations.

Scoping site investigations and sampling regime in terms of sampling locations and frequency is an important and dynamic process. While BS 5930 details sampling frequency in terms of soil and rock geotechnical and environmental testing, standard provides guidance on the spacing and frequency of sampling points, which may vary depending on the site conditions, the purpose of the investigation, and the type of sampling method being used. It is important to scope and align appropriate methodologies and sampling regime with specific objectives and within specific environments, including Peat & Slope Stability Risk Assessments in peatland areas.

8.2.5.3 Scottish Government (2017) Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments

The Scottish Government's Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments is a document that provides guidance on the assessment of landslide hazard and risk in peatland areas, particularly in relation to proposed electricity generation developments. The document is published and written in context of Scottish peatlands, however in the absence of relevant guidance, it is widely accepted as relevant guidance in Ireland.

The guide emphasizes the need for a comprehensive assessment of landslide hazard and risk in peatland areas, which is particularly important due to the unique characteristics of these environments. Peatlands are often found in areas of high rainfall, and the accumulation of peat can result in unstable ground conditions, which can increase the risk of landslides.

The guide provides a step-by-step approach to landslide hazard and risk assessment, including the identification of potential landslide triggers, the characterization of the peatland environment, the assessment of landslide susceptibility, and the estimation of landslide hazard and risk. The guide also provides guidance on the selection of appropriate methods for landslide hazard and risk assessment, such as field mapping, remote sensing, and numerical modelling. The guide emphasizes the importance of stakeholder engagement and communication in the landslide hazard and risk assessment process, particularly in relation to proposed electricity generation developments, which can potentially have significant impacts on the surrounding environmental receptors and communities. The guide covers the following aspects which should be included in the site risk assessment:

- Sampling Regime: The guide recommends a sampling regime that includes both surface and subsurface surveys, using techniques such as; depth probing, gouge coring, trial-pitting, drilling, and geophysical surveys. The aim is to obtain a comprehensive understanding of the geology and hydrogeology of the site, as well as the depth and condition of the peat layer.

- Assessment of Desk Top Data: The guide recommends an assessment of desktop data to identify potential sources of instability, such as steep slopes, drainage features, and areas of peat degradation. This assessment should be based on available data sources such as geological maps, aerial photographs, and LiDAR data.
- Degree of Geomorphological Assessment: The guide recommends a high degree of geomorphological assessment, using methods such as aerial photography interpretation and field mapping to identify potential instability features such as landslides and erosion channels. Many sources of data can input to the interpretation of stability risk at any particular location, and field reconnaissance is also a valuable tool in this respect.
- Interpretation of Data: The guide recommends a detailed interpretation of all data collected, including the results of field surveys and laboratory testing. This should involve the identification of key parameters such as peat depth, soil properties, and groundwater levels or saturation, as well as the integration of all available data to develop a comprehensive understanding of the potential for instability. This can result in screening out peat stability risk, for example; in areas of extensive shallow bedrock or bedrock outcrops, or areas with very minor inclines. Conversely, high risk areas can potentially be identified by desk top assessment alone, for example; steep slopes in excess 15 degrees, or areas with historical stability issues or historic landslides.
- The development of numerical models for peat stability risk assessments has been driven by advances in computer technology (e.g. QGIS) and modelling techniques, as well as an increased awareness of the risks associated with peat instability. The use of numerical modelling in peat stability risk assessments typically involves the following steps:
    - Development of a conceptual model: This involves the development of a conceptual model of the site based on the results of field investigations and laboratory testing. The conceptual model should include information on the geometry and properties of the peat layer, as well hydrogeological characteristics such as pore water pressure or bul unit weight (saturation).
    - Selection of appropriate modelling techniques: There are a variety of modelling techniques that can be used to simulate peat stability, including finite element and finite difference methods. The selection of an appropriate modelling technique will depend on the specific characteristics of the site and the goals of the assessment.
    - Calibration and validation of the model: The model is calibrated and validated using data collected during field investigations and laboratory testing. This involves adjusting model parameters to improve the match between simulated and observed data.

Overall, the guide emphasizes the importance of a comprehensive and integrated approach to peat landslide hazard and risk assessments, which includes a thorough sampling regime, an assessment of desktop data, a high degree of geomorphological assessment, and a detailed interpretation of all data collected. By following these guidelines potential hazards and risks associated with peat instability can be identified and managed effectively.

8.2.6 Desktop baseline characterisation & approach

The Project and Proposed Development are assessed using QGIS mapping software with relevant environmental data layers published by relevant bodies including; EPA, and GSI.

Open source Global Digital Elevation Model (GDEM) data is used to determine the general nature of the topography at the site, including interrogating elevation data to determine slope inclines across the site.

All Areas of the Project undergo preliminary risk assessment and development constraints are identified and mapped. This will include slope inclines >8 degrees, 50 m and 150 m surface water or other environmental receptor buffers, etc. This data is used to inform the initial design phase of a project and to scope the site survey and sampling regime.

On completion of the initial phases of site surveys, georeferenced data is compiled and mapped in QGIS along with the initial desktop data. The Project undergoes further preliminary risk assessment, preliminary modelling and constraints are updated and the process repeats i.e. phase 2.

Other environmental data, including peatland ecological data is incorporated where relevant.

8.2.7 Peat depth probing & topography assessments

Peat depth probing was undertaken at the site including at each proposed potential turbine location, at proposed locations for other infrastructure, and elsewhere on site where desktop assessment could not screen out stability risk. Peat depth probing is presented in **Figure 8.7a.**

Depth probing was conducted using a fibreglass depth probe and at each survey point the depth of peat, local incline (incline within a c. 5-10 m radius of the survey point) and grid reference (Irish Grid) were recorded. Notes on observations were also recorded including time of taking photographs, presence of drains etc.

8.2.8 Peat gouge coring & qualitative assessments

Gouge coring of peat was carried out to a limited extent, as the majority of the Proposed Development consisted of generally shallow peat depths. Peat quality assessment were made at existing cuttings and during trial pitting.

8.2.9 Piezometer installation & groundwater assessments

Not carried out. Peat depth at the site observed to be shallow generally at the Proposed Development.

8.2.10 Topography & substrate topology

Using available topographical data provided for the site and peat thickness / depth data obtained during MEL surveys, the topology (characteristics of a surface) of the substrate underlying the peat on site was assessed and cross sections generated to evaluate variance from the surface topology.

8.2.11 Peat stability numerical assessment

This stability assessment has been undertaken using a relatively simple infinite slope stability approach (Boylan, N, and Long, M, 2012) (derived from Bromhead's formula (Scottish Gov., 2017)), as follows:

$$FoS = \frac{cu}{yz \sin a \cos a}$$

For the purpose of this assessment, the above formula will be referred to as the Factor of Safety (FoS) Formula.

Qualifying peat stability at all peat survey points and trial pit locations was done using the following parameters:

Table 8.1: Formula Parameters & Symbols

Symbol	Description	Unit
FoS	Factor of Safety	FoS
c_u	Effective cohesion or Undrained Shear Strength	kPa
y	Bulk Unit Weight of Peat	kN/m^3
z	Depth to failure plain	m
α	Slope Angle	Degrees

The Factor of Safety (FoS) result will range from 0 to infinity, however the following ranges are prescribed ratings as follows:

Table 8.2: Factor of Safety (FoS) Classifications (Scottish Gov., 2017)

Description	FoS Value Range	Classification
Stable	>1.3	Acceptable
Marginally Stable	1.0 > < 1.3	Acceptable
Unstable	<1.0	Unacceptable

As per the guidance listed in Section 2 of this report, FoS values of 1.0 or greater are considered acceptable in terms of peat stability (Scottish Gov., 2017).

The assessment has been completed on the basis of 2 no. scenarios, which are as follows:

- Scenario A – Peat stability in terms of the receiving environment as is, that is using the depth of peat observed and recorded during site surveys.
- Scenario B – Peat stability in terms of the in-situ peat with 1 m fill (presumed peat) placed on top, that is using the depth of peat observed and recorded during site surveys plus 1 metre fill (depth + 1.0 m). This is the assessment worst case scenario, and this will be used to assess stability at proposed infrastructure locations.

Undrained shear strength (effective cohesion) (cu) has been derived by means of assessing moisture content results, which is; there is a correlation between peat moisture content and shear strength (effective cohesion). Shear vane testing has been carried out on the site however, shear vane test, or in situ barrel shear tests are not considered representative of shear strength characteristics of the peat being assessed in terms of stability assessment given numerous flaws with the test itself, namely; the shear vane test evaluates the shear strength where by the force is exerted in a vertical and cylindrical plane, which is not indicative of forces at play with respect to slope stability or mass movement; and fibres and roots within the peat will effect the test itself, potentially exaggerating, or giving misleading data. The following graph presents conceptual shear strength values for peat (Boylan N, Jennings P & Long M., 2008).

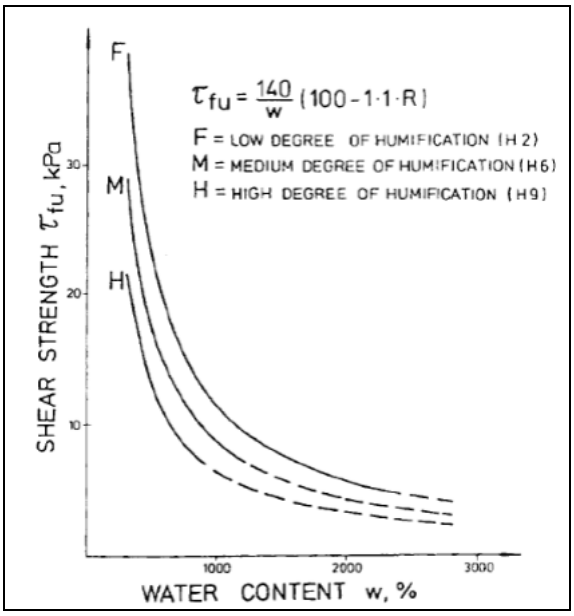

Figure 8.1: Correlation Between Moisture Content and Shear Strength of Peat (N. Boylan, P. Jennings & M. Long, 2008)

The following table presents the typical minimum, average and maximum moisture content which have been used to determine indicative shear strength values for the Wind Farm Site.

Table 8.3: Peat Moisture Content Range & Indicative Shear Strength

Category	Moisture Content (%)	Indicative Shear Strength (kPa)
Minimum	200	>20
Average	750	10-20
Maximum	1500	<10

For the purpose of assessing peat stability for the Wind Farm Site a conservative undrained shear strength (effective cohesion) value will be used in numerical assessments, i.e., 3.5 kPa. In other words, a weak shear strength for peat is used for the assessment. Actual peat shear strengths will likely range higher, up to one to two orders of magnitude higher.

In situ bulk density (kg/m^3), or bulk unit weight (kN/m^3) of peat (y) is typically within the range of 900-1100 kg/m^3 (Munro R, 2004), or 8.8-10.8 kN/m^3. For the purpose of assessing peat stability for the Wind Farm Site a conservative bulk unit weight value will be used in numerical assessments i.e., 11 kN/m^3. In other words, peat is considered saturated (and heavy) in the assessment. Actual bulk unit weight or saturation is likely less, particularly in areas possessing existing drainage networks associated with active peat cutting.

The depth to failure plane (z) is presumed to be thickness or depth of peat at any given sampling point being assessed, however it should be noted that the failure plane can potentially be within peat (peat on peat movement), or the substrate i.e., weathered rock or underlying soils. In using the full depth of peat, the assessment considers the full bulk unit weight of the in situ peat at a particular location.

Slope angle (α) is presumed to be topographical incline measured on site / evaluated using elevation data at any given sampling point being assessed, however it should be noted that the slope angle (α) relates to the failure plane angle, which is presumed to be the peat and substrate interface, and which is presumed to be parallel to the surface when using FoS Formula (Infinite Slope Formula). In reality the underlying substrate is unlikely to be parallel to the surface topology. This is evidenced by varying peat depths across an area of relatively stable or flat surface topology.

It should be noted that FoS Formula does not account for forces related to the toe and head of an area or mass of soil with the potential for mass movement, which is; in reality the Infinite Slope formula will likely exaggerate stability conditions negatively.

The following table lists parameter values, including inferred conservative parameter values used in numerical assessments.

Table 8.4: Formula Parameters, Symbols & Inferred Conservative Values

Symbol	Description	Value	Unit
c_u	Effective cohesion	3.5	kPa
y	Bulk Unit Weight of Peat	11	kN/m^3
z	Depth to failure plain	Depth of Peat	m
α	Slope Angle	Surface Topography	Degrees

8.2.12 Risk Matrices & Ranking

In assessing the risk in relation to peat stability on site it is important to rate the risk in terms of the hazard, the likelihood and the consequences if any such issue should arise. Therefore, the slope stability risk assessment considers the following parameters, which are assessed by means of a series of risk matrices (Scottish Gov., 2017).

Table 8.5: Parameters Included in Risk Matrices and Assessed

Category	Description
Landslide History	Considers the likelihood of landslide events occurring based on the history of the site, including the current site use.
Factor of Safety	As described above, includes the following: • Peat depth • Peat quality / condition • Moisture content • Incline (surface topography) • Shear strength • Bulk unit weight of peat
Substrate Topology	Identifying and qualifying variance in substrate topology and qualifying variance from theory underlining the stability formula used i.e., Infinite Slope (Parallel and no foot and head forces)
Significance of Receptor	Qualifying potential receptors in terms of significance.
Distance to Receptor	Qualifying localised Proposed Development areas in terms of distance to nearest receptor.

Considering the above parameters, the stability assessment follows the following steps:

1. FoS_{RAW} – Assess the site in terms of soil stability using the FoS Formula and calculate a Factor of Safety (FoS) using the *raw* data. This step is considered as preparation of the data obtained for the site i.e., translating the data to a value related to stability, and is not considered the final output of the stability assessment.
2. $FoS_{ADJUSTED}$ – Assess the FoS_{RAW} values in terms of suitability of the application of FoS Formula by considering the history of landslides in relation to the proposed site, and the topology of the substrate compared to the surface topology of the site. This is done by means of a risk matrix which qualifies the point, and also applies a coefficient for the next risk assessment step.
3. Risk Ranking RR_{SF} – The $FoS_{ADJUSTED}$ data is assessed in terms of significance of associated receptor. This is done by means of a risk matrix which qualifies the point, and also applies a coefficient for the next risk assessment step.
4. Risk Ranking RR_{D} – The RR_{SF} data is assessed in terms of distance to associated receptor. This is done by means of a risk matrix which qualifies the point.

Results and conclusions made by means of the above risk assessment are viewed as two tiered, that is:

1. The likelihood of a stability issue or landslide while considering the significance of the receptor (RRSF).

2. The consequence of a stability issue or landslide while considering the distance to the receptor (RRD).

For example, (1) The risk of a stability issues or landslide occurring at location X and impacting on receptor Y is negligible. (2) Considering the short distance from location X to receptor Y, in the unlikely event that an issue did arise the risk of adverse impacts effecting receptor Y is moderate.

Risk Matrices are presented in **Appendix 8.1a**.

8.2.13 Interpretation of Results

Results of the numerical stability risk assessment are modelled / mapped and interrogated in the context of site topography, site conditions, the Project and receptor sensitivity and susceptibility. Interpretation of results in the context of the development, activity and any potential consequences is an important step of the slope stability risk assessment. It is important to consider groups of data sets and site-specific dynamics at a particular location (for example, at a proposed turbine location) and to qualitatively risk assess stability in the context of all observed site characteristics, including topography, substrate topology, geology, hydrogeology, and hydrology, etc. For example; data might indicate a single point of unacceptable FoS / stability, however this needs to be considered in context of neighbouring data and actual site conditions, such as the presence of deep peat within a localised basin confined by shallow bedrock at the surface at neighbouring points, that is; deep, "unstable" peat (by numerical model) observed to be confined by shallow bedrock does not equate to an elevated risk of a catastrophic landslide event occurring, but does equate to potential localised stability issues arising if excavating at that particular location with deep peat.

In turn, any potential stability hazard must be considered in risk assessments in terms of potential consequences to receptors, and not simply likelihood of a stability issues arising. For example, in an area with low risk in terms of stability or Factor of Safety (FoS), but immediately and directly upgradient of a sensitive receptor such as a surface water body, in the unlikely event (low risk = acceptable FoS) that a significant stability issue should arise, due to the proximity to the receiving receptor the consequences of such an event have the potential to be significant.

8.2.14 Methodology Adopted for the Evaluation of Potential Effects

8.2.14.1 Sensitivity

Sensitivity is defined as the potential for a receptor to be significantly affected by a proposed development.[1] Potential affects arising by a proposed development in terms of soils and geology will be limited to a localised scale, and therefore in describing the sensitivity of soils and geology it is appropriate to rate such while considering the value of the receiving environment or site attributes.

The following table presents rated categories and criteria for rating site attributes.

Table 8.6: Criteria for Rating Site Attributes – Soils and Geology Specific

Importance	Criteria
Extremely High	Attribute has a high quality or value on an international scale.
Very High	Attribute has a high quality, significance or value on a regional or national scale.
High	Attribute has a high quality, significance or value on a local scale.
Medium	Attribute has a medium quality, significance or value on a local scale.
Low	Attribute has a low quality, significance or value on a local scale.

Considering the above categories of rating importance and associated criteria, the following table presents rated sensitivity categories.

Table 8.7: Criteria for Rating Site Sensitivity – Landscape Character Specific

Importance	Criteria
High Sensitivity	Key characteristics and features which contribute significantly to the distinctiveness and character of the landscape character type. Designated landscapes e.g. National Parks, Natural Heritage Areas (NHAs) and Special Areas of Conservation (SACs) and landscapes identified as having low capacity to accommodate proposed form of change, that is; sites with attributes of **Very High Importance**.
Medium Sensitivity	Other characteristics or features of the landscape that contribute to the character of the landscape locally. Locally valued landscapes which are not designated. Landscapes identified as having some tolerance of the proposed change subject to design and mitigation etc., that is; sites with attributes of **Medium to High Importance**.
Low Sensitivity	Landscape characteristics and features that do not make a significant contribution to landscape character or distinctiveness locally, or which are untypical or uncharacteristic of the landscape type. Landscapes identified as being generally tolerant of the proposed change subject to design and mitigation etc, that is; sites with attributes of **Low Importance**.

[1] Environmental Protection Agency (EPA) (2022) "Guidelines on the Information to be Contained in Environmental Impact Assessment Reports"

8.2.14.2 ***Magnitude***

The magnitude of potential impacts arising as a product of the Proposed Development are defined in accordance with the criteria provided by the EPA, as presented in the following table.

Table 8.8: Describing the Magnitude of Impacts

Magnitude of Impact	Description
Imperceptible	An effect capable of measurement but without significant consequences.
Not Significant	An effect which causes noticeable changes in the character of the environment but without significant consequences.
Slight Effects	An effect which causes noticeable changes in the character of the environment without affecting its sensitivities.
Moderate Effects	An effect that alters the character of the environment in a manner that is consistent with existing and emerging baseline trends.
Significant Effects	An effect which, by its character, magnitude, duration or intensity, alters a sensitive aspect of the environment.
Very Significant Effects	An effect which, by its character, magnitude, duration or intensity, significantly alters most of a sensitive aspect of the environment.
Profound	An effect which obliterates sensitive characteristics.

In terms of soils and geology, magnitude is qualified in line with relevant guidance, as presented in the following table.

Table 8.9: Qualifying the Magnitude of Impact on Soil and Geological Attributes

Magnitude of Impact	Description	Example
Large Adverse	Results in a loss of attribute.	Removal of the majority (>50%) of geological heritage feature.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute.	Removal of part (15-50%) of geological heritage feature.
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute.	Removal of small part (<15%) of geological heritage feature.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity.	No measurable changes in attributes.
Minor Beneficial	Results in minor improvement of attribute quality.	Minor enhancement of geological heritage feature.
Moderate Beneficial	Results in moderate improvement of attribute quality.	Moderate enhancement of geological heritage feature.
Major Beneficial	Results in major improvement of attribute quality.	Major enhancement of geological heritage feature.

8.2.14.3 Significance Criteria

Considering the above definitions and rating structures associated with sensitivity, attribute importance, and magnitude of potential impacts, rating of significant environmental impacts is done in accordance with relevant guidance as presented in the Table below (NRA, 2008). This matrix qualifies the magnitude of potential effects based on weighting same depending on the importance and/or sensitivity of the receiving environment. In terms of Hydrology and Hydrogeology, the general terms for describing potential effects (**Table 8.8: Describing the Magnitude of Impacts**) are linked directly with the Proposed Development specific terms for qualifying potential impacts (**Table 8.9: Qualifying the Magnitude of Impact on Geological Attributes**) therefore, qualifying terms (**Table 8.10**) are used in describing potential impacts of the development. This is largely driven by the likely transboundary far reaching characteristic of potential effects arising as a product of the Proposed Development in terms of Hydrology and Hydrogeology.

Table 8.10: Sensitivity (Importance of Attribute) & Magnitude of Impact Matrix

Sensitivity (Importance of Attribute)	Magnitude of Impact			
	Negligible (Imperceptible)	**Small Adverse (Slight)**	**Moderate Adverse (Moderate)**	**Large Adverse (Significant to Profound)**
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

8.2.15 Scoping Response and Consultation

A full list of scoping responses and consultations are set out in Chapter **1: Consultation Responses,** Soils and geological related consultations are listed in **Table 8.11** below.

Table 8.11: Scoping Responses and Consultation

Consultee Organisation	Response Received	Implications for the EIA/Design	EIAR Chapter/Section where comments have been addressed
Mayo County Council Planning Department	Preplanning meeting held on 19th January 2023 with Alan Dilucia (Senior Planner Mayo County Council – MCC), John McMyler (Senior Planner Mayo County Council – MCC), Brendan Munnelly (Executive Planner Mayo County Council – MCC), Carina McGinty (Executive Planner Mayo County Council – MCC), Killian Farrell (Senior Environmental Officer Mayo County Council – MCC). Orla Bourke (Senior Executive Engineer Mayo County Council Roads Department – MCC), John Kearns (Mayo County Council Roads Department – MCC), Declan Ginnelly (Area Engineer Mayo County Council Roads Department – MCC) Topics discussed; MCC queried if Mercury or JOD had consulted with the correct department in TII (Tara Spain). MCC queried the timeline for the construction of the project and when a road opening license would be sought for it. MCC queried what the reinstatement details were for the road where the grid connection and interconnector is to be placed. MCC queried if passing bays would be proposed along the construction haulage routes. MCC (John Kearns) requested that the TLI planning drawings be issued to MCC for comment before submitting the planning application. MCC suggested that JOD should review the further information request for the proposed hydrogen plant in Bellacorrick.	All items raised were considered during the design and assessment processes. EPA Preplanning meeting requested. IFI sent scoping documents.	**Chapter 2**; Project Description, **Chapter 10;** Air and Climate and **Chapter 15** Traffic and Transport addressed Hydrogen transport vehicles. The Grid Connection and interconnected are addressed in **Chapter 2** Project Description and **Chapter 15** Traffic and Transport. **Chapter 8** Soils and Geology, land take, excavations, road widening.

