8. Soils and Geology

8.1 Introduction

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

A detailed description of the proposed development assessed in this EIAR is provided in Chapter 3. The proposed development includes the wind turbines, internal access tracks, hard standings, temporary meteorological mast, internal electrical and communications cabling, temporary construction compound, drainage infrastructure and all associated works related to the construction of the proposed wind farm.

Electricity generated from the proposed wind turbines shall be collected at medium voltage (20/33kV) by an internal circuit of buried cables which will follow on-site access tracks. This circuit shall be terminated at the proposed substation.

8.2 Statement of Competence

This chapter of the EIAR was prepared by Ian Higgins.

Ian Higgins (BSc Engineering Geology, MSc Geotechnical Engineering, FGS, MIEI) is a Geotechnical Engineer with 25 years consultancy experience in Ireland. Ian has completed several Soils, Geology & Hydrogeology chapters for EIAR submissions for wind farms, quarries and other developments. In addition, he has significant experience in the geotechnical design of road projects at construction stage and was the geotechnical designer for the proposed scheme. The chapter was checked by Mr. Tom Clayton (MEng Civil Engineering, CEng) a Chartered Engineer with 15 years consultancy experience in Ireland and the UK.

8.3 Relevant legislation and guidance

The general Environmental Impact Assessment (EIA) guidelines (Environmental Protection Agency, 2022) are listed in Chapter 1 Introduction in Volume 2 of this EIAR, other topic specific reference documents used in the preparation of this section include the following:

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

- Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements (Institute of Geologists of Ireland, 2013).

- Scottish Executive (2017) Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments, 2nd Edition;

8.4 Methodology

The aim of this assessment is to identify the impacts of the construction, operation and decommissioning of the proposed development and associated works on the existing Soils, Geology and Hydrogeology of the study area. The assessment also identifies appropriate mitigation measures to minimise these impacts.

The following elements were examined to determine the potential impacts of the Proposed Project on the Soils, Geology and Hydrogeology within the study area:

- Characterisation of the soils and geology underlying the Proposed Project;
- Evaluation of the potential impacts of the Proposed Project.

The baseline geological and hydrogeological conditions within the study area were determined following a desktop review of publicly available information including aerial photography and EPA and GSI online databases. Two site walkovers were also carried out, in May 2022 and more recently in April 2023. The study area is defined as the area that could potentially experience impacts from any element of the proposed development.

Following the assessment of the existing environment, the unmitigated impacts of the proposed scheme during the construction, operational and decommissioning phases on sensitive receptors identified were determined. The evaluation of the significance of the impacts was undertaken in accordance with the IGI guidance (IGI, 2013).

During each phase (construction, operation, and maintenance) of the proposed scheme, several activities will take place on site, some of which will have the potential to cause impacts on the geological regime at the proposed scheme site and the associated Soils & Geology. These potential impacts are discussed throughout this chapter. Mitigation measures where required are presented in Section 8.9.

The residual impact from the proposed scheme was then re-appraised taking into account the recommended measures. The residual impacts from the proposed scheme are presented in Section 8.10.

8.4.1 Evaluation Criteria

During each phase (construction, operation, maintenance and decommissioning) of the proposed development, several activities will take place on site, some of which will have the potential to cause impacts on the geological regime at the proposed development site and the associated Soils, Geology & Hydrogeology. These potential impacts are discussed throughout this chapter. Mitigation measures where required are presented in Section 8.9.

8.4.2 Assessment of Magnitude and Significance of Impact on Soils & Geology

An impact rating has been developed for each of the phases of the proposed development based on the Institute for Geologists Ireland (IGI) "Guidance for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements". In line with the IGI Guidance, the receiving environment (Geological Features) was first identified.

Using the NRA rating criteria in Appendix C of the IGI Guidance, the importance of the geological features are rated (Table 8.1.) followed by an estimation of the magnitude of the impacts on geological features (Table 8.2).

This determines the significance of the impact prior to application of mitigation measures as set out in Table 8.3.

Table 8.1 Criteria rating Site Importance of Geological Features (NRA, 2009)

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

The assessment of the magnitude of an impact incorporates the timing, scale, size and duration of the potential impact. The magnitude criteria for impact on Geological features are outlined in Table 8.2.

Table 8.2 Estimation of Magnitude of Impact on Geological Features (NRA, 2009)

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

Table 8.3 Ratings of Significance of Impacts for Geology (NRA, 2009)

Importance of Attribute	Magnitude of Impact			
	Negligible	Small Adverse	Moderate Adverse	Large Adverse
Very High	Imperceptible	Significant/Moderate	Profound/Significant	Profound
High	Imperceptible	Moderate/Slight	Significant/Moderate	Profound/Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight/Moderate

The determination of the significance of each impact for the proposed development is discussed in Section 8.7.

8.4.3 Desk Study - Methodology

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

- Geology of North Mayo (Sheet 6)
- Aerial imagery from Google and Bing accessed in 2024;
- Current and historical (6 inch and 25 inch) Ordnance Survey maps and aerial imagery
- DoEHLG Wind Farm Planning Guidelines
- IWEA Best Practice Guidelines