Consultee Organisation	Response Received	Implications for the EIA/Design	EIAR Chapter/Section where comments have been addressed
	MCC queried how the integrity of the local roads would be maintained after the installation of the grid connection and the interconnector. MCC noted that JOD should review their comments issued in 2020 when the first round of scoping was completed.		
Sligo County Council	A Pre-Planning meeting was held at Sligo City Hall Council Chamber on 29/11/2022 with Frank Moylan (Senior Planner Sligo County Council – SCC) and Ian Bailey (Senior Executive Planner Sligo County Council – SCC) A presentation was given outlining the project purpose, impact assessments carried out and the application process under SID guidelines. The main geological related points of interest during the consultation included: • Sligo County Council queried if the interconnector was to be placed in the public roads for its entire route. • Sligo County Council noted that they have concerns regarding construction of an industrial development in an unspoilt rural setting. • Sligo county council noted that as per their county development plan they are supportive of renewable energy projects.	All items raised were considered during the design and assessment processes.	**Soils and Geology** addressed in Chapter 8
Geological Survey of Ireland	Response received 26/4/2022. Containing the same guidance received from initial scoping round on where to find data sets on information to be contained in the EIAR.	NA	NA

Consultee Organisation	Response Received	Implications for the EIA/Design	EIAR Chapter/Section where comments have been addressed
Irish Peatland Conservation Council	No response to second round of scoping received	NA	NA
Minister for Agriculture, Food and the Marine, Department of Agriculture, Food and the Marine	Acknowledgement of receipt received 29/4/2022 from Hilda Verling, Minister's Office. No further response received.	NA	NA
Minister for Environment, Climate and Communications, Department of the Environment, Climate and Communications	No additional information received in second scoping response	NA	NA
Department of Transport	Response Received 7/4/2022 from Jacqui Traynor. The main points included; It should be noted that the Department considers the construction involved in providing this development and especially, the connection cables to the national grid may have effects on both the environment and the Regional and Local Road network. Where the developer proposes the placement of any cables (or additional cables) in one or more trenches within the extents of the (regional and local) public road network, it is necessary to consider the following: • Their installation within the lands associated with the public road may affect the stability of the road. In particular where the road is a "legacy road" (where there is no designed road structure and the subgrade may be poor or poorly drained) the design needs to take account of all the variable conditions and not be based on a sample of the general conditions.	NA	NA

Consultee Organisation	Response Received	Implications for the EIA/Design	EIAR Chapter/Section where comments have been addressed
	• The possible effect on the remaining available road space (noting that there may be need to accommodate other utilities within the road cross-section in the future). • The Department consider it important that the examination of the proposal should include consideration of the following: - Examination of options other than the routing of cables along the public road, - Examination of options for connection to the national grid network at a point closer to the wind farm in order to reduce the adverse impact on public roads. - Details of where within the road cross section cables are to be placed so as to minimise the effect on the Roads Authority in its role of construction and maintenance, - Examination of details of any chambers proposed within the public road cross section so as to minimise the effect on the Roads Authority in its role of construction and maintenance and, - Rationalisation of the number of cables involved (including existing electric or possible future cables) and their diversion into one trench, in order to minimise the impacts on the road network and the environment along the road boundary (hedgerows). The response also included a list of recommended planning conditions.		

Consultee Organisation	Response Received	Implications for the EIA/Design	EIAR Chapter/Section where comments have been addressed
The Heritage Council	Response received 28/4/2022; Unfortunately, due to busy work commitments, the Heritage Council is unable to respond to the application at this time. They would be grateful if you would place this correspondence on the planning file.	NA	NA

8.3 BASELINE DESCRIPTION

8.3.1 Introduction

The Proposed Development associated with the Project is situated upon two separate sites, i.e., the Wind Farm Site and the Hydrogen Plant Site. Other components of the Project are located on lands connecting these sites as well as other discrete locations which are required to facilitate the Project. The following sections describe the location and setting of the Wind Farm Site, the Hydrogen Plant Site and the other lands associated with the Project.

The Proposed Development is 'significant' relative to the historic use of the Wind Farm Site which is characterised as being rural peatland generally, however, there are a number of established wind farms in the region including, for example; Carrowleagh Wind Farm directly to the adjacent (east) and the Bunnyconnellan Wind Farm c. 5 km south of the proposed site (**Chapter 2, Figure 2.3**).

8.3.2 Site Description

Wind Farm Site

The Wind Farm Site is situated in the townland of Carrowleagh, northeast of the village of Bunnyconnellan, Co. Mayo, Irish Grid Reference (ITM): 536617, 821819. The Wind Farm Site is within the lower northwestern foothills of the Ox Mountains, adjacent to the county boundary between Mayo and Sligo. The site elevations range from 120 m O.D. in the northwest up to c. 170 m O.D. in the southeast, **Figure 8.1a.**

The Wind Farm Site area measures approximately 445 ha and is covered in extensive cutover blanket bog with some forestry to the west and southwest of the boundary. Due to its historical use, the Wind Farm Site is partially connected via a network of existing access tracks to turf cutting plots, which will require widening for turbine and machinery delivery. In addition to this, there is an extensive drainage network throughout the Wind Farm Site that has been established to facilitate peat cutting in the area (**Figure 2.13)**. It is noted that peat cutting will continue adjacent to the Wind Farm Site for the duration of the Project.

Spoil deposition areas will be created as part of the Proposed Development on the Wind Farm Site. These areas have mitigated by avoidance of constraints and are presented in **Figure 8.8b**. The three spoil deposition areas will be created near T2, T12 and the final area is directly east of T4, northeast of T3. Peat Depths are as follows T2 area – 2.0 m, T12 area – 2.0 m and east of T4 – 1.0 m.

The three spoil deposition areas will be located within 50 m and 25 m surface water buffer zones. Potential for localised stability issues and risk to SW receptors. Mitigation measures outlined in **Section 8.5.2.5.2.1** of this chapter aims to reduce these risks to SW receptors.

Watercourse crossings over mapped rivers at the Wind Farm Site as presented in Hydrology **Figure 9.6a**; include the following:

- Brusna (North Mayo)_020:
  - **WCC1:** Existing; recommend Clear Span Bridge (ITM: 535655.0, 822422.7),
  - **WCC2:** Existing; recommend Clear Span Bridge (ITM: 535962.07, 822192.53),
  - **WCC3:** New; recommend Clear Span Bridge (ITM: 535618.8, 821488.6)

All identified existing culverts that will require upgrading at the Wind Farm Site, pending an assessment by a qualified engineer, including:

- **WCC4 and WCC4a:** Existing; (ITM: 536307.9, 820831.0)
- **WCC5:** Existing; (ITM: 536333.6, 820511.8)
- **WCC6:** New; (ITM: 536248.3 821365.5)
- **WCC7:** Existing; (ITM: 536219.8, 821696.3)
- **WCC8:** Existing; (ITM: 535928.1, 822525.1)
- **WCC9:** New; (ITM: 537144.7, 822336.6)
- **WCC10:** Existing; (ITM: 537155.3, 822183.6)
- **WCC11:** New (ITM: 536636.0, 822009.3)
- **WCC12:** Existing; (ITM: 536906.3, 821550.5)
- **WCC13:** New (ITM: 535387.5, 822742.1)

When working within a surface water buffer zone particular attention is required in relation to the design and methodology of bridges and/or culverts along with their associated risks, mitigation measures laid out in Section 9.5 of the Hydrology Chapter.

Hydrogen Plant Site

The Hydrogen Plant Site is located in a rural setting and has an area of c. 6.5 ha, 0.6 km from the N59 national road. It is located in County Sligo in the townland of Carraun, adjacent to the Co. Mayo border, 6 km west of the Wind Farm Site, **Figure 8.2b.** Site elevations range from 53 m OD at the northwest corner to 45 m OD along the southern boundary. A watercourse runs 70 m at the closest point along the south of the Hydrogen Plant Site which forms the Co. Sligo/Mayo County boundary and Carraun (Sligo)/Dooyeaghny (Mayo) townland boundary.

The Hydrogen Plant Site is pastureland, currently an agricultural field used for grazing horse. There is an area of cutover, boggy peat adjacent to the south of the site boundary which has been avoided. It is 5.3 km northwest of the village of Bunnyconnellan (Co. Mayo) and 2.9 km south of the village of Corballa (Co. Sligo).

As outlined in **Section 8.1.1**, no watercourse crossings are required as part of the Hydrogen Plant Site development, the drainage design takes into account a discharge point for wastewater from the Hydrogen Plant Site via a formed headwall and outfall pipe directly to the receiving river sub basin.

Grid Connection Route

The Wind Farm will be connected to the Glenree – Moy 110 kV Overhead Line (OHL) via underground cabling (UGC). The Grid Connection Route will extend approximately 6.65 km in length and traverse in an east to southeasterly direction from the Wind Farm Substation to the Glenree – Moy 110 kV Overhead Line. Approximately 300 m of the Grid Connection Route will follow internal Wind Farm access roads proposed for the Project / Forestry Roads, 375 m of cabling will cross private lands, while c. 6,040 m is located along the public road corridor until reaching the OHL in Rathreedaun. The grid connection cable will be buried, with intermittent cable joint bays and other ancillary infrastructure where required. There will be two new 16 m high steel lattice loop-in/out masts at the connection point location, they will be 6.196 m wide and will require 4 x 3.6 m² foundation stands that have a total width of 10.7 m.

The identified watercourse crossings along the proposed Grid Connection Route as presented in Hydrology **Figure 9.6b**; include:

- Brusna (North Mayo)_020
    - **GCR WCC6:** (ITM: 533876.6,822171.4)
    - **GCR WCC5:** (ITM: 532571.2,821960.1)
- Glenree_020:
    - **GCR WCC4:** (ITM: 532665.2, 821361.9)
    - **GCR WCC3:** (ITM: 532457.2, 820870.0)
- Behy (North Mayo)_010:
    - **GCR WCC2**: (ITM: 532509.2, 820278.8)
    - **GCR WCC1:** (ITM: 532738.0, 819171.9)

Interconnector Route

The interconnector route will connect the Wind Farm Substation to the Hydrogen Plant Substation, extending 8.2 km along local roads in the townlands of Carrowleagh, Carha, Knockbrack and Carraun. of which 6.7 km is located along the public road corridor, 0.44 km is in the Wind Farm Site along existing roads and the remaining 1.05 km is located off road in third party lands.

The identified watercourse crossings along the proposed Interconnector Route as presented in Hydrology **Figure 9.6c**; include:

- Brusna (North Mayo)_020
  - **GCR WCC5:** (ITM: 532571.2, 821960.1)
  - **GCR WCC6:** (ITM: 533876.6, 822171.4)
  - **ICR WCC4:** (ITM: 532363.8, 822055.4)
  - **ICR WCC3:** (ITM: 532067.2, 822288.0)
  - **ICR WCC2:** (ITM: 531535.6, 822437.5)
  - **ICR WCC1:** (ITM: 531027.8, 822551.4)

Killybegs Turbine Delivery Route, Galway Turbine Delivery Route & Construction Haulage Route

The wind turbine components will be delivered from either Killybegs Port or Galway Port to the Wind Farm Site.

Killybegs Turbine Delivery Route; From Killybegs Port the turbine nacelles, tower hubs and rotor blades will be transported to the N56 some 4 km northeast of the harbour. The route primarily follows the national road network namely the N56, N15, N4 and N59 before turning left onto the local road L-2604-0, L-5137-0 and L-5137-9 towards the Wind Farm Site entrance.

Galway Turbine Delivery Route; From Galway Port the turbine nacelles, tower hubs and rotor blades will be transported to the N83 some 3 km north of the harbour. The route primarily follows the national road network namely the N83, N17, N5, N4 and N59 before turning left onto the local road L-2604-0, L-5137-0 and L-5137-9 towards the Wind Farm Site entrance.

The full description can be found in **Chapter 2: Project Description**.

The Killybegs Turbine Delivery Route and Galway Turbine Delivery Route will cross a number of watercourses as presented in Hydrology Figure 9.6c:

- Bellawaddy_020: **TDR WCC1** - (ITM: 532337.0, 826153.5)

- Bellawaddy_010: **TDR WCC2** - (ITM: 533267.9, 825695.6)
- Brusna (North Mayo)_010: **TDR WCC3** - (ITM: 533913.4, 825282.7)
- Brusna (North Mayo)_020: **TDR WCC4** - (ITM: 535009.4, 821949.8

No upgrade works are necessary on the Construction Haulage Routes (L6612 and L1102) to facilitate the delivery of materials. As outlined in **Chapter 15, Section 15.4.4**.

8.3.3 Land Use

Mapped land use for the Wind Farm, Hydrogen Plant, Grid Connection Route, Interconnector Route and Killybegs Turbine Delivery Route and Galway Turbine Delivery Routeare presented in **Figures 8.2 (a and b)**.

Wind Farm Site

Although much of the Wind Farm Site is mapped as Peat Bogs, these areas are significantly impacted by agricultural practices including extensive land improvement works involving drainage and excavation and manipulation of natural soil profiles or horizons, **Figure 8.2a**. For further information on extent of drainage see **EIAR Chapter 9: Hydrology and Hydrogeology**.

Hydrogen Plant Site

Land underlying the proposed location of the Hydrogen Plant Site is comprised of *peat bogs* and surrounded by *pastures* **Figure 8.4b**. The proposed Hydrogen Plant Site is currently an agricultural field used for grazing horses, **Figure 8.2b**.

Grid Connection Route

The proposed Grid Connection Route traverses both *coniferous forests* land along with *peat bogs* upon exiting the Wind Farm Site (c. 1.3 km) and the remaining of its entirety traverses *pastures*, **Figure 8.2a**.

Interconnector Route

The proposed Interconnector Route similarly traverses both coniferous forestry land along with peat bogs upon exiting the Wind Farm Site (c. 1.3 km), the remaining route to the Hydrogen Plant traverses *pastures* and *peat bogs* until terminating at the Hydrogen Plant Site.

Killybegs Turbine Delivery Route & Galway Turbine Delivery Route

Consultation with Corine (2018) Land Use maps (EPA) the land underlying the Killybegs Turbine Delivery Route is a combination of *pastoral land, peat bogs* and *coniferous forests*. Corine (2018) and Land Use maps (EPA) the land underlying the Galway Turbine Delivery Route is a combination of *discontinuous urban fabric, moors and heathland, peat bogs, coniferous forests* and *land principally occupied by agriculture, with significant areas of natural vegetation* **Figure 8.2a**.

8.3.4 Bedrock Geology

Mapped geology for the Wind Farm, Hydrogen Plant, Grid Connection Route, Interconnector Route Construction Haulage Route Killybegs Turbine Delivery Route and Galway Turbine Delivery Route are presented in **Figures 8.3a and b.**

There is just one mapped (GSI, Bedrock 100k[2]) geological formation underlying the Proposed Development. This formation is classified as the Ballina Limestone Formation (Lower) which is comprised of dark-fine grained limestone and shale.

There are three (3 no.) faults associated with this underlying geological formation. The northern 'anticlinal axis' fault line runs parallel along the Killybegs Turbine Delivery Route and the Galway Turbine Delivery Route from a north to southeast direction. The second fault, a 'synclinal axis' runs in the same direction. The southern-most 'anticlinal axis' fault intersects in Grid Connection Route (ITM: 532432,820697), running in the same directional manner as the other two faults. The proposed location of the Hydrogen Plant Site is located approximately 100 m southwest of this fault line **Figure 8.3a** and **Figure 8.3b**.

Limestone is usually within the range of unconfined compressive strength of rock [3], from 'Medium Strong' (25-50 MPa) to 'Extremely Strong' (>250 MPa).

Rock strength is strongly correlated to grain size but is affected by other characteristics such as layering and weathering and limestone is considered a relatively coarse grained rock.

The appended **Firlough Hydrogen Plant – Groundwater Supply Assessment (2022) (Appendix 9.7)** details intrusive ground works related to 8 no. drilled boreholes on the Hydrogen Plant Site. Boreholes were drilled to depths ranging from 3 to 6 mbGL, depending on the depth to bedrock.

[2] Geological Survey of Ireland (GSI) Spatial Resources. Online: <https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228> Accessed: November 2022
[3] Norbury D. (2010) *Soil and Rock Description in Engineering Practice*. Whittles Publishing, Scotland, UK.

8.3.5 Seismic Activity

The island of Ireland does experience, monitor and record seismic activity, although the magnitude of such occurrences are generally low and do not generally pose a risk to infrastructure or human health. Seismic activity is monitored on an ongoing basis by the Irish National Seismic Network (INSN). Since 1980, a low number of earthquakes of <M5.0 (Richter magnitude scale (M)) have been detected in the Atlantic close to Ireland. Some relatively recent earthquakes detected on or near the mainland of Ireland include[4]:

- An M2.4 earthquake which occurred on 07/04/19, the epicentre for which was located within Donegal Bay, and at a depth of 4 km;
- An M2.0 earthquake which occurred on 29/04/19, the epicentre for which was located approximately midway between Donegal Town and Lough Derg, and at 16 km depth;
- An M0.9 earthquake that occurred 20/08/21, the epicentre of which was located near the townlands of Lambstown at a depth of 8 km.

Although earthquakes are considered a triggering mechanism for landslides in some places around the world, given the low magnitude experienced in Ireland earthquakes are not considered an important triggering factor in terms of stability risks.[5]

8.3.6 Soils and Subsoils

Mapped soils from available soil maps (SIS, EPA, Teagasc) for the Wind Farm, Hydrogen Plant, Grid Connection Route, Interconnector Route, Construction Haulage Route, Killybegs Turbine Delivery Route and Galway Turbine Delivery Route are presented in **Figures 8.4a and b,** Subsoils are mapped and presented in **Figures 8.5a and b**.

Wind Farm Site

Consultation with available Teagasc (2022) data indicates that soil types across the Wind Farm Site are comprised of *Peat Bogs* (Blanket Peat), **Figure 8.4a.** Although much of the Wind Farm Site is mapped as Peat Bogs, these areas are significantly impacted by agricultural practices including extensive land improvement works involving drainage and excavation and manipulation of natural soil profiles or horizons. For further information on extent of drainage see **EIAR Chapter 9: Hydrology and Hydrogeology**. Consultation with published subsoil maps compiled by GSI (2022) specify that subsoil type of the Wind Farm Site is described as "Blanket Peat" **Figure 8.5a.**

[4] INSN (2022) "All Earthquakes" *Irish National Seismic Network: Dublin Institute for Advanced Studies*. Available at: <https://www.insn.ie/recent-local-earthquakes/all-earthquakes/.

[5] Creighton, R., Doyle, A., Farrell, E. R., Fealy, R., Gavin, K., Henry, T., Johnston, T., Long, M., McKeown, C., Pellicer, X., Verbruggen, K. (2006) "Landslides in Ireland" *Geological Survey Ireland: Irish Landslides Working Group.*

Hydrogen Plant Site

Land underlying the Hydrogen Plant Site is mapped as being comprised of 'Grey Brown Podzolics, Brown Earths' and 'Basin Blanket Peats', **Figure 8.4b**. Underlying subsoils have been classified as '(Carboniferous) Limestone tills' along with 'Cutover peat', **Figure 8.5b**. With reference to **Appendix 9.7 - Firlough Hydrogen Plant – Groundwater Supply Assessment (2022),** Works carried out by Minerex concluded that the quaternary sediments underlying much of the Hydrogen Plant Site are classed as '*till derived from limestones (TLs)*' and 'alluvium overburden' was identified to the south west of the Hydrogen Plant Site which is consistent with the mapped stream at this location.

Grid Connection Route

The proposed Grid Connection Route traverse both pastoral and coniferous forestry land along its entirety, **Figure 8.3a.** The combination of underlying soils are comprised of: 'Blanket Peat', 'Surface water Gleys, Ground water Gleys', 'Basic Shallow Well Drained Mineral', 'Cutaway Basin Peats', 'Mineral Alluviums', 'Grey Brown Podzolics, Brown Earths', 'Acid Brown Earths, Brown Podzolics' and 'Acid Deep Poorly Drained Mineral'.

The underlying subsoils along the Grid Connection Route include: 'Blanket Peat', '(Carboniferous) Glaciofluvial Limestone sands and gravels', 'Alluvium' and 'Metamorphic till, **Figure 8.4a** and **Figure 8.5a.**

Interconnector Route

The proposed Interconnector Route traverse a combination of underlying soils are comprised of: 'Blanket Peat', 'Surface water Gleys, Ground water Gleys', 'Basic Shallow Well Drained Mineral', 'Cutaway Basin Peats' and 'Peaty Gleys (Shallow)'.

Subsoils along the Interconnector Route include: '(Carboniferous) Limestone tills', 'Cutover peat', and 'Limestone sands and gravels (Carboniferous)', **Figure 8.4a** and **Figure 8.5a.**

Killybegs Turbine Delivery Route and Galway Turbine Delivery Route

Soils underlying the Killybegs Turbine Delivery Route is a combination of 'Blanket Peat', 'Peaty Gleys' and 'Grey Brown Podzolics, Brown Earths'.

Underlying subsoils along the Killybegs Turbine Delivery Route have been classified as 'Blanket Peat' and '(Carboniferous) Limestone till (diamictons)' and 'Metamorphic till', **Figure 8.4a** and **Figure 8.5a.**

Soil maps (Teagasc) shows underlying the Galway Turbine Delivery Route is a combination of 'Deep well drained mineral (mainly basic)', 'Mineral poorly drained (mainly basic)', 'Cutover/cutaway Peat', 'Blanket Peat', Peaty poorly drained mineral (Mainly acidic), Deep well drained mineral (Mainly acidic). EPA maps describe the soils as 'Peat' 'Course Loamy' 'Fine Loamy'.

Underlying subsoils along the Galway Turbine Delivery Route have been classified as 'Blanket Peat', 'Cutover Peat', '(Carboniferous) Limestone till (diamictons)', 'Metamorphic till', 'Bedrock at Surface', 'Alluvium undifferentiated', 'Shales and sandstones till (Namurian)', 'Sandstone till (Devonian)', 'Sandstone and shale till (Lower Paleozoic)' 'Sandstone sands and gravels (Devonian/Carboniferous)' **Figure 8.4a** and **Figure 8.5a**.

8.3.6.1 Peat Depth

Wind Farm Site

The results of the Peat Depth Probing surveys at the Wind Farm Site are presented in **Figure 8.7a**. Furthermore, in **Figure 8.7b**, peat depths have been overlayed on Slope data gathered from the Global Digital Elevation Model[6] public data source.

Peat depths at survey points (105 no.) range from 0.00 m to <4.40 m. Peat depths were generally shallow, with isolated minor pockets of deeper peat observed at some locations, particularly around the proposed locations of T9, T7, T4, T3 and south of the proposed material storage location. However, given the relatively flat topography at these locations, the presence of deep peat at these locations are considered isolated and bounded by surrounding till and rock layers,

Peat depths have been mapped by category (**Table 8.12**). Certain peat depths are associated with particular hazards and constraining characteristics in terms of infrastructure construction methodology. Peat depth of 2.0 m or greater is considered '*deep'* or '*deeper*' peat, and in extensive areas of peat which is >2.0 m depth excavation and construction activities become greatly more complicated and present greater risk.

Table 8.12: Peat Depth Distribution by Peat Depth Category

Peat Depth Category	No.
A – Rock (0.00-0.01 m)	3
B – Very Shallow (0.01-0.5 m)	28
C – Shallow (0.5-2.0 m)	44
D – Moderately Deep (2.0-3.5 m)	22

[6] Copernicus (2023) Global Digital Elevation Model E30N30

Peat Depth Category	No.
E – Deep (3.5-5.0 m)	8
F – Very Deep (>5.0 m)	0

Hydrogen Plant Site

As mentioned in **Section 8.3.6** soils and subsoils the Hydrogen plant is underlain by a mix of 'Grey Brown Podzolics, Brown Earths' and 'Basin Blanket Peats'. However, the Hydrogen Plant Site is situated on an area classified as 'improved' agricultural land.

Logged data for a series of eight boreholes drilled on or in proximity to the Hydrogen Plant Site indicate depth to bedrock ranging from 3 m to 6 m. No soil description is available.

Directly south of the Hydrogen Plant Site, a peatland area adjacent to the surface water feature, peat depths in this area ranged to maximum 1.9 m depth.

8.3.7 Geological Resource Importance

Consultation with available maps (GSI) indicates that there are no recorded 'Geoheritage' sites either audited or unaudited located within or near the Wind Farm Site of Hydrogen Plant Site. Furthermore, there are no mapped (GSI) Active Quarries within or near either of the sites. There are a number of 'Non-metallic' Mineral Locality features within 5 km of both sites, however none of these features interfere with the proposed routes or locations of elements as part of the Proposed Development.

8.3.8 Slope Stability

Peat, subsoil and slope stability assessments for the proposed Wind Farm Site as well as identified site geohazards are presented in **Figures 8.6a, 8.7a, 8.7b, Figure 8.8 and 9.12a**. Conclusions are summarised as follows.

8.3.8.1 Peat Stability – Wind Farm Site

Peat depth across the proposed Wind Farm Site are generally shallow with the exception of minor isolated pockets of moderately deep and deeper peat delineated by shallow subsoils and/or bedrock at or near the surface. There was no very deep peat observed at the Wind Farm Site. Any potential peat instability was screened out post GSI Landslide Susceptibility Risk Database review of 'low risk' generally across the Wind Farm Site, **Figure 8.6a**.

The Factor of Safety (Adjusted) (Conservative approach *: Scenario B i.e. +1 m surcharge relative to baseline conditions, or Scenario A) at peat probe locations is generally Acceptable with the exception of marginally stable / unstable point locations associated with moderately deep peat.

* This conservative approach, in combination with conservative values presented in the Peat Database, **Appendix 8.1** (e.g. conservative values for moisture content, shear strength etc), the assessment itself is highly sensitive to and bias towards worst case environmental conditions in terms of peat or slope stability. This gives added confidence in sample locations which are classified as acceptable, and marginally stable or unacceptable stability sample points can be identified, interrogated and further risk assessed.

The Risk Ranking (Distance) Scenario B i.e. +1 m surcharge) at peat probe locations is generally Very Low to Low with the exception elevated risks at locations associated with deeper peat, and/or close proximity to sensitive receptors.

The following tables summarise the peat stability risk assessment data interpretation per turbine or infrastructure unit location. Note: results discussed are for Scenario B whereby 1.0 m material surcharge is applied to ensure which e.g. allows for surcharges due to construction activity is considered in the assessment risk including stockpiled material to 1 m.

Geo-Hazards are identified in the following table/s and a register of Geo-Hazards is presented in **Figure 8.8a**, and listed in **Table 8.13** and **Table 8.14.**

Table 8.13: Peat Stability Risk Assessment – Factor of Safety (Adjusted)(Scenario B) at Main Infrastructure Units at the Wind Farm Site

Turbine No. / Unit	Average surrounding Peat Depth (m)	FoS_{ADJ} (Factor of Safety adjusted according considering site specific conditions)	Geo-Hazard / Comment (Important to consider when carrying out detailed design and pre construction planning)
T1	0.85	FoS(ADJ) data is generally acceptable across the site. This is driven by low inclines across the site with the exception of some localised zones.	Potential for localised risk; proposed turbine hardstanding intersects a significant drain connected to mapped WFD river (SW receptor). Potential for localised stability issues.

Turbine No. / Unit	Average surrounding Peat Depth (m)	FoS_{ADJ} (Factor of Safety adjusted according considering site specific conditions)	Geo-Hazard / Comment (Important to consider when carrying out detailed design and pre construction planning)
T2	0.27	FoS(ADJ) data indicates peat stability is acceptable.	Proposed works (Spoil Deposition Areas) will be located within 50 m and 25 m SW buffer zones. Potential for localised stability issues and risk to SW receptors.
T3	2.37	FoS(ADJ) data indicates peat stability is acceptable, with the exception of isolated pockets of deeper peat (marginally acceptable at localised scale).	Potential for localised stability issues and risk to SW receptors.
T4	1.98	FoS(ADJ) data indicates peat stability is acceptable, with the exception of isolated pockets of deeper peat (marginally acceptable at localised scale).	Potential for localised risk. Proposed turbine hardstanding crosses a significant drain connected to headwaters of mapped WFD river (SW receptor). Furthermore, proposed works (Spoil Deposition Areas) will be located within 50 m and 25 m SW buffer zones. Potential for stability issues with areas of moderately deep peat.
T5	0.47	FoS(ADJ) data indicates peat stability is acceptable.	Potential for localised risk; proposed turbine hardstanding intersects a significant drain connected to mapped WFD river (SW receptor). Potential for localised stability issues.
T6	1.57	FoS(ADJ) data indicates peat stability is acceptable.	Potential for localised risk; proposed turbine hardstanding intersects with significant drain connected to headwaters of mapped

Turbine No. / Unit	Average surrounding Peat Depth (m)	FoS_{ADJ} (Factor of Safety adjusted according considering site specific conditions)	Geo-Hazard / Comment (Important to consider when carrying out detailed design and pre construction planning)
			WFD river (SW receptor). Potential for localised stability issues.
T7	2.00	FoS(ADJ) data indicates peat stability is acceptable, with the exception of isolated pockets of deeper peat (marginally acceptable at localised scale).	Potential for localised risk to SW receptor and stability issues.
T8	0.20	FoS(ADJ) data indicates peat stability is acceptable.	Potential for localised risk; proposed turbine hardstanding intersects with significant drain. Potential for localised stability issues.
T9	2.28	FoS(ADJ) data indicates peat stability is acceptable, with the exception of isolated pockets of deeper peat (marginally acceptable at localised scale).	Potential for localised risk. Proposed turbine hardstanding crosses a significant drain connected to headwaters of mapped WFD river (SW receptor). Potential for stability issues with areas of deeper peat.
T10	0.73	FoS(ADJ) data indicates peat stability is acceptable.	Potential for localised risk. Proposed turbine hardstanding and Spoil Deposition Areas will cross several significant drains that have the potential to be connected to mapped WFD river (SW receptor). Potential for stability issues.
T11	1.08	FoS(ADJ) data indicates peat stability is acceptable.	Potential for localised stability issues.
T12	0.73	FoS(ADJ) data indicates peat stability is acceptable.	Potential for localised risk. Proposed turbine hardstanding and proposed works (Spoil Deposition Areas)

Turbine No. / Unit	Average surrounding Peat Depth (m)	FoS_{ADJ} (Factor of Safety adjusted according considering site specific conditions)	Geo-Hazard / Comment (Important to consider when carrying out detailed design and pre construction planning)
			cross several significant drains which have the potential to be connected to mapped WFD river (SW receptor). Potential for stability issues.
T13	1.08	FoS(ADJ) data indicates peat stability is acceptable.	Potential for localised risk. Proposed turbine hardstanding and crosses a significant drain connected to headwaters of mapped WFD river (SW receptor). Furthermore, proposed works (Spoil Deposition Areas) will be located within 50 m and 25 m SW buffer zones. Potential for stability issues.
Material Storage Area	Not available	FoS(ADJ) data indicates peat stability is acceptable, with the exception of isolated pockets of deeper peat (marginally acceptable at localised scale).	Potential for localised risk. Proposed location boarders 50 m SW buffer zone of mapped WFD river. Potential for stability issues.
Substation	Not available	FoS(ADJ) data indicates peat stability is acceptable.	Proposed works will be located within 50 m SW buffer zone. Proposed location of On-Site Substation will be in afforested areas which will need to be clear felled. Potential for localised stability issues.
Material Storage Area	Not available	FoS(ADJ) data indicates peat stability is acceptable.	Location unknown at this time.

Table 8.14: Peat Stability Risk Assessment – Risk Ranking (Distance) at Main Infrastructure Units

Turbine No. / Unit	RR_D (Ranked Risk considering Distance to Sensitive Receptors)	Geo-Hazard / Receptor / Comment
T1	Risk is considered Low due to acceptable FoS and where distance of proposed works is outside 150 m sensitive receptor buffer.	Drainage / Surface Water
T2	Risk is elevated, proposed works fall within sensitive receptor buffer (150 m) of EPA mapped river.	Surface Water
T3	Risk is elevated, proposed works fall within sensitive receptor buffer (150 m) of EPA mapped river.	Surface Water / Drainage
T4	Risk is elevated, proposed works fall within sensitive receptor buffer (150 m) of EPA mapped river.	Surface Water
T5	Risk is considered Low due to acceptable FoS and where distance of proposed works is outside 150 m sensitive receptor buffer.	Drainage / Surface Water
T6	Risk is considered Low due to acceptable FoS and where distance of proposed works is outside 150 m sensitive receptor buffer.	Drainage / Surface Water
T7	Risk is considered Low due to acceptable FoS and where distance of proposed works is outside 150 m sensitive receptor buffer.	Drainage / Surface Water
T8	Risk is considered Low due to acceptable FoS and where distance of proposed works is outside 150 m sensitive receptor buffer.	Drainage / Surface Water
T9	Risk is considered Low due to acceptable FoS and where distance of proposed works is outside 150 m sensitive receptor buffer.	Drainage / Surface Water
T10	Risk is considered Low due to acceptable FoS and where distance of proposed works is outside 150 m sensitive receptor buffer.	Drainage / Surface Water
T11	Risk is considered Low due to acceptable FoS and where distance of proposed works is outside 150 m sensitive receptor buffer.	Drainage / Surface Water
T12	Risk is considered Low due to acceptable FoS and where distance of proposed works is outside 150 m sensitive receptor buffer.	Drainage / Surface Water

Turbine No. / Unit	RR_D (Ranked Risk considering Distance to Sensitive Receptors)	Geo-Hazard / Receptor / Comment
T13	Risk is elevated, proposed works fall within sensitive receptor buffer (150 m) of EPA mapped river.	Surface Water / Drainage
Substation	Elevated risk. Proposed works fall within sensitive receptor buffer (150 m and 50 m) of EPA mapped river.	Surface Water / Drainage
Material Storage Area	Elevated risk. Proposed works fall within sensitive receptor buffer (150 m) of EPA mapped river.	Surface Water / Drainage

8.3.8.2 Peat Stability – Hydrogen Site

The Hydrogen Plant Site is situated on an area of 'improved' agricultural land and not on peatland. The area of peatland to the south and bounding the river is relatively shallow (<1.9 m depth) and with very minor incline if not flat. Significant peat or slope stability issues at this location are therefore unlikely. There remains the risk of localised stability issues arising during construction works.

8.3.9 Designated & Protected Areas

Any potential impacts to Soils or Geology are not considered to have direct impacts to downgradient designated sites, however entrainment of soils in runoff is a significant potential impact of the Proposed Development covered under **EIAR Chapter 9: Hydrology and Hydrology.** Therefore, impacts to soil have the potential to have secondary or indirect and far reaching impacts via hydrology in particular.

Wind Farm Site

The Wind Farm Site is not positioned within any designated or protected area (SPA, SAC, NHA), as presented in **Chapter 9 Figure 9.9b**. However, directly adjacent to the land holding is the Ox Mountains Bogs SAC (EU_Site_Code:IE0002006). Surface waters draining the east of the Wind Farm Site (Gowlan (Sligo)_010) flow through this SAC. Further downstream, surface waters draining the west of the Site (Glenree_SC_010) are hydrologically connected to the River Moy SAC and Killala Bay/Moy Estuary (SPA, NHA, SAC), c. 12 km west of the Wind Farm Site, **Figure 9.5**.

The nearest national designated site is Ox Mountains Bogs Proposed Natural Heritage Area bordering the Wind Farm Site also to the south and east.

Hydrogen Plant Site

The Hydrogen Site is not positioned within any designated or protected area (SPA, SAC, NHA). However similar to the proposed Wind Farm Site it is hydrologically linked to the Killala Bay / Moy Estuary (SPA, NHA, SAC). The River Moy SAC is located c. 2.29 km to the south and the Killala Bay/Moy Estuary Proposed Natural Heritage Area is located c. 6.29 km to the west of the Hydrogen Plant, **Figure 9.9a, Figure 9.5**.

Grid Connection Route

The Grid Connection Route does not traverse or intersect any designated or protected areas but is however hydrologically linked to the River Moy SAC, c. 1 km downstream of proposed works along the Grid Connection Route.

Interconnector Route

The Interconnector Route does not traverse or intersect any designated or protected areas but is hydrologically linked to the River Moy SAC, c. 3.8 km downstream of proposed works along the Interconnector Route.

Killybegs Turbine Delivery Route, Galway Turbine Delivery Route and Construction Haulage Route

Both the Killybegs Turbine Delivery Route and Galway Turbine Delivery Routes do not intersect any designated or protected areas, but they are however hydrologically linked to the Killala Bay / Moy Estuary (SPA, NHA, SAC), c. 5.8 km downstream as well as the River Moy SAC, located c. 9.2 km downstream of proposed works along both the Turbine Delivery Route.

The Construction Haulage Route is located adjacent south west to the Turbine delivery Routes and therefore are linked to the same SPA, NHA and SAC.

8.4 ASSESSMENT OF POTENTIAL EFFECTS

This section can be broken down into the following sub-sections:

- How potential effects are classified in terms of Magnitude from the Wind Farm
- How potential effects are classified in terms of Magnitude from the Hydrogen Plant
- The 'Do Nothing' impact
- Impacts of Climate Change
- Assessments of All potential effects on Soils and Geology during the construction, operational phase and decommissioning of the Project.

- The effects are outlined, summarized and the following section 10.5 will outline the mitigation measures for these effects and then state the residual effects.

8.4.1 Significance Rating for Wind Farm

Given the condition of the Wind Farm Site in terms of land use practices, peat and soil quality, bedrock quality etc, Land, Soils and Geology as environmental attributes at the Wind Farm Site are considered to be of Medium Importance i,e, *Attribute has a medium quality, significance or value on a local scale* (**Section 8.2.5**).

With reference to **Section 8.2.5** of this report and as summarised in **Table 8.15a: Weighted Rating of Significant Environmental Impacts – Within Footprint of Wind Farm**, the receiving environment (geological attributes) associated with the Project is considered as being of **Low to Medium Importance** and **Low to Medium Sensitivity**, and therefore classification of any potential impacts associated with the Proposed Development will be limited to Magnitudes associated with **Medium Importance**, where by the site attributes (Land, Soils and Geology) are considered to be of "*medium quality, significance or value on a local scale*".

Table 8.15a: Weighted Rating of Significant Environmental Impacts – Within Footprint of Wind Farm

Sensitivity (Importance of Attribute)	Magnitude of Impact			
	Negligible (Imperceptible)	**Small Adverse (Slight)**	**Moderate Adverse (Moderate)**	**Large Adverse (Significant to Profound)**
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight / Moderate

In terms of determining and assessing the magnitude of impacts, categories of magnitude relate to the scale of the attribute, that is; the attribute/s driving the classification of sensitivity is the area of the proposed Wind Farm Site, and therefore scale is relative to the area of the proposed site itself. That is, the area of the Wind Farm Site is approximately 445 ha, and the area of the Wind Farm Site footprint is 27.55 ha, therefore the area of the footprint of the Proposed Development equates to approximately 5.516% of the area of the Wind Farm Site. This means that the land take associated with the Proposed Development is considered a negative, Slight Adverse significance (<15% area) impact on attribute with Medium importance), localised impact of the Proposed Development.

8.4.1.2 Significance Rating for Hydrogen Plant

Given the condition of the Hydrogen Plant Site in terms of land use practices, peat and soil quality, bedrock quality etc, Land, Soils and Geology as environmental attributes at the Hydrogen Plant Site are considered to be of Low to Medium Importance i,e, *Attribute has a medium quality, significance or value on a local scale* (**Section 8.2.5**).

With reference to **Section 8.2.5** of this report and as summarised in **Table 8.15b: Weighted Rating of Significant Environmental Impacts – Within Footprint of Hydrogen Plant**, the receiving environment (geological attributes) associated with the Project is considered as being of **Low to Medium Importance** and **Low to Medium Sensitivity**, and therefore classification of any potential impacts associated with the Proposed Development will be limited to Magnitudes associated with **Low Importance**, where by the site attributes (Land, Soils and Geology) are considered to be of "*medium quality, significance or value on a local scale*".

Table 8.15b: Weighted Rating of Significant Environmental Impacts – Within Footprint of Hydrogen Plant

Sensitivity (Importance of Attribute)	Magnitude of Impact			
	Negligible (Imperceptible)	**Small Adverse (Slight)**	**Moderate Adverse (Moderate)**	**Large Adverse (Significant to Profound)**
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight / Moderate

In terms of determining and assessing the magnitude of impacts, categories of magnitude relate to the scale of the attribute, that is; the attribute/s driving the classification of sensitivity is the area of the proposed Hydrogen Plant Site, and therefore scale is relative to the area of the proposed Hydrogen Plant Site itself. That is, the area of the Hydrogen Plant Site is approximately 6.5 ha, and the area of the proposed Plant footprint is 6.5 ha, therefore the area of the footprint of the Proposed Development equates to approximately 100% of the area of the Hydrogen Plant Site. This means that the land take associated with the Proposed Development is considered a negative, Large Adverse significance (>50%) impact on attribute with Low importance), localised impact of the Proposed Development.

8.4.2 Do Nothing Impact

Site investigations of the baseline geological conditions of the Wind Farm Site and Hydrogen Plant Site indicate the following:

- The sites have already experienced impacts to baseline conditions due to the land use practices including agricultural (pastures, extensive drainage on Hydrogen Plant Site), commercial afforestation activities (on-site substation location – Wind Farm), and peat cutting activities (Wind Farm Site).
- There is no indication that current land use practices have had adverse impacts in terms of ground stability, with the exception of enhanced erosion in underlying tills at a localised scale.
- The cumulative impact of afforestation on the proposed site appear to be excavation of soil to construct drainage ditches and localised drainage of the soil, and varying degrees of soil erosion due to constructed roads and tracks, constructed drainage, vehicular movements, livestock movements etc.

Should the Proposed Development not proceed, the existing land-use practices will continue with associated modification of the existing environment.

8.4.3 Effects from Climate Change

Climate change vulnerability is outlined in **Chapter 16 Section 16.3.1.2,** this assesses the projected changes, project exposure, project assessment, and the project risk of sea level rise, storm surges, coastal erosion, cold snaps/frost, heatwaves, dry spells, extreme rainfall, flooding, wind speeds.

8.4.4 Construction Phase Potential Effects

8.4.4.1 Typical Sequence of Events in Wind Farm and Hydrogen Plant Construction on the Receiving Environment

The following sections outline and summarises the general stages and elements of construction related to the Project. Detailed assessment of effects follow in the subsequent headings.

8.4.4.1.1 Activities – Pre-mitigation

- Site Investigation:

- Site Preparation:
  a. Install Surface Water Monitoring Equipment.
  b. Install Silt Screens, Interceptor Drains, and SuDS.
  c. Prepare construction areas for compounds and facilities.
  d. Clear Vegetation and Topsoil.

e. Excavate and grade the area for the construction of access roads, hardstand areas, foundations, and other significant infrastructure units.

- Access Roads and Hardstand Areas:
  a. Install silt screens, interceptor drains, and SuDS
  b. Clear vegetation and excavate topsoil, subsoil, and bedrock.
  c. Temporarily stockpile arisings.
  d. Install drainage structures and erosion control measures, such as culverts and SuDS
  e. Construct the road base (and hardstand – wind farm) using suitable materials, such as crushed rock or concrete.
  f. Construct hardstand areas for the installation and maintenance of wind turbines.
  g. Use designated temporary stockpile areas and segregation of materials for different types of material, including materials arising at the sites, and being imported to the sites.

- Drainage & Sustainable Drainage Systems (SuDS):
  a. Install drainage and Sustainable Drainage Systems (SuDS)
  b. SuDS maintenance, including during construction phase.

- Watercourse crossings and culverts:
  a. Design and plan the culvert to meet the required hydraulic capacity and align with the watercourse's natural flow pattern.
  b. Install silt screens and sediment traps upstream of the construction area to intercept, manage, and divert runoff, reduce entrainment of solids and capture sediment, and prevent it from entering the watercourse.
  c. Excavate the area for the culvert installation.
  d. Construct the culvert.
  e. Backfill the area around the culvert
  f. Install headwalls or other associated infrastructure.
  g. Restore the natural watercourse flow.

- Clear Span Bridges:
  a. Design and plan the clear span bridge to meet the required hydraulic capacity and align with the watercourse's natural flow pattern.
  b. Prepare the area for the bridge construction.
  c. Construct the bridge abutments and piers using suitable materials.
  d. Install the bridge beams or arches using suitable materials.

e. Backfill the areas around the abutments and piers with suitable materials.
f. Restore the area.

- Foundations:
  a. Excavate and Backfill: To construct the wind turbine foundations and foundations for buildings in the Hydrogen Plant, the area will be excavated to the required depth and diameter. The area around and above the Turbine Foundation will be backfilled with compacted stone or crushed rock.
  b. Form and Pour Foundation: Shuttering and membranes are used to form the foundation pour structure, and foundation reinforcement steel rebar is installed and formed. Concrete is then poured into the foundation structure.

- Other Significant Infrastructure Units:
  a. Construct Infrastructure Units: Other significant infrastructure units, such as substation buildings, electrical cabling, and meteorological masts, underground water tanks will be constructed using suitable materials such as concrete or steel. Temporary infrastructure units such as temporary stockpile areas are also included here.
  b. Install Drainage Structures and Erosion Control Measures: As with access road and hardstand areas, drainage structures and erosion control measures such as culverts and erosion control blankets will be installed for other significant infrastructure units.

- Site Restoration:
  a. Backfilling: Excavation areas, such as those where wind turbine foundations were installed, will be backfilled with suitable materials.
  b. Soil and Vegetation: Topsoil that was removed during the site preparation phase will be redistributed.
  c. Waste Management: Waste arising from construction activities, including general construction waste and/or excess soils will be removed from site to a licensed waste management facility. The nearest licensed waste facility is Ballina to the west of the Proposed Development.

8.4.4.2 Compaction, Erosion and Degradation

Compaction of soils will occur during construction and to a limited extent during operation and decommissioning on the Wind Farm. In general, compacted soils will be excavated during construction, and access to soils away from hardstanding areas will be prevented. Ongoing compaction of soils will occur in areas of floated road construction, which will continue during operation and Decommissioning. Compaction effects for the Wind Farm are considered to be **direct, likely**, **slight** to **moderate, permanent and adverse**.

Compaction of soils will occur during construction, operational and decommissioning phases on the Hydrogen Plant. In general, compacted soils will be excavated during construction, and access to soils away from the surface water area to the south will be prevented. Ongoing compaction of soils will occur in areas of access roads, which will continue during operation and decommissioning. Compaction effects for the Hydrogen Plant are considered to be **direct, likely**, **slight** to **moderate, permanent and adverse**.

Erosion and degradation of exposed soils will occur, primarily during construction for both the Wind Farm and Hydrogen Plant, which will potentially lead to loading of runoff with solids and other contaminants. Entrainment of solids in storm or construction water runoff are assessed under **Chapter 9: Hydrology & Hydrogeology**. Erosion effects are considered to be **direct, likely, moderate to large, permanent and adverse**.

8.4.4.3 Ground or Soil Sealing

Ground or Soil sealing is the covering of a soil with an impermeable material which in turn changes the geotechnical and hydrogeological attributes, for example; increased runoff. The use of impermeable material is an inevitable direct effect to some extent of most types of construction particularly in greenfield sites. This will be taken into account on the potential effects outlined in the subsections below.

Soil sealing effects are considered to be **direct, unavoidable, slight** to **moderate, Long term/permanent and adverse**.

8.4.4.4 Land Take Windfarm

Land take is a Slight (development footprint = 27.55 ha (existing infrastructure 7.56 ha), Wind Farm Site boundary area = c. 445 ha, land take equates to 6.19% relative to the scale of the site) direct impact of the proposed Wind Farm, that is; land being used as forestry and agricultural pastures currently will be replaced by the Wind Farm. The extent of land take will correlate with the footprint of the proposed Wind Farm with the exception of some existing track ways, however there is also additional land take considering required cut and fill, drainage and cable trench infrastructure, and the increased excavation foot print required for safe excavation practices (e.g. batter back, discussed in the following sections).

Excavation activities associated with land take required for Proposed Development will lead to disturbance of otherwise generally undisturbed, greenfield land, that is; the natural soil profile, important for the purpose of facilitating current land use practices, namely agricultural pastures, will be disturbed. Without careful planning, an area excavated which can otherwise be potentially reinstated will potentially be impacted significantly and permanently. This is considered a **direct, negative, significant, slight weighted significance, localised** impact of the proposed development. With appropriate mitigation measures, planning and management this impact can be reversed and disturbance minimised.

8.4.4.5 Land Take Grid Connection Route, Killybegs Turbine delivery Route, Galway Turbine Delivery Route, Interconnector route

Minimal land take is required for the Grid Connection Route considering the line will principally be buried in or directly adjacent to existing roadways. The Grid Connection Route, Interconnector Route, Killybegs Turbine Delivery Route and Galway Turbine Delivery Route possess minor portions which traverse greenfield / green verge areas that are associated with public / private lands.

The Galway Turbine Delivery Route will have 4-5 road widening areas on the Stockane road (L5137-9).

The Killybegs Turbine Delivery Route will have two road widening areas located at N59 and L-6612 junction in the townland of Ballymoghany and widening of the L-6612 road in the townland of Cloonkeelaun. The associated accommodation works will include the installation of new drainage pipes, the construction of a 1.2 m high concrete retaining wall and the erection of timber stock proof fencing and 2 no. agricultural gates.

Grid Connection Route and Interconnector Route includes sections of underground cabling. They can be broken down into the following cable trenches. HDPE communications duct will be installed in excavated trenches, details of these are described in **Chapter 2 Section 2.6.12**. Any such impact is described similarly to general land take described above, however considering the small scale of disturbance, shallow cable trench (c. 1.425 mbGL), the effect is considered This is considered to be an **unavoidable, adverse, direct, small in scale, slight significance, localised effect, permanent but reversible**. With the implementation of appropriate mitigation measures and environmental engineering controls, these potential risks can be significantly reduced.

8.4.4.6 Land Take Hydrogen Plant

Land take is a 'Large Adverse' (site footprint = c. 6.5 ha, Site area = c. 6.5 ha, land take equates to 100% relative to the scale of the site) direct impact of the proposed Hydrogen Plant, that is; land being used as agricultural pastures currently will be replaced by the Hydrogen Plant. The extent of land take will correlate with the footprint of the proposed Hydrogen Plant with the exception of existing drainage and the increased excavation foot print required for safe excavation practices.

The effect of Land take during construction is considered to be **Large-scaled, direct, adverse, moderate, localised, and permanent but reversible.** The probability of this effect occurring is **unavoidable** during the construction phase. With appropriate mitigation measures, planning and management this effect and disturbance can be minimised.

8.4.4.7 Clear Fell of Afforested Areas

Felling of forestry at the proposed Wind Farm Site will be necessary for the Proposed Development at the location of the Wind Farm Substation. The likely felled area of approximately 2.9 ha will represent approximately 0.68% of the proposed site area.

This may lead to a slight increase in parameters such as nitrate, dissolved organic carbon and potassium in receiving waters flowing from the site, which is considered a negative impact of the Proposed Development (this is discussed in greater detail in **EIAR Chapter 9: Hydrology and Hydrogeology**).

If the Proposed Development does not take place, it is likely that the historical peat harvesting activities will continue and forestry at the site will eventually either be felled in large volumes or left in place.

Mechanism/s:	• Construction activities; Excavation, handling/transport, temporary storage of soils / subsoils / bedrock, vehicle tracking. • Erosion in areas impacted by construction activities. • Erosion in areas with newly formed preferential pathways for water runoff. • Peat / slope stability, significant or localised. • Reinstatement activities; similar to construction.

Impact	• Erosion of soils and release of suspended solids entrained in runoff, intercepted by surface water network. • Compaction of soils, potentially reducing recharge capacity etc.
Receptor/s:	• Soil and subsoil structure and lithology. • Surface Water. Surface water quality, ecological sensitivities and WFD status.

The overall potential effects here are considered to be **direct**, **small scale**, of **moderate significance**, **permanent but reversible**, and **adverse**. The probability of this effect occurring is **unavoidable** during the construction phase and is in contrast to baseline conditions.

8.4.4.8 Demolition of Existing House and Agricultural Sheds

The demolition of a house (A) and four agricultural sheds (B-E) will be necessary on the Project. This is an **unavoidable** consequence of the Project.

There is a range of potential **adverse** impacts associated with the activity which will require management and mitigation. Potential effects include:

1. Soil erosion, compaction and degradation: The demolition of a house and agricultural sheds can expose soils to wind and water erosion, leading to soil loss, compaction and degradation. This is mainly caused by vehicular movements.
2. Geology: Demolition of a house and agricultural sheds can cause changes in the geology of an area, as mentioned in point 1.
3. Hydrology and Hydrogeology: The demolition of the House and Agricultural sheds will increase the area of unsealed ground therefore increasing the recharge capacity of the area, leading to reduced surface water runoff.
4. Soil nutrient loss and nutrient loading of receiving waters: demolition involves the removal of vegetation and concreate sealing, this leaves soil bare, exposing it to weathering, which can cause the entrainment of solids and/or the loss of soil nutrients, essential for plant growth. This in turn will lead to an increase in nutrients i.e., Nitrogen and Phosphorous compounds, dissolved organic carbon, potassium etc. in receiving waters flowing from the area, which is considered a negative impact of the proposed Development, however the new sealing of ground for construction of replacement house will neutralise this effect.

The overall potential effects here are considered to be of **slight** significance**, permanent**, and **adverse**, **small** in scale. With appropriate mitigation measures, planning and management this effect can be reduced, and disturbance minimised.

8.4.4.9 Subsoil and Bedrock Removal

Subsoil and bedrock removal will occur during construction excavations and is an **unavoidable** consequence of the Proposed Development for underground water storage tanks, turbine base, foundations of building to store the equipment for the Hydrogen plant, or other foundation construction is a direct impact of the Proposed Development. Removal of the soil and bedrock is considered to be a **permanent but reversible** effect if breaking into competent bedrock, and is otherwise considered to be an **unavoidable, adverse, direct and indirect, large in scale, moderate significance, encompassing the Proposed Development footprint.**

During the construction phase of the Proposed Development, an increased volume of material will likely be excavated to facilitate the construction of foundations and other works, however it is envisaged that excavated material will be used as back fill and reinstatement purposes, that is; reused on site.

The amounts of subsoil and bedrock to be removed will depend on specific construction and excavation plans which will be specified in the Construction Environmental Management Plan (CEMP). Currently the total volume of excavated material for the wind farm amounts to 136,883 m^3 which is to be stored in the Material Storage Area (Note: this figure is subject to change once the drainage design has been agreed upon, but likely only to a minor extent). The total volume of excavated material for the Hydrogen Plant amounts c. 26,080 m^3. The breakdown of this volume is outlined in **Chapter 2: Project Description: Table 2.11 Hydrogen Plant Key Development Infrastructure Metrics.**

The removal and replacement of subsoil and bedrock for excavating the area for turbine foundation construction will have a **direct and indirect, adverse, permanent but reversible, slight to moderate* weighted significance****, **localised** impact of the Proposed Development.

The removal and replacement of subsoil and bedrock for excavating the area for underground water storage tanks, building and turbine foundation construction is a **direct, negative, permanent, moderate to significant*, Moderate weighted significance***, localised** impact of the Proposed Development.

*Moderate to significant – accounts for the fact that the impacts will alter a sensitive aspect of the environment, however it is to a degree consistent with existing and emerging baseline trends.

**Slight weighted significance – accounts for the fact that the impact will be limited to less than 15 % ("Small" Table 8.9: Qualifying the Magnitude of Impact on Soil and Geological Attributes) of the area of the proposed site which is classified as having Medium importance.

Moderate weighted significance*** - accounts for the fact that the impact will be (>50%) (Table 8.9: Qualifying the Magnitude of Impact on Soil and Geological Attributes) of the area of the proposed site which is classified as having Low importance.

The removal of subsoil and bedrock to facilitate Killybegs Turbine Delivery Route and Galway Turbine Delivery Route is an **unavoidable, direct and indirect, small adverse effect with slight weighted significance, localised impact** of the proposed development, but is considered **permanent/ reversible** and **conforms to baseline site conditions.**

The removal of subsoil and bedrock to facilitate construction of grid connection route is an unavoidable component with **direct and indirect, negative, moderate scale, slight weighted significance, localised impact of the proposed development**, but is considered **permanent and reversible and conforms to baseline conditions**. However, worst case scenarios include the triggering of a significant landslide event, a potentially profound, and permanent adverse impact. Discussed in following sections.

The approach and methodology in which excavation of in-situ earth materials is undertaken is very important for ground stability in any environment. Excavation has the potential to cause slippage or mass failure under the right prevailing geotechnical and hydrological conditions, for example; excavating in deep saturated peat on, above or below steep inclines in peatland areas (Feehan, J. and O'Donovan, G., 1996).

Mitigative and reductive measures with regard to materials budget handling and potential indirect impact on water quality from mineral subsoil and bedrock excavation activities are outlined in the mitigation section of this report.

Mechanism/s:	• Construction activities; Excavation, handling/transport, temporary storage of soils / subsoils / bedrock, vehicle tracking.

	• Erosion in areas impacted by construction activities. • Erosion in areas with newly formed preferential pathways for water runoff. • Peat / slope stability, significant or localised. • Reinstatement activities; similar to construction.
Impact	• Erosion of soils and release of suspended solids entrained in runoff, intercepted by surface water network. • Compaction of soils, potentially reducing recharge capacity etc.
Receptor/s:	• Soil, subsoil and bedrock structure and lithology. • Surface Water. Surface water quality, ecological sensitivities and Water Framework Directive status.

8.4.4.10 Storage of Stockpiles

Of significance, during the construction phase of the Project, is the management of excavated materials handling, storage and re-use. There is potential for **direct negative impact** of **small to profound significance** on **localised** ground stability particularly in the vicinity of ongoing excavation works throughout the **developmental footprint**. For example, loading or surcharging of ground in proximity to open excavations is considered in good practices and health and safety procedures associated with excavation works, as presented in **Plate 8.1. Direct and indirect negative impacts** of **slight to moderate significance** on surface water quality can also occur **(EIAR Chapter 9: Hydrology & Hydrogeology**). Such impacts are considered **permanent but reversible**. For example, the release of soil washings and suspended solids to the surface water system and soil instability due to excessive loading (surcharge) adjacent to open excavations are both considered temporary and reversible impacts. However, worst case scenarios include triggering of a significant landslide event particularly in areas identified as having high landslide susceptibility (**Figure 8.6 (a – b**)). These works **conform to baseline conditions**, and with the implementation of appropriate mitigation measures and environmental engineering controls, these potential risks can be significantly reduced.

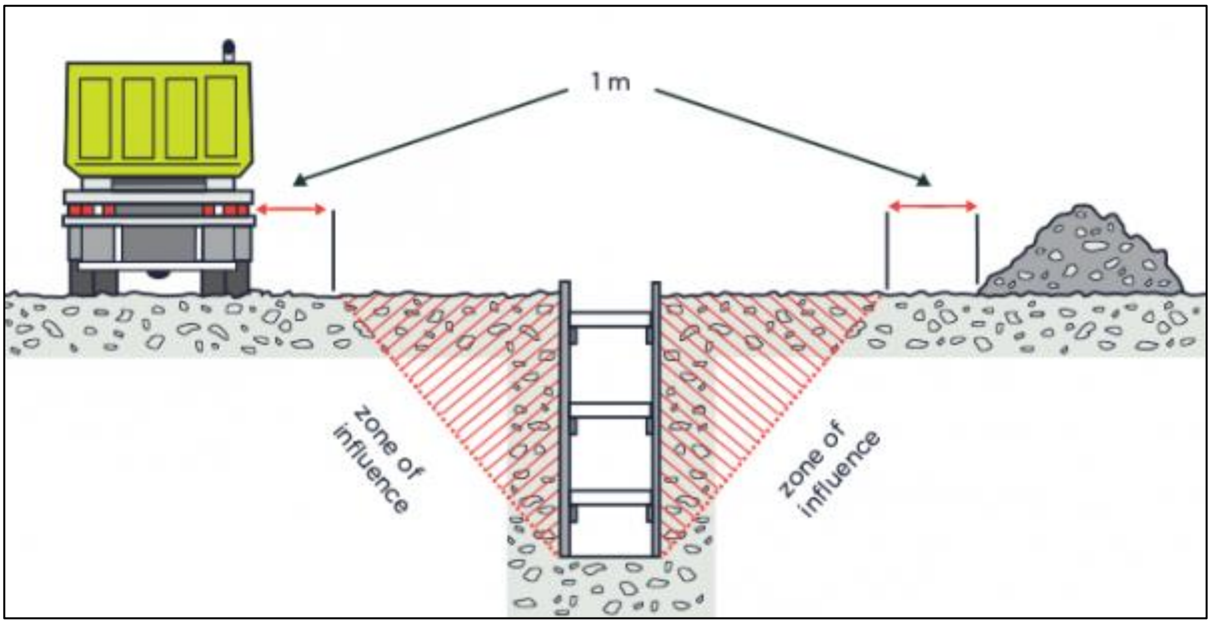

Plate 8.1: Examples impact of loading or surcharge on ground in proximity to open excavations.[7]

The potential impact by construction works activity on water quality is discussed in **EIAR Chapter 9: Hydrology and Hydrogeology**.

The effects associated with spoil management on the Wind Farm are considered to be direct, adverse and moderate to Large (in terms of overall project scale), slight to moderate significance, permanent (life of project) and reversible through reinstatement during the decommissioning phase of the Project. The probability of this effect occurring is unavoidable during the construction phase but conforms to baseline conditions e.g. public roads and services.

The effects associated with spoil management on the Hydrogen Plant are considered to be direct, adverse and moderate to Large (in terms of overall project scale), slight to moderate significance, permanent (life of project) and reversible through reinstatement during the decommissioning phase of the Project. The probability of this effect occurring is unavoidable during the construction phase but conforms to baseline conditions.

The potential impact on soil stability is considered a **direct**, **negative**, **slight**, Slight **weighted significance**, **localised** impact of the Project, however it is considered **temporary** and **reversible**. Ground stability on a larger scale is discussed further in the following section.

[7] New Zealand Government (2016) Good Practice Guidelines – Excavation Safety

8.4.4.11 Ground Stability

Ground stability, as discussed in the Baseline section of this report, is not considered an impact with significant potential within the redline boundaries of the Proposed Development, that is; the potential for slope stability issues arising or landslides to occur is generally considered Low. Some areas possess elevated risk on a **localised** scale (isolated pockets of deeper peat), and some areas possessing elevated risk on a larger scale when associated with respective receptors (elevated risk associated with proximity of receptors with varying sensitivity).

Considering there remains a residual risk at the sites, it is also important to distinguish between types of landslide, the material in question and associated receptor. The risk of significant peat landslide events occurring at the sites is low given the flat nature and depth of peat at the sites. However, the sites also possess a degree of elevated risk in terms of subsoil stability. Subsoil, or till landslide events are generally characterised as relatively isolated in comparison to the fluid nature of peat landslides. None the less, a significant movement of subsoils, if intercepted by the downgradient surface water network can have similarly devastating consequences to that of a significant peat landslide.

The potential for soil stability issues to arise during the construction phase of the Proposed Development is largely dependent on vehicular movement and operation during excavation works, or vehicular movements over areas with an increased or severe slope incline, and likely in combination with severe weather conditions. In terms of peat, potential impacts to hydrology can also play a large role in stability issues.

Soil stability issues brought about by excavation or vehicular movement activities have the potential to lead to open excavation side wall collapse, which in turn will potentially compromise ground stability in the vicinity of the works, thus increasing the effective footprint of the Proposed Development.

This is considered a potential **direct or indirect, negative, moderate to large scale, slight to moderate weighted significance, permanent impact** over the **developmental footprint** for both sites.

8.4.4.12 Geological Stability

Geological stability will be limited to the management, excavation and breaking of weathered and competent bedrock and boulders where required. This will include a number of proposed turbine locations as well as proposed substation, and Material Storage Area for the Wind Farm Project and will include the equipment storage building and the underground water storage tanks for the Hydrogen plant.

Considering the variability of subsoil depths on the Wind Farm Site, with reference to **Figure 8.7a**, and in line with infrastructure manufacturer specification, further site Investigation tailored to specifying turbine and infrastructure foundation design on a case by case basis is recommended.

Construction activities can give rise to localised stability issues, however considering the complex topography at the Wind Farm Site, including some localised steep inclines, particularly at surface water crossings, and within receptor buffer zones, and the close proximity of the Hydrogen Plant Site to a surface water network, there is potential for localised geological stability issues to impact downgradient receptors in terms of, for example; the sliding of temporarily stockpiled excavation arisings towards receptors. Worst case scenarios include construction activity and the movement of excavated material triggering landslide events, for example; spread or flow of stockpiled material into a surface water receptor within the footprint of the Proposed Development, in particular the Wind Farm Site.

There are no karst features associated with the Wind Farm Site, Killybegs Turbine Delivery Route Galway Turbine Delivery Route, Grid Connection Route or Hydrogen Plant Site and Interconnector Route. The closest mapped (GSI, 2022) karst feature is c. 6.5 km north of the Wind Farm Site.

Potential **direct and indirect adverse** soil stability issues that **contrast to baseline conditions** including downgradient of both the Proposed Development footprints brought about by construction activities are considered to be **slight (to profound) on a moderate to large scale, with localised impact (geology)**, **adverse**, potentially **permanent** effect but reversible.

8.4.4.13 Soil Contamination

Construction activities associated with the Project have the potential to introduce a number of contaminants in a number of ways. Potential causing activities and associated contaminants include:

- Chemical Storage on site

- Operation of plant vehicles and other petrol / diesel driven equipment - Hydrocarbons e.g. diesel, oil, grease.
- Waste water sanitation – sewage
- Construction materials – e.g. concrete or cement
- General waste – e.g. plastic

8.4.4.13.1 Fuel and Oil Spillages

Hydrocarbon is a pollutant risk due to its toxicity to all flora and fauna organisms. Hydrocarbons chemically repel water and sparingly dissolve in water. The majority of hydrocarbons are light non-aqueous phase liquids (L-NAPL's) which means that they are less dense than water and therefore float on the water's surface (whether surface water or groundwater). Hydrocarbons adsorb (stick) onto the majority of natural solid objects it encounters, such as vegetation, animals, and earth materials such as peat. It burns most living organic tissue, such as vegetation, due its volatile chemistry. It is also a nutrient supply for adapted micro-organisms, which can deplete dissolved oxygen at a rapid rate and thus kill off water based vertebrate and invertebrate life. Any accidental contaminant spillage of fuel or oil, depending on the volume, would potentially present a **direct, moderate** to **significant, localised, long term to permanent**, **adverse** effect on the soil and geological environment on the site.

In terms of the HDD process, drilling will involve plant machinery which will be powered by hydrocarbons, therefore risk during the refuelling process as stated previously remains the same. The risk of hydrocarbon spills stems primarily from broken hydraulic hoses used during the drilling/boring process. Small-scale quantities of greases known as 'drilling fluids' are also commonly used during the drilling process to keep components of the drill rig cool and lubricated. These drilling fluids are commonly composed of a mixture of bentonite clay, which can be harmful to the environment. Therefore, there is a risk of a potential oil leak from horizontal directional drilling (HDD) along the Grid Connection Route and Interconnector Route. It is unspecified at this time which drilling lubricant will be used during Grid Connection Route works. From experience in the industry the use of Clearbore is recommended. Clearbore is a single component polymer-based product that is designed to instantly break down and become chemically destroyed in the presence of small quantities of calcium hypochlorite. The product is not toxic to aquatic organisms and is biodegradable.

The hazard posed by hydrocarbon contamination to soil is significant in terms of adversely impacting on the health of the soils associated with the proposed site and the flora and fauna it supports, however the risk is considered limited considering the movement of same is limited. The more significant risk of hydrocarbons contamination of soils is the eventual and likely migration to surface water systems, a potentially significant negative impact - this is covered in the Hydrology and Hydrogeology chapter of this EIAR.

An accidental contaminant spillage, namely hydrocarbons, would have a significant, long term to permanent, negative impact on soil quality on the site. However, this potential impact is considered **adverse in nature, of small to moderate scale**, **localised, naturally reversible** (natural attenuation over a relatively medium to long term period of time), or reversible (through remediation and restoration activities over a relatively short to medium term period of time). With appropriate environmental engineering controls and measures, this potential risk can be significantly reduced.

Drill Arisings

Spoil arising from drilling activities will require temporary stockpiling and has the potential to be entrained by surface water runoff (suspended solids). Spoil arising from drilling activities could be mobilised by large volumes of water which would rapidly traverse overland if not managed appropriately and has the potential to mobilise additional solids via eroding soils, or other contaminants, and infiltrate the receiving surface water bodies, or groundwater bodies.

Breakouts and drilling fluid returns

Generally speaking, drilling fluids used in HDD practices are released at the beginning (launch) and termination (reception) sites of a borehole path, collected and disposed of properly. However, breakouts can in theory occur as a result of unstable conditions within the drilled bore due to low cohesion; for example, 1) the swelling and hydration of clay materials, 2) the movement and dispersion of clay minerals, 3) water blocks, and 4) low-permeability of mud cakes.[8] Drill fluid returns/frackouts can occur as a result of: poor drilling methods, and/or improper mud formulation used in bore drilling which can cause stability issues within the bore. Given the local lithology of the sites with underlying sandy, clayey gravel and tills, potential for breakouts must be considered. Breakouts can lead to failure in returns at either end of the bore path and subsequent drill mud being released outside the bore to the receiving environment (i.e., soils, subsoils, ground and/or surface waters).

In the case of a major spill, the leak should be stopped if safe to do so, contained and prevented from entering drains or water courses. Any recoverable product should be

[8] Willoughby, D. A. (2005) "Horizontal Direction Drilling Utility and Pipeline Applications" *McGraw-Hill Civil Engineering Series,* ISBN: 978-0-07-150213-9.

collected, by similar means of a hydrocarbon spill, and disposed of properly. If a significant quantity of material enters drains or watercourses, emergency services will be advised immediately.

Drilling Fluid Disposal

Drilling mud containing spoil recovered from the bored path can be retrieved at the launch and reception sites of the bore. This bentonite contaminated spoil can be treated in one of two ways. It can either be transferred off-site to an approved and authorized EPA license facility (in accordance with the Waste Management Act 1996, as amended) to be properly disposed of; or the spoil can be pumped to a mechanical separation container. This involves drill mud being stored within a holding tank until separation of particulates can be achieved, only then can the fluid be discharged to the surrounding area.

Very fine solids, or colloidal particles, are very slow to settle out of waters and the finest of particles require near still water and relatively long periods of time to settle, therefore, such particles are unlikely to settle despite sufficient rates. To address this, it is recommended that flocculant is used to promote the settlement of finer solids prior to discharging to surface water networks. Flocculant 'gel blocks' are passive systems, self-dosing and self-limiting, however they still require management as per the manufactures instructions. Flocculants are made from ionic polymers. Cation polymers (positive charge) are effective flocculants; however, their positive charge makes them toxic to aquatic organisms. Anionic polymers (negative charge) are also effective flocculants, and are not toxic i.e., environmentally friendly.[9] Therefore, if flocculants are deployed the material used must be made from anionic polymers.

Potential Effects

A worst-case scenario could possibly occur whereby the proposed works of HDD could result in a direct, negative, potentially significant, impact of the development. This impact could result from any number of indirect anthropogenic sources, most commonly would be from: inadvertent drill returns containing bentonite clay, as mentioned above or by spillages of oil, fuel, or drilling fluid disposal. Such spillages could potentially affect the local land and soil environment, depending on the nature of the contamination issue, and to varying degrees depending on the characteristics of the site area. Considering the proximity to surface water associated with this type of infrastructure (i.e., directly below watercourses), the risk is elevated.

[9] USEPA (2013) "Stormwater Best Management Practice: Polymer Flocculation" *United States Environmental Protection Agency: Office of Water*, 4203M.

While the Grid Connection Route traverses ground rated at 'High Vulnerability' (i.e., high risk) categories, this risk can be deescalated due to the lack of karst features present and baseline description of the underlying bedrock aquifer. There are no karst features associated with the Wind Farm Site, Hydrogen Plant Site, Killybegs Turbine Delivery Route, Galway Turbine Delivery Route, Grid Connection Route or Interconnector Route.

8.4.4.13.2 Waste Water

The Proposed Development includes for temporary sanitation facilities for site workers during the construction phase of the Wind Farm development and permanent sanitation facilities for site workers during the construction and operational phases of the Hydrogen Plant. The Proposed Development therefore has the potential to result in the accidental leakage of wastewater or chemicals associated with wastewater sanitation onto soils, and into the drainage network during the construction and operational phases of the project.

Wastewater and wastewater sanitation chemicals are pollutant risks due to their potential impact on the ecological productivity or chemical status of surface water systems, and toxicity to water-based flora and fauna.

The worst-case scenario/s associated with wastewater sanitation is the potential for sanitation chemical, particularly related to porta-loos, accidentally spilling or leaking and being intercepted by surface water drainage features and in turn surface water networks associated with the proposed development.

Potential incidents of release contaminants at the sites will likely be short lived or temporary, however the potential effects to downstream receptors can be **long lasting, or permanent**. With appropriate environmental engineering controls and mitigation measures these potential effects can be significantly reduced. The effects associated with wastewater and sewerage is considered to be **adverse, long-term to permanent direct, moderate to significant, localised, contrast to baseline conditions.**

8.4.4.13.3 Construction or Cementitious Materials

The Proposed Development will require concrete for the formation of turbine bases, the base for the underground water tanks, including in locations which are in proximity to receptors e.g., drains and surface waterbodies. This gives rise to result in the accidental spillage or deposition of construction waste into soils and in turn impact on surface water runoff, or accidental spillages directly intercepted by drainage or surface water networks associated with the Development.

Depending on the chemistry of the material in question, the introduction of such materials can lead to a local change in hydrochemistry and impact on sensitive attributes e.g., ecology. For example, the introduction of cementitious material (concrete / cement / lean mix etc.) can lead to changes in soil and water pH, and increased concentrations of sulphates and other constituents of concrete can further impact water quality. Fresh or wet concrete is a much more significant hazard when compared to set or precast concrete which is considered inert in comparison, however it should also be noted that any construction materials or waste deposited, even if inert, is considered contamination.

Surface water runoff, or groundwater coming into contact with concrete will be impacted to a degree, however water percolating through lean mix concrete will be impacted significantly. Therefore, the production / acquisition, transport of material and management of plant machinery must also be considered.

The worst case effects associated with a release of wet or lean mix cementitious materials is considered to be potentially **adverse, direct, slight to significant, likely, long-term to permanent,** particularly in terms of potential indirect or secondary effects on the receiving surface water system**.**

8.4.3.12.4 General Waste

The construction phase of the Proposed Development has the potential to generate excess general wastes from construction personnel such as organic food waste, plastics (bottles and/or packaging), metals (aluminium cans and/or tins) and cardboard waste (Tetra Pak cartons, newspaper, wastepaper). This is an unavoidable impact of the Proposed Development but every effort will be made to ensure that every piece of general waste will be disposed of properly and removed from site. The effects associated with waste materials is considered to be **direct, localised, slight, likely, long term to permanent** and **adverse**.

Further information and mitigation in relation to the management of potential contaminants is provided in **EIAR Chapter 9: Hydrology & Hydrogeology**.

8.4.5 Operational Phase Potential Effects

8.4.5.1 Storage of Chemicals and Hazardous Materials on Wind Farm Site and Hydrogen Plant Site

Health and Safety protocols for chemical storage on the Proposed Development is outlined in **Chapter 2 Section 2.6.6.2**. There is a larger risk associated with the Hydrogen Plant Site than the Wind Farm Site but both have been assessed in terms of potential effects to soils and geology of the Project.

It is noted there will be a degree of chemical storage (Nitrogen, Potassium hydroxide for electrolysis process (lye), Sodium bisulphite for de-chlorination of mains water, Oils used by hydraulic systems, compressors and transformers and diesel, Antiscalant used to prevent/reduce scaling of water treatment equipment, Glycol for coolant) on the Hydrogen Plant Site, for the lifetime of the project. Chemical wastes from water treatment process includes RO and CEDI chemical cleaning which will be directed to a chemical waste sump. The sump will be emptied by portable pumps or vacuum truck to licenced disposal offsite periodically.

Chemicals on the Wind Farm Site will be limited to minor quantities of hazardous materials used for maintenance purposes, or household materials e.g. bleach including in canteens and welfare facilities.

The risk for potential spills as outlined in **Section 8.4.3.6,** are applicable during the operational phase of the Hydrogen Plant and occasionally on the Wind Farm for turbine maintenance activities.

These effects are **direct, adverse, Large to scale, Slight to significant, localised, likely** and **long term but reversible**.

8.4.5.2 Environmental Impact of a hazard event at the Hydrogen Plant Site

Major Accidents Prevention Policy, Quantitative Risk Assessment (QRA incl. cover letter), HAZID, Project Description and Major Accidents EIAR Chapters for consideration.

Hazards posed by contamination to soil is significant in terms of **adverse** effects on the health of the soils associated with the proposed sites and associated flora and fauna. A contamination incident, would have a **significant, long term to permanent,** negative impact on soil quality on the Hydrogen Plant Site. However, this potential impact is considered to be **localised**, **reversible.**

8.4.5.3 Vehicular Movement

8.4.5.3.1 Overview

Vehicle movement will occur during the construction phases of the wind farm and the Hydrogen Plant. Construction vehicles will include cranes, excavators, dumper trucks, concrete trucks, private cars (construction personnel). During the operational phase of the Wind Farm, vehicles will be limited to occasional maintenance vehicles only. In contrast during the Operational phase of the Hydrogen Plant Site there will be constant transport of hydrogen and 24h personnel and their vehicles.

8.4.5.3.2 Peat Stability and Slope Failure

As discussed under excavation spoil management, vehicular movements on site have the potential to trigger soil or slope stability.

8.4.5.3.3 Turbine Delivery Route, Grid Connection Route, Interconnector Route and Site Access Roads

The delivery and connection routes will utilise existing roadways and infrastructure along the majority of the routes and therefore, the effects associated with vehicle movements along the Grid Connection Route, Killybegs Turbine Delivery Route and Galway Turbine Delivery Route and Interconnector Route is considered to be not significant to **slight, permanent** and **adverse**.

Vehicle movement along the site access roads will result in a slight compaction of the underlying soils. The effects associated with vehicle movements along the site access roads is considered to be **slight, permanent** and **adverse.**

8.4.5.4 Soil Compaction and Subsidence

The Wind Farm will include floating access roads on peat or other infrastructure on soils, which over time have the potential compact underlying peat / soils leading to subsidence. Excessive subsidence can potentially lead to localised track or structure stability issues, and development of new preferential flow paths for runoff and potentially erosion leading to further localised track stability issues. The overall potential effects here are considered to be of slight to moderate significance, adverse, long term to permanent (life of the Project), but with appropriate monitoring, mitigation and maintenance these potential effects can be minimised.

8.4.6 Decommissioning Phase Potential Effects

No new impacts envisaged, however baseline conditions will change over the life time of the project, in relation to ecology and peatlands in particular.

8.5 MITIGATION MEASURES AND RESIDUAL EFFECTS

8.5.1 Design Phase

8.5.1.1 Mitigation by Avoidance

A process of "mitigation by avoidance" was undertaken by the EIA team during the design of the turbine and associated infrastructure layout for the Wind Farm. This process was also conducted in the design phase of the Hydrogen plant. Arising from the results of these studies, constraints maps were produced that identifies areas where geotechnical constraints could make parts of the site less suitable for development. Constraints are mapped and presented in **Figures 9.12 a-b**.

MEL/RSK, in consultation with the design team has reviewed the layout plans and has identified them as the best layout design available for protecting both site's existing geotechnical (and hydrological) regime, but while also incorporating and overlaying landownership, engineering and avoiding environmental constraints as detailed in this EIAR.

8.5.1.2 Nature Based Solutions

8.5.1.2.1 Wind Farm Site – Infrastructure Footprint

Due to baseline conditions and ongoing peat cutting activities at the Wind Farm Site, implementing beneficial mitigations measures, beneficial impacts and promoting healthy peatland conditions e.g. rewetting and maintaining high bog water levels, is not conducive with how the adjacent lands are valued locally and in turn the current practices on Wind Farm Site i.e. draining, cutting and harvesting.

To address conflicting systems and objectives[10], the Proposed Development will use an approach as presented conceptually in EIAR Chapter 9 Appendix 9.7 Conceptual Graphics WF Site – Conceptual Hardstand – Plan, Conceptual Graphics WF Site – Conceptual Hardstand – Section A, and Conceptual Graphics WF Site – Conceptual Hardstand – Section B, and as summarised follows:

- Isolate areas of land adjacent to the Proposed Development footprint by means of subsoil berms. The actual area will depend on land holding rights, proximity to receptors, and results of detailed materials balance assessment i.e. the area required will be dictated by the volume of material available with the intention of limiting the area in order to achieve original ground level with the deposited peat material.

[10] Joosten H, Clarke D (2022) Wise Use of Mires and Peatlands - Background and Principals including a Framework for Decision Making [Online] - Available at: ISBN 951-97744-8-3 [Accessed: n/a]

The dimensions and angle of repose for the berms will be specified by a suitably qualified geotechnical engineer during the detailed design phase, constraints to decide locations are outlined in (**Figure 8.8b**).

- Hardstand areas for both cranes and turbines will be constructed by means of infilling suitable material from competent ground up to the design elevation or Finished Ground Level (FGL).
- The areas now isolated between the berms and hardstand areas will be back filled with surplus excavated subsoils (minimal), catotelm peat (to GGL minus c. 0.3 m), and acrotelm peat (c. 0.3 m), ordered respectively. The deposition area will be managed in terms of ecological regeneration, including planting key species e.g. Sphagnum moss.
- Drainage i.e. interceptor drains surrounding the hardstand area will include check dams, or dams which will promote the diffuse discharge of runoff in to deposited peat / regeneration areas. Overflow will be directed to a stilling pond prior to buffered discharge (through coarse aggregate) into the receiving drainage network. This conceptual design is aimed at promoting and maintaining high bog water levels and healthy peatland conditions, refer to EIAR Chapter 9 – Hydrology & Hydrogeology for further information.
- Areas identified as suitable for soil berms will be isolated with silt screens prior to any construction / excavation works.

Implementing the above will ensure the reuse of all suitable (uncontaminated) soil material arising on site is achieved. The regeneration of the deposition areas will require monitoring and management, however assuming successfully implemented these areas will provide beneficial impacts in terms of improving environmental services on lands, including; reduced hydraulic response to rainfall, promoting active blanket bog and associated ecological and biodiversity attributes, and reduction in peat carbon emissions.

This approach will be implemented and refined in the detailed design phase and will be used at each turbine location, and other available land holdings on the site as detailed in **Figure 8.8a and Figure 8.8b**.

Further measures on the management of soils are detailed in the following sections.

8.5.1.2.2 Wind Farm Site – Improvement Areas

Areas outside of the red line boundary and adjacent to the southeast corner of the Wind Farm Site have been identified for enhancement works (Figure 8.1a). The areas and works involved are presented in Biosphere Environmental Services (2023) Biodiversity

Enhancement and Management Plan. The plan describes measures including the blocking of existing drains in the enhancement areas, rewetting peat and monitoring.

8.5.1.2.3 Hydrogen Plant

Due to baseline conditions of agricultural practices of grazing and historic peat cutting activities at the Hydrogen Plant Site, implementing beneficial mitigations measures, beneficial impacts and promoting healthy peatland conditions e.g. rewetting and maintaining high bog water levels, is not conducive with how the adjacent lands are valued locally and in turn the current practices on site i.e. grazing, and the draining, cutting and harvesting of peat.

The Proposed Development will use approaches as presented conceptually in EIAR **Chapter 9 Appendix 9.7 Conceptual Graphics – Soil Berms and Silt Screens.**

- Isolate areas of land adjacent to the Proposed Development footprint by means of subsoil berms. The actual area will depend on land holding rights, proximity to receptors, and results of detailed materials balance assessment i.e. the area required will be dictated by the volume of material available with the intention of limiting the area in order to achieve original ground level with the deposited peat material.
  The dimensions and angle of repose for the berms will be specified by a suitably qualified geotechnical engineer during the detailed design phase.
- Areas identified as suitable for soil berms will be isolated with silt screens prior to any construction / excavation works.

Implementing the above will ensure the reuse of all suitable (uncontaminated) soil material arising on site is achieved. The regeneration of the deposition areas will require monitoring and management, however assuming successfully implemented these areas will provide beneficial impacts in terms of improving environmental services on lands, including; reduced hydraulic response to rainfall, promoting active blanket bog and associated ecological and biodiversity attributes, and reduction in peat carbon emissions.

8.5.2 Construction Phase

Any and all direct impacts on soils/peat and bedrock arising from the Project are considered localised, therefore the above assessment and classification of the weighted significance of land take encompasses all impacts to soils and bedrock considering the Project as a whole. Therefore, impacts assessed and classified in the following section/s are considered at the localised scale, with the exception of potential indirect impacts on downgradient receptors, for example; associated with surface water.

8.5.2.1 Erosion and Degradation

Erosion and degradation of exposed soils will occur at a minimal, primarily during construction. Considering the variability of metrological conditions and the potential for significant events to occur at any stage of the year, the construction phase will be limited to favourable meteorological conditions to avoid erosion and runoff from the site. In order to mitigate for particular earth works tasks and suitable meteorological conditions, construction activities will not occur during periods of sustained significant rainfall events, or directly after such events (allowing time for work areas to drain excessive surface water loading and discharge rates reduce).

To avoid potentially loading of runoff with solids and other contaminants into the surface water network. Entrainment of solids in storm or construction water runoff are assessed under **Chapter 9: Hydrology & Hydrogeology.**

8.5.2.2 Soil Sealing

Soil sealing will be mitigated by the use of a geotextile membrane on top of in situ peat material the Wind Farm substation and access roads (CEMP) will likely lead to a degree of subsidence with time. Geotextile membrane will also be used for the Hydrogen Plant substation (CEMP). This will reduce the changes the geotechnical and hydrogeological attributes, for example; increased runoff. The use of impermeable material is an inevitable direct effect to some extent of most types of construction particularly in greenfield sites. However this will be mitigated by reducing the area of sealed soil to a minimal.

8.5.2.3 Land Take – Wind Farm

The Proposed Development footprint (wind farm) will require c. 27.55 ha in total, considering the area of the existing infrastructure (7.26 ha) the Proposed Development will require an additional c. 20 ha of land take to facilitate the construction of hardstands, widening site access roads, and cut and fill associated with same. This implies that, relative to the area of the Wind Farm Site, the magnitude of the impact of land take equates to approximately 5.5% (Small), that is; this is considered a likely, direct, negative, localised, permanent effect of the Development. Considering the effect conforms to baseline the significance is classified as moderate at a localised scale (conforms to existing or emerging baseline trends), and the weighted significance is Slight.

8.5.2.4 Land Take – Hydrogen Plant

The Hydrogen Plant Site footprint is c. 6.5 ha, however the Hydrogen Plant Site area is c. 6.5 ha which will involve the infrastructure for the Hydrogen plant such as Contractor

Compound and Welfare Facilities, storage facilities for chemicals, underground water tanks, battery storage, substation etc. Relative to the area of the site, the magnitude of the impact of land take equates to approximately 100% (Large), that is considered a likely, direct, negative, localised permanent effect of the Development. That is; land being used as agricultural pastures currently will be replaced by the Hydrogen Plant.

The extent of land take will correlate with the footprint of the proposed Hydrogen Plant with the exception of existing drainage and the increased excavation footprint required for safe excavation practices.

8.5.2.5 Subsoil and Bedrock Removal or Disturbance

8.5.2.5.1 Mitigation by Avoidance

The removal of peat and mineral subsoil / bedrock is an unavoidable impact of the Project but every effort will be made to ensure that the amount of earth materials excavated is kept to a minimum in order to limit the impact on the geotechnical and hydrological balance of the sites. This has been done initially through a process of "mitigation by avoidance" whereby the proposed hydrogen plant and infrastructure layout, and proposed turbines was dictated to a large degree by the existing infrastructure, peat depth and the topography, locating turbines in areas where the existing infrastructure is utilised, peat is shallow, and the topography is favourable. Similarly, engineered cut and fill extents which have been designed will minimise the volumes of subsoils to be removed either directly by excavation (turbine foundations) (underground water tanks) or as a function of cut and fill requirements (hardstands) (swale to south of hydrogen plant to an extent).

Although the removal of peat is unavoidable, it will be minimised through the use of floating roads at some locations, namely the portion of new access road central to the Wind Farm Site (orientated north south directly west of T10, **Figure 8.1a**)

Riparian zones and / or 25 m surface water buffer zones will be maintained, in line with relevant forestry guidance. This includes minimising impacts during design and construction of surface water crossings, and maintaining the 2 5 m riparian zone in afforested areas including commercial forestry, in line with relevant guidance. Mitigation measures have been set out in the **Appendix 2.1 CEMP** where this is not possible.

8.5.2.5.2 Mitigation by Good Practices

8.5.2.5.2.1 Wind Farm

Excavation of peat in areas where there is >1.0 m in peat depth will follow appropriate engineering controls such as the drainage of the peat along the proposed Wind Farm Site access roads in advance of excavation activity (1 month in advance where possible) so as to reduce pore water content and thus instability of the peat substrate prior to excavation. Such drains will be positioned at an oblique angle to slope contours to ensure ground stability. Drains will not be positioned parallel to slope contours. This drainage will be attenuated prior to outfall (**Chapter 9: Hydrology and Hydrogeology**). It is noted that peat depth at the Wind Farm Site is generally shallow and management of saturated peat will be required at relatively few locations.

In those parts of the Wind Farm Site where excavation may intercept areas of peat that are >1.0 m depth, a geotechnical engineer/engineering geologist will be onsite to supervise and manage the excavation works and confirm the necessity for supporting newly excavated peat exposures or redirect initial construction phase drainage to maintain ground stability.

For side walls in all excavations a safe angle of repose will be established. This will ensure the potential for side wall collapse will be minimised. For peat, the safe angle of repose is approximately 15°, which equates to a c. 10 m horizontal distance if excavating to 2.5 m depth, however given the quality of the peat, and the potential residual water content after pre excavation drainage works, or increased water content following heavy rainfall events, there remains a risk of localised stability issues arising in areas of deeper peat. Therefore, for excavation in areas of deeper peat (>2.0 m) and for any areas adjacent to peat areas with increased sensitivity (e.g. wet peat areas or adjacent SAC areas identified in Biodiversity Chapter) excavation supports will be used and this will be incorporated into the CEMP for the Development, for example; temporary sheet piling, or similar. This will minimise the effect of excavation to the minimum required. Areas of the Wind Farm Site where deeper (>2.0 m) peat was detected during site surveys are presented in **Figure 8.7a.** Similarly, the safe angle of repose for subsoils at the Wind Farm Site (GRAVELS), or any other material (e.g. crushed rock) arising at the Wind Farm Site must also be considered and similar consideration and mitigation applied respectively.

Adopting good practices, planning ahead and real time monitoring in more sensitive (>1 m peat depth, **Figure 8.7a**) areas will ensure that any excavations associated with the Proposed Development will have minimal impact, that is; the risk of the activity of excavation having an increasing or variable impact will be reduced. Similarly, application of the above mitigation measures will reduce the risk of stability issues arising at a localised scale.

8.5.2.5.2.2 Hydrogen Plant

Where necessary, dewater excavations. Store soil locally for backfilling and re-use **Chapter 2 Section 2.6.15**. The interface mast foundations will be backfilled one leg at a time with the material already excavated at the location. The backfill will be placed and compacted in layers. All dimensions will be checked following the backfilling process.

Excavations for the proposed Hydrogen Plant as outlined in **Section 8.4.3.2** includes underwater storage tanks and foundation structures as well as trenches for single circuit sections of UGC; HDPE power and communications ducts to be installed. Dirty water that forms due to excavations will be fully and appropriately attenuated, through silt bags, before being appropriately discharged to swale vegetation areas or surface water drainage feature. A Geotechnical Engineer will complete daily monitoring of excavations during the construction phase. If high levels of seepage inflow occur, excavation work will immediately be stopped and a geotechnical assessment undertaken.

Drainage at the proposed Hydrogen Plant location is limited to approximately 3 no. field drains, an area of cutover, boggy peat adjacent to the south of the Hydrogen Plant Site boundary and the Dooyeaghny_or_Cloonloughan_010 River which runs 70 m at the closest point along the south of the Hydrogen Plant Site.

Drainage measures will be provided to attenuate runoff on both sites, guard against soil erosion, soil compaction, and safeguard local water quality. Details of the drainage system are shown on **drawing no 410135-3000-G1000** and outlined in detail in the Surface Water Management Plan, part of the **CEMP (Appendix 2.1)**. Full details are provided in **Chapter 9: Hydrology and Hydrogeology.**

8.5.2.5.3 Mitigation by Reduction

Apart from the measures taken in the design phase of the Proposed Development (avoiding the need for and reducing volumes of subsoils to be removed) there are no other reductive mitigation measures in terms of subsoil and bedrock removal, that is; the layout of the Proposed Development minimise the impact of subsoil and bedrock removal in so far as practical, without compromising or reducing the Proposed Development.

8.5.2.5.4 Mitigation by Reuse

- Subsoil and bedrock which are excavated as part of the initial decommissioning and construction phases of the Proposed Development and will be reused onsite where possible. The excavated peat material will be stored in designated spoil deposition areas as shown on Drawing 6129-PL-100 There are 3 areas designated for spoil storage. During excavation works peat will be deposited in the peat storage are closest to the works, as outlined in the **Peat management plan and Spoil management plan.** Bedrock material arising at the sites will be reused as fill material where applicable, and access roads. Excess bedrock will be reused as backfill in areas previously excavated, or as backfill in cut and fill operations. Using the local geology as fill will ensure that impacts to hydrochemistry are minimised. The estimated total volume of excavated material from the Wind Farm Site and Grid Connection is 193,246 m^3 of which 140,137 m^3 will be reused or placed in the designated spoil deposition areas and 17,344 m^3 will be moved off site for disposal. The designated spoil storage areas have a capacity of 178,614 m^3. This means there is 2,712 m^3 of surplus capacity in the designated spoil areas. The estimated total volume of excavated material from the Hydrogen Plant Site is 26,080 m^3 of subsoil of which all will be reused on the Hydrogen Plant Site.

Geotechnical testing on imported material from neighbouring quarries will be carried out prior to its reuse onsite, particularly for reuse as a running or load bearing surface and will only be reused for those purposes if the suitability of same is conforms to relevant standards. Useful guidance in this regard include:

- Good Practice during Wind Farm Construction (SNH, 2015)
- Notes for Guidance on the Specification for Road Works Series NG 600 – Earthworks (TII, 2013)
- Constructed tracks in the Scottish Uplands (SNH, 2015)

On the Wind Farm Site, peat material excavated will be reused as backfill in areas previously excavated as much as possible, and/or for reinstatement works elsewhere on the sites. A volume of 2,113 m^3 excavated peat will be used as berms around Turbine Hardstands (**Peat management plan and Spoil management plan)**. Any surplus will be deposited in the designated spoil storage areas. To facilitate this the acrotelm (living layer) and the catotelm (lower layer) will be treated as two separate materials. Catotelm peat will be used to backfill, for example; around turbine foundation pads once established. Acrotelm peat will be used as a dressing on top of deposited catotelm peat in order to promote and re-establish flora and ensure the acrotelm layer becomes relatively cohesive in terms of localised peat stability (vegetated), **Appendix 9.6 Conceptual Graphics.**

Temporary storage areas identified on the Wind Farm are outlined in **Figure 8.8a,** and have avoided associated constraints (presented in **Figure 8.8b),** for example avoiding buffer zones of sensitive receptors, i.e. T4 and T13.

Both, all soil and subsoil types or horizons identified during actual construction phases will be treated as separate materials and arisings separated accordingly. This includes, for example; Acrotelm peat, catotelm peat, subsoils (/TILL), weathered rock.

The management, movement, and temporary stockpiling of material on both the Wind Farm Site and the Hydrogen Plant Site will be detailed in the CEMP, this will include identification of suitable temporary set down areas which will be located within the Proposed Development footprint and will consider and avoid geo-constraints identified in this report (**Figure 9.12a-b**). Temporary set down / stockpile areas will be considered similarly to active excavation areas in terms of applying precautionary measures and good practices, and mitigation measures, including those relating to control of runoff and entrainment of suspended solids (**Chapter 9: Hydrology & Hydrogeology**).

8.5.2.5.5 Mitigation by Remediation

The mitigation measures listed above, namely backfilling with peat in layers, are in effect remediation measures, whereby the impact of required excavation works are remediated and limited to the extent of the actual proposed infrastructure.

Excess subsoils and bedrock will be used for remediation and reinstatement purposes elsewhere on the sites, including areas already impacted by peat cutting and agricultural activities, eroded or degraded areas, for example, reinstating original ground level in areas of cut peat and/or damming drains in peat areas **(Figure 8.8a and 8.8b).**

Mitigation measures outlined here will ensure the impacts arising from excavation activities are minimised to the footprint of the Proposed Development, and improve some other degraded areas of the sites, thus minimising (Hydrogen Plant) or offsetting (Wind Farm) the adverse impacts of the Proposed Development.

It is recommended that the ongoing destructive agricultural and peat cutting practices within the Wind Farm footprint ceases for the lifespan of the project, for example; the cutting of peat and soils and the installation of drainage features at the Wind Farm Site. With reference to **Chapter 9: Hydrology & Hydrogeology**, drainage features adjacent to the Proposed Development footprint will be designed and / or modified to include appropriate attenuation features and buffered outfalls etc.

8.5.2.6 Storage of Stockpiles

8.5.2.6.1 Mitigation by Avoidance and Good Practice

As discussed in previous sections, excavation of materials on both sites is unavoidable however the impacts of same can be minimised if managed appropriately. Similarly, given that excavations are unavoidable, so too are temporary stockpiles, however if managed appropriately the impact of same can be minimised. Stockpiles will be restricted to less than 1 m in height and located outside of the surface water buffer zones. All stockpiling locations will be subject to approval by the Site Manager and Project Ecological Clerk of Works (ECoW). No permanent stockpiles will remain on either of the sites. All excavated materials from the sites or introduced materials for construction will be either used or removed from the sites. All stockpiles will be covered with geotextiles layering to protect against water erosion and runoff in rainy weather, and/or cessation of works in certain areas such as working on a high gradient during wet and windy weather.

Wind Farm

No temporary stockpiles will be positioned or placed on peat. All temporary stockpiles will be positioned on established and existing hardstand areas. No temporary stockpile placed on established hardstands within 150 m surface water buffer zones or 15 m from artificial drainage, or in areas of deeper peat, will be in excess of 1 m in height. This is due to potential localised stability issues in relation to the peat in the vicinity of the stockpile, discussed in the following sections of this Chapter.

As discussed in **EIAR Chapter 9: Hydrology and Hydrogeology**, stockpiling of material will invariably lead to the entrainment of solids in surface water runoff. Mitigation measures to address same are detailed in **Chapter 9**, however it is recommended that the CEMP incorporates a Materials Management Plan which facilitates the near immediate reuse of material in so far as practical, thus reducing the potential for temporary stockpiles in general. For example; the material arising from the first excavation is deposited in areas identified as having potential for restoration or requiring fill, the material arising from the second excavation is used as fill and reinstatement material in the first excavation location, etc

8.5.2.6.2 Mitigation by Reduction

The volume of material to be managed including temporary stockpiling is directly proportional to the volumes of material required to be excavated on the Wind Farm Site (136,883 m^3), Grid Connection Route (21,467 m^3), Hydrogen Plant Site (26,025 m^3), and Interconnector Route (6,619.5 m^3), however if managed appropriately the volume of material to be managed at any particular time can be dramatically reduced.

A Materials Management Plan, forming part of the CEMP, will be established for the sites to identify volumes and types of materials arising, temporary stockpiling locations, routes for reuse and remediation, requirements in terms of logistics and considerations in terms of timing and planning of movements of material.

The Materials Management Plan will ensure that the material arising from any excavation will have a predetermined plan and route for re-use / remediation, or disposal if all potential for reuse / remediation have been exhausted.

8.5.2.7 Vehicular Movements

8.5.2.7.1 Mitigation by Avoidance and Good Practice

Vehicular movements will be restricted to the footprint of the Proposed Development, and advancing ahead of any constructed hardstand will be minimised in so far as practical, for example; excavation ahead of established hardstands will be in line with expected phases of hardstand and road construction in terms of both delivery of and installation of material and site activity periods whereby excavations will not be opened ahead of site shut down periods. This will be done with a view to minimising soils / subsoils exposure to rain and runoff.

Ancillary machinery will be kept on established hardstands and no vehicles will be permitted outside of the footprint of the Proposed Development, and will not move onto land that is not proposed for the Proposed Development if it can be avoided.

Where vehicular movement are necessary outside of the Proposed Development footprint, ground conditions will be maintained as well as possible. This includes for example; replacing sods, smoothing over with excavator bucket etc. Where ground conditions are poor, or prolonged works, temporary access measures will be deployed, for example; floating platforms / floating access road.

Adhering to the mitigation measures described here will minimise the adverse impacts posed by vehicular movements, and ultimately any impacts arising will be temporary considering the initial decommissioning and construction of the Proposed Development will in effect reverse any impact by vehicular movement within the footprint of the Proposed Development.

Mitigation measures are specified in the Construction Environmental Management Plan (CEMP).

8.5.2.8 Ground Stability

8.5.2.8.1 Mitigation by Avoidance and Good Practice

Peat and slope stability investigations at both sites (**Figure 8.6 a-b. Figure 8.7a-b**) indicate that the Wind Farm Site and Hydrogen Plant Site have a generally low risk probability with respect to slope failure under the footprint of the Proposed Development. The investigation includes some key limiting factors and assumptions which should be noted:

- The area assessed is in line with the footprint of the Proposed Development.
- The assessment 'worst case scenario' assumes a maximum of 1 m fill, that is; stockpiles are limited to 2 m height.

Considering the assessment conclusions are related to the footprint of the Proposed Development and initial decommissioning and construction activities including vehicular movements will be limited to the footprint of the Proposed Development, areas of potentially high risk (GSI landslide susceptibility) in terms of peat and slope stability will be avoided.

Temporary stockpiles will be limited to 2 m height in sensitive areas, and removed for reuse/remediation purposes or disposed offsite as soon as possible. It is envisaged that all material will be reused on site, unless obviously contaminated. Therefore, the risk posed by the management of material in terms of peat and slope stability is dramatically reduced if not avoided completely.

Furthermore, with a view to applying the precautionary principle, the following procedures will be adopted as best practice mitigation measures at the sites.

- All site excavations and construction will be supervised by a geotechnical engineer/engineering geologist.
- The contractor's * methodology statement and risk assessment will be in line with the Construction Environmental Management Plan and will be reviewed and approved by a suitably qualified geotechnical engineer/engineering geologist prior to sites operations. (*Contractor here refers to the chosen or contracted construction company at the commencement stage of the proposed development).
- Particular attention and pre-construction assessment (developer / sub-contractor site specific risk assessment and method statement (RAMS) and on site toolbox talks etc.) and mitigation planning will be given to any new infrastructure, for example; the proposed access roads, culverted watercourse crossing and hardstand associated with proximal geo-hazards including for example T2, T3 and T13 which are above particularly sensitive areas of the Wind Farm Site as discussed in the attached SI report (**EIAR Chapter 8 - Appendix 8.7**), and as presented in constraints maps (**EIAR Chapter 8 – Figure 8.11**)

- Any excavations that have the potential to undermine the up-slope component of a peat and / or unstable subsoil slope will be sufficiently supported by buttress, frame or rampart to resist lateral slippage. To this end, all new turbine foundation excavation locations will incorporate a safe angle of repose, however with a view to minimising the impact of the Proposed Development Excavation in peat of >1 m depth will be supported by a restraining / support wall during the construction phase. Floating road volume estimation 8,292 m³ **(Peat Management Plan and Spoil Management Plan).**
- In such excavations, the groundwater level (pore water pressure) will be kept low at all times (excavation dewatering) to avoid ground stability risks (subsidence) associated with peat and careful attention will be given to the existing drainage and how structures might affect it. Draining water from the construction area will be done through advanced dewatering techniques. In particular, ponding of water will not be allowed to occur in recent excavations, particularly in any areas encountered where peat is >1 m. All deliberate or incidental sumps will be drained to carry water away from the sump following rainfall. Otherwise, this water will increase hydraulic heads locally (or increased bog water or groundwater levels), increase pore water pressure and can potentially lead to instability.
- In areas of saturated peatlands on the Wind Farm, prior to excavation, drains will be established to effectively drain grounds prior to earthworks. Such drains will be positioned at an oblique angle to slope contours to ensure ground stability. Drains on areas of the Wind Farm Site with minimal risk of bog failure as identified by site investigations will be positioned at a more acute angle to the slope contour in order to reduce the velocity of surface water drainage. It is noted that deeper (>2.0 m) peat at the Wind Farm Site is generally confined to isolated pockets and the need for 'heavy duty' measures such as sheet piling is very low.
- Due to peat's fluid-like properties, all peat excavated will be immediately removed from sloping areas. Peat will be carefully managed particularly when in temporary storage. Temporary storage areas will be isolated from the receiving environment by means of temporary infrastructure such as boundary berms comprised of subsoils sourced at the site, or similar material. There is potential for large volumes of bog water draining from new stockpiles which will also be managed. Mitigation will include removal of gross solids from runoff prior to bog water intercepting the wind farm drainage network. Temporary measures such as dewatering and pumping through silt bags will be employed to assist this process. Draining of stockpiled peat, in a controlled manner is recommended with a view to reducing the weight and mobility of the material, therefore reducing risk in terms of localised stability. Similar measures will be applied to the management of subsoil arisings at the site.

- Peat is required for reinstatement, therefore acrotelm peat (top living layer, c. 0.5 m) will be stripped off the surface of the bog and placed carefully at the margins of the Proposed Development along the site access road and hardstand margins that are characterised by near-horizontal slopes (<6°).
- Relatively high impact construction activities (e.g. excavations, movement of soils / subsoils / rock) will be limited to the spring to autumn period as this period is considered to be the optimal seasonal period in terms of likely rainfall conditions, low soil moisture deficit (SMD), and relatively stable pore water pressure conditions (not withstanding excessive human interference of pore waters). However, it should also be noted that the hypothesis of the spring to autumn period being optimum in terms of dry metrological conditions is based on 30 year average data, and in reality 30 year max rainfall events are observed to be significant throughout the year over the 30 year period (**EIAR Chapter 9: Hydrology and Hydrogeology**). Therefore, considering the variability of metrological conditions and the potential for significant events to occur at any stage of the year, the construction phase will be limited to favourable meteorological conditions. Construction activities will not occur during periods of sustained significant rainfall events, or directly after such events (allowing time for work areas to drain excessive surface water loading and discharge rates reduce).
- From examination of factual evidence to date, the majority of landslides occur after an intense period of rainfall. Stability issues at a localised scale will be similarly impacted by rainfall events, particularly when dealing with exposed soils or open excavations. An emergency response system will be developed for the construction phase of the project, particularly during the early excavation phase. This, at a minimum, will involve 24-hour advance meteorological forecasting (Met Eireann download) linked to a trigger-response system. When a pre-determined rainfall trigger level is exceeded (e.g. one in a 100-year storm event or very heavy rainfall at >25 mm/hr), planned responses will be undertaken. These responses will include; cessation of construction until the storm event including storm runoff has passed over. Following heavy rainfall events, and before construction works recommence, the Site will be inspected and corrective measures implemented to ensure safe working conditions, for example; dewatering of standing water in open excavations, etc.
- Any impact to the hydrological and/or hydrogeological regime will be avoided as far as practical in relation to identified Geo-Hazards (**Figure 9.12a Figure 9.12b**) where the presence of steep inclines, deep till deposits and iron pan give rise to elevated ground stability, particularly where the potential for impacts to hydrogeology in those area / subsoils exists. For example; runoff from constructed hardstands will not be diverted and discharged into Geo-Hazard areas where possible. If unavoidable, due to slope

direction etc., erosion control will be implemented in so far as practical, as discussed under **EIAR Chapter 9: Hydrology & Hydrogeology.**

Mitigation measures are specified in the CEMP.

8.5.2.8.2 Mitigation by Reduction

The temporary storage of construction materials, equipment, and earth materials will be kept to an absolute minimum during the construction phase of the Proposed Development. This will be achieved by means of appropriate planning and logistical considerations forming part of the CEMP, similar to the measures set out in relation to the management of spoil on the Site.

For example; the excavation material for the construction of access road will not progress ahead of actual road construction (as discussed under mitigation addressing vehicular movements), therefore minimising the volume of arisings to be managed. Areas for permanent deposit of material e.g. backfill adjacent to constructed infrastructure, will be identified and suitable material deposited as it becomes available **(Figure 8.1a)**. These efficiencies will be designed into the detailed CEMP.

The Hydrogen Plant Site Temporary Construction Compound will be positioned where the Hydrogen Tube Trailer parking is proposed.

8.5.2.8.3 Mitigation by Remediation

There are no indications of significant issues on the Sites in terms of ground stability, however excavation and construction activities will lead to some impacts with respect to the immediate area adjacent to the Proposed Development footprint and areas impacted by potential localised stability issues. In these instances, remediation of soils will include the deposit of suitable material where required. This will include replacement of soils / subsoils in line with baseline conditions. For example on the Wind Farm Site; the three principal materials excavated in order of depth will include peat / peat soil (including segregated acrotelm (top living layer) and catotelm peat) or topsoil at the surface, till, and crushed rock. Remediated areas will be managed and monitored in terms of reestablishment of vegetated cover.

In the unlikely event that a peat or slope stability issue does arise on the Site during the construction or operational phases of the Development, given the variable potential extent of associated impacts, remediation will be assessed, prescribed and monitored by a suitably qualified geotechnical engineer/engineering geologist on a case by case basis.

8.5.2.8.4 Emergency Response

Mitigation measures as outlined in the previous sections will reduce the potential for stability issues arising during the initial decommissioning and construction phase of the Proposed Development. However, there remains a low risk of stability issues arising, particularly at a localised scale.

Emergency responses to potential stability incidents will be established and form part of the CEMP before construction works initiate. The following potential emergencies and respective emergency responses are addressed in brief:

- Peat stability issues at a localised scale during excavation works – In the event that soil stability issues arise during construction activities, all ongoing construction activities at the particular area of the Site will cease immediately, the assigned geotechnical supervisor will inspect and characterise the issue at hand, corrective measures will be prescribed.
- Significant peat or slope stability issues during construction activities – In the unlikely event that soil and slope stability issues arise during construction activities, all ongoing activities in the vicinity will cease immediately, operators will evacuate the area by foot, the assigned geotechnical supervisor will inspect and characterise the issue at hand, corrective measures will be prescribed.

Considering the highly dynamic nature of peat or soil stability issues at any particular site, it is important to establish an equally dynamic yet robust framework to follow in the event of an incident. Establishment of an emergency framework will follow relevant guidance to initially qualify any incident (by on site competent geotechnical engineer) and risk assess the area, and to then apply initial measures and design a complete emergency / contingency plan in line with an established structured emergency response. Relevant guidance includes:

- Forestry Commission, Scotland (2006) Guidelines for the Risk Management of Peat Slips on the Construction of Low Volume / Low Cost Roads Over Peat
- CIRIA (2006) Control of water pollution from linear construction projects. Site guide (C649)).

The principal receptor and pathway for impacts associated with stability. Emergency response will prioritise isolating and containing any materials which is being or will be intercepted by the established drainage network or receiving surface water network. Emergency materials and equipment requirements will be identified, incorporated in the CEMP, and will be managed on site with a view to be being easily accessible and readily available.

On site training and toolbox talks will ensure any response to any potential incident is escalated quickly and efficiently.

The combination with mitigation measures as described under **EIAR Chapter 9: Hydrology and Hydrogeology** whereby precautionary measures e.g. silt screen fencing etc. will be in place. Emergency response above existing or in place measures might include crudely building dams with an excavator to attenuate or direct flow until conditions stabilise, depositing subsoil or crushed rock material to dam drainage channels, and reactionary dewatering through silt bags to appropriate areas of the site i.e. vegetated area and without impacting on problem area in terms of stability.

8.5.2.9 Soil Contamination

Any accidental spillage of introduced materials, such as concrete, will be removed from the Sites. Soil contamination, or the potential for same, is an inherent risk associated with any development. As such, good practice during construction activities, as detailed in the CEMP, will address and minimise the potential for soil contamination to occur. The CEMP will be developed to include the scheduled checks of assets (plant, vehicles, fuel bowsers) on a regular basis during the construction phase of the Development. The purpose of this management control is to ensure that the measures in place are operating effectively, prevent accidental leakages, and identify potential breaches in the protective retention and attenuation network during earthworks operations. In addition, all such management plans will be revised as 'live' documents, so that lessons learned and improvements will be made over course of the Proposed Development.

8.5.2.9.1 Mitigation by Avoidance and Good Practices

8.5.2.9.1.1 Release of Hydrocarbons

Contaminants which pose the most significant risk to soils, namely hydrocarbons and construction materials such as cement / concrete, pose an even greater risk to surface waters and groundwaters. In the event an accidental discharge were to occur without mitigation, contaminates will likely leak or be spilled on soils initially. Protecting soils from such will in turn mitigate against the potential for contaminates reaching the hydrological network associated with the Site, however given that such features are fundamental to the potential effect of contaminants down gradient of surface water receptors, mitigation measures for contaminants are presented in detail in **Chapter 9: Hydrology and Hydrogeology.** To control and contain any potential hydrocarbon or other harmful substance spillages by vehicles during construction, it is recommended where possible to refuel plant equipment off the development site, thus mitigating this potential impact by avoidance.

Where fuelling offsite is impractical (e.g., bulldozers, cranes, etc.) and fuelling must occur on Site, all oil and chemical storage facilities will be bunded to 110% volume capacity of fuels stored at the site. A "fuel station" will be designated for the purpose of safe fuel storage and fuel transfer to vehicles, located at the Temporary Contractor's Compound. Furthermore, a Emergency Response Plan will be in place as part of the Construction and Environment Management Plan (**Appendix 2.1**) before consented works are carried out.

As discussed, construction activities will be restricted to the footprint of the Proposed Development, therefore the potential for contaminants reaching soils is likely limited to the footprint of the Proposed Development or construction area. There remains the potential for contaminant migration through soils however, scope for migration is limited considering the site geology i.e., peat / loamy soil with low permeability and transmissivity rates, and similarly poorly productive bedrock aquifers with only localised connectivity. The highest permeability and transmissivity rates at the Sites are attributed to the underlying till / gravels. It is also noted that the scale of any potential contamination impact will likely be minor in scale, for example; plant machinery leak (on exposed ground), as opposed to a fuel tank rupture (in bunded structure).

A fuel management plan will be prepared (and included in the CEMP) which will incorporate the following elements:

- Mobile bowsers, tanks and drums will be stored in secure, impermeable storage area, away from drains and open water;
- Fuel containers will be stored within a secondary containment system e.g., bund for static tanks or a drip tray for mobile stores
- Ancillary equipment such as hoses, pipes will be contained within the bund
- Taps, nozzles or valves will be fitted with a lock system
- Fuel and oil stores including tanks and drums will be regularly inspected for leaks and signs of damage
- Only designated trained operators will be authorised to refuel plant on Sites.

In the event of an accidental spill during the construction, operational or decommissioning phase of the Development, contamination occurrences will be addressed immediately, this includes the cessation of works in the area of the spillage until the issue is resolved. In this regard, appropriate spill kits must be provided across the site to deal with the event of a spillage and made available at all times. Spill kits will contain a minimum of; oil absorbent granules, oil absorbent pads, oil absorbent booms, and heavy-duty refuse bags (for collection and appropriate disposal of contaminated matter). Staff will be trained in their use and details of personnel and location and type of spill kits will be listed in the CEMP (**Appendix 2.1**), which will be updated by the selected site Contractor. No materials contaminated or otherwise will be left on the Site. Suitable receptacles for hydrocarbon contaminated materials will also be at hand. Upon usage, spill kits will be promptly replaced.

The mitigated effects associated with hydrocarbons is considered to be **neutral and temporary**.

8.5.2.9.1.2 Release of Wastewater Sanitation Contaminants

A temporary compound area (**Figure 8.1a**) will be constructed on-site for the Wind Farm to contain temporary facilities for the construction phase including 'port-a-cabin' structures. The Wind Farm Temporary Construction Compound and Hydrogen Plant Temporary Construction Compound will be constructed on a base of geo-textile matting laid at ground level. This will be stabilized with the laying of hardcore material on top. During the construction phase, foul effluent will be periodically removed for offsite disposal.

The Hydrogen plant will consist of permanent on-site 110 kV Hydrogen Plant Substation including 2 no. control buildings with welfare facilities, and wastewater holding tank. The two wastewater streams will initially be dealt with separately. Welfare wastewater will be run through a septic tank, and then through a welfare constructed wetland (WCW). The WCW will be positioned in the northeast corner of the site and will be approximately 80 m^2 to facilitate the required retention time of c. 12 days to adequately treat the welfare effluent loading.

Wastewater/sewerage from the staff welfare facilities located in the Wind Farm Temporary Construction Compound and Hydrogen Temporary Construction Compound will be collected and held in sealed storage holding tanks, fitted with a high-level alarm. The high-level alarm is a device installed in the storage tank that is capable of sounding an alarm during a filling operation when the liquid level nears the top of the tank. Chemicals are likely to be used to reduce odours.

All wastewater will be emptied periodically, tankered off-site by a licensed waste collector to the local Ballina wastewater sanitation plant for treatment. There will be no onsite treatment of wastewater. A wastewater or sewerage leakage is not anticipated in a properly managed site.

The mitigated effects associated with wastewater and sewerage on the Wind Farm Site is considered to be **slight**, **temporary** and **neutral**.

The mitigated effects associated with wastewater and sewerage on the Hydrogen Plant Site is considered to be **slight**, **permanent** and **neutral**.

8.5.2.9.1.3 Release of Construction and Cementitious Materials

In order to mitigate the potential impact posed by the use of concrete and the associated effects on surface water in the receiving environment, the following precautions and mitigation measures are recommended as outlined in the CEMP:

Precast concrete will be used wherever possible i.e., formed offsite. Elements of the Proposed Development where the use of precast concrete is not possible includes Turbine Foundations. Where the use of precast concrete is not possible the following mitigation measures will apply:

- Lean mix concrete, often used to provide protection to main foundations of infrastructure from soil biome, will be minimized, limited to the requirement of turbine foundations if necessary. Lean mix concrete can alter the pH of water if introduced, which would then require the treatment of acid before being discharged to the surrounding environment. The risk of runoff will be minimal, as concrete will be contained in an enclosed, excavated area
- The acquisition, transport and use of any cement or concrete on site will be planned fully in advance of commencing works by the Contractor's Environmental Manager and supervised at all times by the Developer appointed Environmental Clerk of Works (EnvCoW).
- There will be no excess cementitious material on the vehicle which could be deposited on trackways or anywhere else on site. To this end, delivery trucks, tools and equipment will be cleaned at designated washout areas located within site compound and within a controlled area of the Site. Vehicles will undergo a visual inspection prior to being permitted to drive onto the proposed site or progress beyond the contractor's yard.

In addition, the following drainage measures will apply:

- Any shuttering installed to contain the concrete during pouring will be installed to a high standard with minimal potential for leaks. Additional measures could be taken to ensure this, for example the use of plastic sheeting or other sealing products at joints.
- Concrete will be poured during periods of minimal precipitation. This will reduce the potential for surface water run off being significantly affected by freshly poured

concrete. This will require limiting these works to dry meteorological conditions i.e., avoid foreseen sustained rainfall (any foreseen rainfall event longer than 4-hour duration) and/or any foreseen intense rainfall event (>3 mm/hour). This also will avoid such conditions while concrete is curing, in so far as practical.

- Ground crew will have a spill kit readily available, and any spillages or deposits will be cleaned/removed as soon as possible and disposed of appropriately.
- Pouring of concrete into standing water within excavations will not be undertaken. Excavations will be prepared before pouring of concrete by pumping standing water out of excavations to the buffered surface water discharge systems in place.
- No surplus concrete will be stored or deposited anywhere on site. Such material will be returned to the source location or disposed of off-site appropriately.

Elements of the Proposed Development where precast concrete will be used will be identified in the CEMP, e.g., structural elements of watercourse crossings (single span / closed culverts) as well as cable joint bay structures.

Supplementary mitigation measures outlined in **Chapter 9: Hydrology and Hydrogeology** to surface water receptors will also apply. The mitigated effects associated with construction waste is considered to be **slight** and **neutral**.

8.5.2.9.1.4 General Waste

All construction and operation waste materials will be correctly sorted, recycled or disposed of in accordance with good site practice and in accordance with the Site Management Plans. A policy of Prevent, Reduce, Reuse and Recycle will apply. The mitigated effects associated with general waste is considered to be **slight**, **temporary** and **neutral**.

8.5.2.9.2 Mitigation by Reduction

The potential for contaminants will be reduced by managing the importation and mobilisation of equipment and materials associated with the Development, as follows;

- Excess packaging and other materials will be discarded appropriately at the temporary construction compounds before advancing to the destined construction area.
- Any vehicles coming onto the sites will be required to be inspected and cleaned before leaving the temporary construction compounds and before advancing to the destined construction area.
- Precast concrete will be used wherever possible i.e. formed offsite. Elements of the Proposed Development where precast concrete will be used have been identified and are indicated in the CEMP. Elements of the Proposed Development where the use of

precast concrete will be used include e.g. structural elements of watercourse crossings (single span / closed culverts). Elements of the Proposed Development where the use of precast concrete is not possible includes e.g. turbine foundations. Where the use of precast concrete is not possible the following mitigation measures outlined in **EIAR Chapter 9: Hydrology and Hydrogeology** will apply.

8.5.2.9.3 Mitigation by Remediation

Mitigation by remediation, for example; housekeeping, maintenance etc, in terms of waste or contaminants will be an ongoing measure throughout the construction phase of the Development, that is; any and all contaminants will be removed from the Site in an appropriate manner when ever produced or observed.

Ongoing remediation measures are specified in the CEMP.

8.5.2.9.4 Emergency Response

Mitigation measures as outlined in the previous sections will reduce the potential for soil contamination during the construction phase of the Proposed Development. However, there remains the risk of accidental spillages and or leaks of contaminants onto soils.

Emergency responses to potential contamination incidents will be established and form part of the Construction Management Plan before construction works initiate. Potential emergencies and respective emergency responses are assessed below:

- Hydrocarbon spill or leak – Hydrocarbon contamination incidents will be dealt with immediately as they arise. Hydrocarbon spill kits will be prepared and kept in vehicles associated with the construction phase of the Development. Spill kits will also be established at proposed construction areas, for example; a spill kit will be established and mobilised as part of the turbine erection materials and equipment. Suitable receptacles for hydrocarbon contaminated materials will also be at hand.
- Significant hydrocarbon spill or leak – In the event of a significant or catastrophic hydrocarbon spillage, emergency responses will be escalated accordingly. Escalation can include measures such as; installation of temporary sumps, drains or dykes to control the flow or migration of hydrocarbons; excavation and disposal of contaminated material. Any such measures will be reviewed by appropriate consultants, however considering that collector drainage (**Chapter 9: Hydrology and Hydrogeology**) will be established prior to construction activities, the need for drainage as an emergency response will be limited, however 'dig and dump' remediation processes will likely be required.

- Cementitious material – Cement / concrete contamination incidents will be dealt with immediately as they arise. Spill kits will also be established at proposed construction areas, for example; a spill kit will be established and mobilised as part of the turbine erection materials and equipment. Suitable receptacles for cementitious materials will also be at hand.

Emergency contact numbers for the Local Authority Environmental Section, Inland Fisheries Ireland, the Environmental Protection Agency and the National Parks and Wildlife Service will be displayed in a prominent position within the vicinity of works. Additionally, emergency responses, including methodologies, will be specified in the CEMP.

In the event of a significant contamination or polluting incident e.g. discharge or accidental release of hydrocarbons / fuel to surface water systems, the relevant authorities, noted above and stakeholders will be informed.

Refer to **Chapter 9: Hydrology & Hydrogeology** for further information.

8.5.2.10 Material and Waste Management

All excavated earth materials will either be re-used in an environmentally appropriate and safe manner e.g. landscaping and bog restoration OR removed from the Sites at the end of the construction phase. No permeant stockpiles will be left on the sites.

Any surplus of natural materials (e.g. peat) to be used as backfill or deposited elsewhere in the Wind Farm Site will not be deposited to above existing ground level for the area in question. This ensures that peat used as backfill around newly established turbine foundations will not exceed local ground level, and any peat or natural materials deposited elsewhere, for example peat cutting areas, will not exceed original ground level. In essence, no permanent stockpiles will be established as a product of the construction phase of the Proposed Development, or associated restoration activities.

Any excess introduced natural (road building materials) or artificial (PVC piping, cement materials, electrical wiring etc.) will be taken offsite and disposed of appropriately at the end of the construction phase.

Any accidental spillage of introduced materials, such as concrete, will be removed from the Sites. The CEMP will include scheduled checks on equipment, materials storage and transfer areas, drainage structures and their attenuation ability (covered in greater detail in the Hydrology chapter of this report) on an ongoing / daily basis during the construction phase of the project. The purpose of this management control is to ensure that the measures in place are operating effectively, prevent accidental leakages, and identify potential breaches in the protective retention and attenuation network during earthworks operations. In addition, all such management plans will be revised as 'live' documents, so that lessons learned and improvements will be made over course of the Proposed Development.

It is noted that the Proposed Development intends to reuse all surplus excavated material at the sites, however in the event of waste arising at the sites, management of waste from the construction phase of the Proposed Development will require classification, appropriate transfer, and appropriate disposal. Surplus excavated material from the Hydrogen Plant Site will be disposed of to a licensed facility.

Waste streams will vary and will include the following potential categories:

- Inert Soils & Stones (EWC Code: 17 05 04) – greenfield subsoils and bedrock is likely to be Inert. This could include surplus coarse / hardcore aggregate contaminated with soils remaining at the end of the construction phase of the development.
- Hazardous Soils & Stones (EWC Code: 17 05 03*) or oily waste (spill kit consumables) – Soils or any materials with significant hydrocarbon contamination will likely be hazardous due to Total Petroleum Hydrocarbon concentrations. Soils impacted by significantly by cementitious material contamination will likely be hazardous due to elevated pH concentrations.

Given the potential range of waste streams, and considering waste streams must not be mixed or blended onsite, the management of such potential waste streams is important so as to not contaminate otherwise clean or Inert materials, therefore designated areas for temporary storage of such wastes will be provided.

Materials and waste management practices will be specified and detailed in the CEMP/CWMP.

8.5.2.11 Clear Fell of Forestry – Wind Farm

No new impacts or remediation measures are associated with forestry activities. However, good practices working in specific environments such as forested areas will be adhered to including:

- working outside of surface water or other buffer zones,

- risk assessing on a case by case basis in terms of drainage intercepting run off, ecological sensitivities, etc.
- All drains crossed during extraction, if necessary, will be cleared of any debris to ensure no drainage issues will occur for the remining trees, which can be a major attributor to windblow.
- Felling and extraction of timber will be undertaken in dry weather conditions.

The maximum use possible has been made of existing forest tracks and firelines, thereby minimising the areas of forestry that will be lost in the construction of access roads.

8.5.2.12 Construction Phase Residual Impacts

Mitigation measures outlined in this report lay down the framework to reduce all potential impacts of the Proposed Development on Geological receptors. It is noted that geological mitigation measures and impacts are strongly connected to those related to Hydrology and Hydrogeology. Furthermore, the mitigation laid out in this chapter provides mitigation by avoidance measures for hydrology and hydrogeology impacts. The Mitigated Potential Impacts lay down the achievable benchmarks provided measures are considered and implemented adequately.

Impact	**Mitigated Impact**
Land Take	Direct, negative, slight to moderate, localised, conforms to baseline, unavoidable, permanent (for the life of the development). Reversible after decommissioning and restoration.
Subsoil and bedrock removal	Direct, negative, slight to moderate, localised, conforms to baseline, unavoidable, permanent.
Storage of stockpiles (general)	Direct, negative, slight to moderate, localised, conforms to baseline, likely, temporary/permanent. Material will be used to infill and reinstate turbine foundation, and any excess material will be removed from site in an appropriate manner. Likely impacts

Impact	Mitigated Impact
	mitigated under **EIAR Chapter 9: Hydrology and Hydrogeology**.
Compaction, erosion and degradation of peat / soils arising from vehicular movement	Direct, negative, slight to moderate, localised, conforms to baseline, avoidable, long term to permanent, reversible.
Stability issues and slope failure arising from construction activities	Direct, negative, slight to significant, localised to large scale, conforms to baseline (regional), avoidable, long term to permanent, reversible at localised scale.
Contamination – Hydrocarbons, cement, construction, general.	Direct, negative, significant, localised, contrast to baseline, avoidable, long term to permanent, reversible (*if managed appropriately). If intercepted by drainage / surface water indirect impacts are larger scale and of greater magnitude. **EIAR Chapter 9: Hydrology and Hydrogeology**.
Soil sealing	Direct, negative, slight to moderate, development footprint, contrast to baseline, unavoidable, long term to permanent.

8.5.3 Operational Phase

An Operational Phase Management Plan will be established, and implemented during the operational phase of the Proposed Development, potential issues arising giving cause to residual impacts are likely to be infrequent, imperceptible to slight, localised and reversible. The Operational Management Plan will include monitoring similar to the construction phase but on a less frequent and / or as required. For example; the sites will be inspected on a routine basis and following storm events. Any potential issues arising will be escalated and remedial action taken in line with construction phase mitigation.

8.5.3.1 Chemical Storage on Site

The storage of Nitrogen, Potassium hydroxide for electrolysis process (lye), Sodium bisulphite for de-chlorination of mains water, Oils used by hydraulic systems, compressors and transformers and diesel, Antiscalant used to prevent/reduce scaling of water treatment equipment, Glycol for coolant during the operational phase of the Hydrogen Plant poses a risk on the geological, geomorphological and geotechnical environment. Therefore, specific detail design is necessary in regards to cement bunding of hazardous materials kept on the Sites, as well as routine inspections and maintenance of the areas. Limiting the volume of hydrogen stored on site mitigates any accidents. Should external factors limit the removal of hydrogen from the Hydrogen Plant Site for transportation, a shutdown system will stop production in order to stay within COMAH lower tier regulation volumes.

8.5.3.2 Maintenance and monitoring

Maintenance and monitoring in itself, during the operational phase of the Wind Farm Site and Hydrogen Site poses similar hazards and risks associated with the construction phase but to a far lesser extent, for example; the potential for fuel spills from vehicles, etc. The mitigation measures described in this EIAR chapter will be adopted and implemented.

Vehicular movements will remain constant on the Hydrogen plant in the operational phase, there will be constant transport of hydrogen from the site. It is a working assumption that as the hydrogen market develops tube trailer technology will evolve and greater volumes will be able to be transported per trailer. This assumption results in a maximum predicted number of truck movement per day 26. If this assumption was not to apply the number of movements would be of the order of 50.

8.5.4 Decommissioning Phase

It is the intention that the Hydrogen Plant will continue operations indefinitely. The source of electricity for the Hydrogen Plant would change upon the decommissioning of the Wind Farm and be changed to one of the following options:

- Subject to planning consents, the repowering of Firlough Wind Farm.
- Reinforced electricity network with a corporate Power Purchase Agreement with a green electricity producer.
- Connection to an offshore wind power generator off the west coast.

No new impacts are anticipated during the decommissioning phase of the Wind Farm project (removal of turbines and similar infrastructure on the geological, geomorphological and geotechnical environment) therefore no new mitigation measures are required, however the decommissioning of major infrastructure including proposed turbines poses similar hazards and risks to the environment compared to that of the construction phase. Further details can be found in **Chapter 2 Section 2.9**.

Restoration of the Wind Farm Site and its substation, following decommissioning of the proposed infrastructure is in its own right a phase of the Proposed Development. Restoration activities have the potential to be disruptive and hazardous to the environment, to the point that a 'benefit analysis' will likely be required to evaluate any such activity before it is permitted (Schumann, M., and Joosten, H., 2008).

Likely difficulties impeding restoration highlighted by means of 'benefit analysis' in terms of soil and geology include the following:

- Removal of Turbine Foundations – Significant disturbance due to the difficulties associated with excavating, breaking concrete, cutting steel, loading and transferring foundation materials offsite, and subsequent disturbance associated with the excavation of suitable material to be used as fill to replace the turbine foundation. Vibration caused, particularly in relation to the breaking of concrete, may impact on peat and slope stability locally. Turbine foundations will likely be left in situ.
- Removal of Hardstand / Substation – Significant disturbance due to operations associated with excavation and removal of hardstand materials. Removal of such materials will likely impact on blanket bog directly adjacent to the hardstand area in question, and change the hydrological characteristics of the area in question (**Chapter 9: Hydrology and Hydrogeology**). For this reason all proposed Wind Farm Site access roads, hardstanding areas and drainage will be left in situ for future use.
- The material required to reinstate any areas where infrastructure is removed will need to be sourced from elsewhere on the Wind Farm Site. Considering the elapsed time (reasonable to presume >20 years) the acquisition of natural material itself will likely do more harm (to established blanket bog) than that of the benefit of removing and restoring infrastructure associated with the Development.

Ultimately, any such restoration activities will need to be assessed under the scope of multiple environmental disciplines, similar to this EIAR, and the potential synergistic effects. Given that the condition of the environment will likely change over the course of the operational phase of the Development, particularly in terms of the health and degree of establishment of blanket bog and associated ecology, and ornithology, it is recommended that the potential for restoration following the decommissioning phase of the Proposed Development is evaluated closer to the time (c. 35-40 years). It should be noted that restoration activities do not currently conform to baseline conditions.

Excavation of all material including concrete turbine foundations will likely not be proposed due to the high impact nature of such works e.g. breaking of reinforced concrete. Extensive vehicular movement on peat is not anticipated to any significant extent considering adequate hardstand will have been established, however the risk of fuel or other contaminant spillages, or management of waste are valid hazards during the decommissioning phase of the Development. The mitigation measures described in this EIAR chapter will be adopted and implemented by means of a Decommissioning Phase Management Plan (DPMP).

On the basis that a Decommissioning Phase Management Plan will be established, and implemented during the decommissioning works associated with the Development, potential issues arising giving cause to residual impacts are likely to be infrequent, imperceptible to slight, localised and reversible.

Residual impacts after the decommissioning phase is complete include all impacts classified as being long-term to permanent effects of the Proposed Development, that is; there will remain a change in ground conditions at the Wind Farm Site with the replacement of natural materials such as peat, subsoil and bedrock by concrete, subgrade and surfacing materials. This is a localised, negative, moderate adverse significance, Significant / Moderate weighted significance, direct permanent change to the materials composition at the Wind Farm Site . However, the carefully managed reintroduction and/or reuse of soils and peat at the Wind Farm Site in place of hardstand areas, and successful habitat management, revegetating and rewilding of those areas will have beneficial impacts, or revert to baseline conditions preconstruction phase.

8.5.5 Cumulative Effects

Considering the discipline under investigation, soils and geology, and the fact that potential effects of the Project on same are generally localised, the cumulative effects of the Project are not considered to vary dramatically or behave synergistically when considering the sites as a unit, or indeed when considering in conjunction with other developments in the vicinity or downgradient of the sites. However, on a national scale the importance of soils and peatlands in particular in terms of ecological value and carbon value must be considered. the cumulative impacts associated with hydrological and hydrogeological characteristics of the site are also identified in **EIAR Chapter 9: Hydrology and Hydrogeology**.

8.6 SUMMARY OF SIGNIFICANT EFFECTS

This chapter comprehensively assesses all scenarios within the Turbine Range which is described in **Section 8.1.1.** The potential impacts that could arise from the Wind Farm Project and the Hydrogen Plant during the construction, operational and decommissioning phases. How these impacts relate to the potential for increased stability issues and suspended sediment concentrations associated with site preparation activities and excavations for the infrastructure elements including the turbine foundations and cable trenches.

The unavoidable residual effects on the soils and geology environment as a function of the Project is that there will be a change in ground conditions at the sites with natural materials such as peat, subsoil and bedrock being replaced by concrete, subgrade and surfacing materials. This is a localised, negative, moderate adverse significance at a local scale, Slight weighted significance at the scale of the sites, direct permanent change to the materials composition at the sites.

Other potential effects are considered to range in significance from slight to significant, and can potentially be long term to permanent, however the mitigation measures prescribed will ensure the risk of such potential impacts can be significantly reduced, or are considered avoidable.

No new effects are anticipated during the operational phase of the Proposed Development. Similar hazards are identified when comparing the construction and operational phases of the Proposed Development, however considering that works will be far less intensive during the operational phase the likelihood of impacts is low, thus the risk is low.

No new adverse impacts are anticipated during the decommissioning phase of the Project however the phase will be considered similar in nature to the construction phase in terms of hazards and application of mitigation measures. Baseline conditions will be qualified again towards the end of the lifetime of the project (c. 40 years). Managed appropriately, the restoration of the Wind Farm Site following the decommissioning phase will have neutral to beneficial impacts relative to baseline conditions. Currently the the Wind Farm Site is already extensively degraded and of low environmental importance, shallow peats, good stability, no steep slopes, very low risk (FoS). The Proposed Development will apply mitigation measures and monitoring, construction and operational phases of the project, to avoid significant impacts on the current environment. The Proposed Development will also safely handle excavated material using Deposition Areas which will be beneficial long term to the environment as habitat enhancement areas.

Table 8.17: Summary of Potential Effects on receiving environment from the Wind Farm Project in the absence of and with mitigation measures.

Wind Farm Site		Qualifying Criteria Pre-Mitigation										Qualifying Criteria With Mitigation	
Effect / Impact Description	**Phase**	**Type**	**Quality**	**Scale**	**Significance**	**Extent**	**Context**	**Probability**	**Duration / Frequency**	**Mitigation**	**Mitigation Applied**	**Quality**	**Significance**
Erosion and Degradation	Construction	Direct and Indirect*	Adverse	Moderate to Large	Slight to Moderate	Development Footprint	Conforms to Baseline (peat cutting)	Likely	Permanent	Section 8.5.2.1	Yes	Adverse	Neutral
Soil Sealing	Construction	Direct and Indirect*	Adverse	Small to Moderate	Slight to Moderate	Development Footprint	Contrast to Baseline	Unavoidable	Long term/ Permanent	Section 8.5.2.2	Yes	Adverse	Slight to Moderate
Land Take Grid Connection Route	Construction	Direct *	Adverse	Small	Slight	Localised	Conforms to Baseline e.g. public roads.	Unavoidable	Permanent but Reversible	Section 8.4.3.4.2	Yes	Adverse	Slight
Land Take Turbine Delivery Route	Construction	Direct *	Adverse	Small	Slight	Localised	Conforms to Baseline e.g. public roads.	Unavoidable	Permanent but Reversible	Section 8.4.3.4.1	Yes	Adverse	Slight
Clear Felling of Afforested Areas	Construction	Direct and Indirect*	Adverse	Small	Moderate	Development Footprint	Contrast to baseline	Unavoidable	Permanent but Reversible	Section 8.5.2.3	Yes	Adverse to Beneficial	Slight Adverse to Small Beneficial
Demolition of House and Agricultural Sheds	Construction	Direct *	Adverse	Small	Slight	Localised	Contrast to Baseline	Unavoidable	Permanent	Section 8.5.2.1, 8.5.2.5.2, 8.5.2.6	Yes	Adverse	Slight Adverse to Small Beneficial
Subsoil and Bedrock Removal – General Excavations	Construction	Direct and Indirect*	Adverse	Large	Moderate	Development Footprint	Conforms to baseline e.g. Tracks to turbary plots	Unavoidable	Permanent but Reversible	Section 8.5.2.4.	Yes	Adverse	Slight to Moderate
Subsoil and Bedrock Removal – Site Access Tracks	Construction	Direct and Indirect*	Adverse	Moderate to Large	Slight to Moderate	Development Footprint	Conforms to baseline e.g. Tracks to turbary plots	Unavoidable	Permanent but Reversible	Section 8.4.3.6.2	Yes	Adverse	Slight to Moderate
Subsoil and Bedrock Removal – Hardstand and Foundation Areas	Construction	Direct and Indirect*	Adverse	Moderate to Large	Slight to Moderate	Development Footprint	Contrast to baseline	Unavoidable	Permanent but Reversible	Section 8.5.2.2.4	Yes	Adverse	Slight to Moderate
Subsoil and Bedrock Removal – Site Cable Trenches	Construction	Direct and Indirect*	Adverse	Small	Slight	Development Footprint	Contrast to baseline	Unavoidable	Permanent / Reversible	Section 8.5.2.2.4	Yes	Adverse	Neutral

Wind Farm Site		Qualifying Criteria Pre-Mitigation										Qualifying Criteria With Mitigation	
Effect / Impact Description	**Phase**	**Type**	**Quality**	**Scale**	**Significance**	**Extent**	**Context**	**Probability**	**Duration / Frequency**	**Mitigation**	**Mitigation Applied**	**Quality**	**Significance**
Subsoil and Bedrock Removal – Turbine Delivery Route	Construction	Direct and Indirect*	Adverse	Small	Slight	Localised	Conforms to Baseline e.g. public roads and services.	Unavoidable	Permanent / Reversible	Section 8.5.2.2.4	Yes	Adverse	Neutral
Subsoil and Bedrock Removal – Grid Connection Route	Construction	Direct and Indirect*	Adverse	Moderate	Slight	Localised	Conforms to Baseline e.g. public roads and services.	Unavoidable	Permanent / Reversible	Section 8.5.2.2.4	Yes	Adverse	Neutral
Spoil Management	Construction	Direct and Indirect*	Adverse	Moderate to Large	Slight to Moderate	Development Footprint; Localised	Conforms to Baseline e.g. public roads and services.	Likely	Permanent / Reversible	Section 8.4.3.9	Yes	Adverse	Neutral / Beneficial
Geological Stability	Construction	Direct *	Adverse	Small to Large	Slight (to Profound)	Localised	Contrast to Baseline	Unlikely	Permanent	Section 8.4.3.9 and 8.4.3.10	Yes	Adverse	Neutral
Vehicular Movements - Compaction, Erosion and Degradation	Construction	Direct and Indirect*	Adverse	Moderate to Large	Slight to Moderate	Development Footprint	Conforms to Baseline (forestry)	Likely	Permanent	Section 8.6.3.10 and 8.6.4.2	Yes	Adverse	Neutral
Subsidence and settlement of newly established and upgraded site tracks	Construction	Direct	Adverse	Moderate to Large	Slight	Localised	Contrast to Baseline	Likely	Permanent	Section 8.5.2.5.7	Yes	Adverse	Slight to Moderate
Compaction, erosion and degradation arising from vehicular movement (Localised displacement)	Construction	Direct and Indirect*	Adverse	Moderate to Large	Slight to Moderate	Localised	Contrast to Baseline	Likely	Long term / Permanent	Section 8.6.3.2 and 8.6.4.2	Yes	Adverse	Neutral
Localised Stability Issue (Peat/soil stability issues arising from e.g. vehicular movement or excavations)	Construction	Direct *	Adverse	Small to Moderate	Slight (to Profound)	Localised (Potentially Regional)	Contrast to Baseline	Likely	Temporary / Reversible	Section 8.6.3.2 and 8.6.4.2	Yes	Adverse	Slight

Wind Farm Site		Qualifying Criteria Pre-Mitigation										Qualifying Criteria With Mitigation	
Effect / Impact Description	**Phase**	**Type**	**Quality**	**Scale**	**Significance**	**Extent**	**Context**	**Probability**	**Duration / Frequency**	**Mitigation**	**Mitigation Applied**	**Quality**	**Significance**
Landslide – worst case (Stability issues and slope failure arising from e.g. vehicular movement and excavations).	Construction	Direct *	Adverse	Small to Moderate	Significant (to Profound)	Localised (Potentially Regional)	Contrast to Baseline	Unlikely	Permanent	Section 8.5.2.7.1	Yes	Adverse	Neutral
Soil Contamination - Hydrocarbon	Construction	Direct *	Adverse	Small	Moderate to Significant	Localised*	Contrast to Baseline	Likely	Long term / Permanent	Section 8.7.2.9.1.1	Yes	Adverse	Neutral
Soil Contamination – Storage of Hazardous chemicals on site	Construction / Operational	Direct *	Adverse	Large	Slight to Significant	Localised (Potentially Regional)	Contrast to Baseline	Likely	Long term but reversible	Section 8.5.2.9.3, 8.5.2.10	Yes	Adverse	Slight
Soil Contamination - Horizontal Direction Drilling Material	Construction	Direct *	Adverse	Small	Slight to Moderate	Localised*	Contrast to Baseline	Likely	Short term / Reversible	Section 8.7.2.9.1.1	Yes	Adverse	Slight
Soil Contamination - Wastewater Sanitation – Waste	Construction	Direct *	Adverse	Small	Moderate to Significant	Localised*	Contrast to Baseline	Likely	Long term / Permanent	Section 8.7.9.1.2	Yes	Adverse	Neutral
Soil Contamination - Construction of Cementitious Material	Construction	Direct *	Adverse	Small	Slight to Significant	Localised*	Contrast to Baseline	Likely	Long term / Permanent	Section 8.7.9.1.3	Yes	Adverse	Slight
Soil Contamination - General Waste	Construction	Direct *	Adverse	Small	Slight	Localised*	Conforms to Baseline	Likely	Long term / Permanent	Section 8.7.2.9.1.4	Yes	Adverse	Neutral
Land Take Wind Farm	Operational	Direct *	Adverse	Small to Moderate	Slight	Development Footprint	Contrast to Baseline	Unavoidable	Long term/ Permanent / Reversible after Decommissioning / Restoration	Section 8.7.2.3	Yes	Adverse	Slight to Moderate

Note:
* Includes Indirect / Secondary impacts to receptors i.e. Hydrology/Hydrogeology. For example: Contamination of soils / peat by hydrocarbons is considered a localised impact, however if hydrocarbon contamination is intercepted by surface water features or groundwater bodies the impact is potentially regional depending in the environmental circumstances (**Chapter 9: Hydrology and Hydrogeology**)
** Not reversible in terms of geology e.g. replacing competent bedrock, but impacts to ground levels will reversible through reinstatement with fill.

Table 8.18: Summary of Potential Effects on receiving environment from the Hydrogen Plant Project in the absence of and with mitigation measures.

Hydrogen Plant Site		Qualifying Criteria Pre-Mitigation									Qualifying Criteria With Mitigation		
Effect / Impact Description	**Phase**	**Type**	**Quality**	**Scale**	**Significance**	**Extent**	**Context**	**Probability**	**Duration / Frequency**	**Mitigation**	**Mitigation Applied**	**Quality**	**Significance**
Erosion and Degradation	Construction	Direct *	Adverse	Moderate to Large	Slight to Moderate	Development Footprint	Conforms to Baseline (forestry)	Likely	Permanent	Section 8.7.2.1	Yes	Adverse	Neutral
Soil Sealing	Construction	Direct *	Adverse	Small to Moderate	Slight to Moderate	Development Footprint	Contrast to Baseline	Unavoidable	Long term/ Permanent	Section 8.7.2.2	Yes	Adverse	Slight to Moderate
Land Take Inter Connection Route	Construction	Direct *	Adverse	Small	Slight	Localised	Conforms to Baseline e.g. public roads.	Unavoidable	Permanent but Reversible	Section 8.4.3.4.2	Yes	Adverse	Slight
Land Take Hydrogen Plant	Construction	Direct *	Adverse	Large	Moderate to Significant	Development Footprint	Conforms to Baseline e.g. public roads.	Unavoidable	Long term/ Permanent / Reversible after Decommissioning / Restoration	Section 8.4.3.4.1	Yes	Adverse	Moderate to Significant Slight
Subsoil and Bedrock Removal – General Excavations	Construction	Direct *	Adverse	Large	Moderate to Significant	Development Footprint	Conforms to baseline e.g. agri/forestry tracks or operations)	Unavoidable	Permanent but Reversible	Section 8.5.3.8	Yes	Adverse	Slight to Moderate
Subsoil and Bedrock Removal – Site Access Roads	Construction	Direct *	Adverse	Moderate to Large	Slight to Moderate	Development Footprint	Conforms to baseline e.g. peat harvesting tracks and/or operations)	Unavoidable	Permanent but Reversible	Section 8.5.3.8	Yes	Adverse	Slight to Moderate
Subsoil and Bedrock Removal – Foundation Areas	Construction	Direct *	Adverse	Moderate to Large	Slight to Moderate	Development Footprint	Contrast to Baseline	Unavoidable	Permanent but Reversible	Section 8.5.3.8	Yes	Adverse	Slight to Moderate
Subsoil and Bedrock Removal – Site Cable Trenches	Construction	Direct *	Adverse	Small to Moderate	Slight	Development Footprint	Conforms to Baseline e.g. public roads and services.	Unavoidable	Permanent / Reversible	Section 8.5.2.2.4	Yes	Adverse	Neutral
Subsoil and Bedrock Removal – Interconnector Route	Construction	Direct *	Adverse	Moderate	Slight	Localised	Conforms to Baseline e.g. public roads and services.	Unavoidable	Permanent / Reversible	Section 8.5.2.2.4	Yes	Adverse	Neutral
Spoil Management	Construction	Direct *	Adverse	Moderate to Large	Slight to Moderate	Development Footprint; Localised	Conforms to Baseline e.g. public roads and services.	Likely	Permanent / Reversible	Section 8.4.3.7.2	Yes	Adverse	Neutral / Beneficial

Hydrogen Plant Site		Qualifying Criteria Pre-Mitigation									Qualifying Criteria With Mitigation		
Effect / Impact Description	**Phase**	**Type**	**Quality**	**Scale**	**Significance**	**Extent**	**Context**	**Probability**	**Duration / Frequency**	**Mitigation**	**Mitigation Applied**	**Quality**	**Significance**
Geological Stability	Construction	Direct *	Adverse	Small to Large	Slight	Localised	Contrast to Baseline	Unlikely	Permanent	Section 8.5.2.5.7	Yes	Adverse	Neutral
Vehicular Movements - Compaction, Erosion and Degradation	Construction	Direct *	Adverse	Moderate to Large	Slight to Moderate	Development Footprint	Conforms to Baseline (forestry)	Likely	Permanent	Section 8.5.2.6.1	Yes	Adverse	Neutral
Subsidence and settlement of newly established and upgraded Site tracks	Construction	Direct	Adverse	Moderate to Large	Slight	Localised	Contrast to Baseline	Likely	Permanent	Section 8.5.2.5.7	Yes	Adverse	Slight to Moderate
Compaction, erosion and degradation arising from vehicular movement (Localised displacement)	Construction	Direct or Indirect / Secondary	Adverse	Moderate to Large	Slight to Moderate	Localised	Contrast to Baseline	Likely	Long term / Permanent	Section 8.5.2.6.1	Yes	Adverse	Neutral
Localised Stability Issue (Peat/soil stability issues arising from e.g. vehicular movement or excavations)	Construction	Direct *	Adverse	Small to Moderate	Slight (to Profound)	Localised (Potentially Regional)	Contrast to Baseline	Likely	Temporary / Reversible	Section 8.5.2.7.2	Yes	Adverse	Slight
Landslide – worst case (Stability issues and slope failure arising from e.g. vehicular movement and excavations).	Construction	Direct *	Adverse	Small to Moderate	Significant (to Profound)	Localised (Potentially Regional)	Contrast to Baseline	Unlikely	Permanent	Section 8.5.2.7.1	Yes	Adverse	Neutral
Soil Contamination - Hydrocarbon	Construction	Direct *	Adverse	Small	Significant	Localised*	Contrast to Baseline	Likely	Long term / Permanent	Section 8.5.2.8.1.1	Yes	Adverse	Neutral
Soil Contamination - Horizontal Direction Drilling Material	Construction	Direct *	Adverse	Small (only once on interconnector route)	Slight to Moderate	Localised*	Contrast to Baseline	Likely	Short term / Reversible		Yes	Adverse	Slight
Soil Contamination - Wastewater Sanitation – Waste	Construction and Operational	Direct *	Adverse	Small? Consistent as 24 h personnel on site	Moderate to Significant	Localised*	Contrast to Baseline	Likely	Long term / Permanent	Section 8.5.2.8.1.2	Yes	Adverse	Neutral

Hydrogen Plant Site		Qualifying Criteria Pre-Mitigation									Qualifying Criteria With Mitigation		
Effect / Impact Description	**Phase**	**Type**	**Quality**	**Scale**	**Significance**	**Extent**	**Context**	**Probability**	**Duration / Frequency**	**Mitigation**	**Mitigation Applied**	**Quality**	**Significance**
Soil Contamination - Construction of Cementitious Material	Construction	Direct *	Adverse	Small	Slight to Significant	Localised*	Contrast to Baseline	Likely	Long term / Permanent	Section 8.5.2.8.1.3	Yes	Adverse	Slight
Soil Contamination - General Waste	Construction	Direct *	Adverse	Small	Slight	Localised*	Contrast to Baseline	Likely	Long term / Permanent	Section 8.5.2.8.1.4	Yes	Adverse	Neutral

Note:
* Includes Indirect / Secondary impacts to receptors i.e. Hydrology/Hydrogeology. For example: Contamination of soils / peat by hydrocarbons is considered a localised impact, however if hydrocarbon contamination is intercepted by surface water features or groundwater bodies the impact is potentially regional depending in the environmental circumstances (**Chapter 9: Hydrology and Hydrogeology**)
****** Not reversible in terms of geology e.g. replacing competent bedrock, but impacts to ground levels will reversible through reinstatement with fill.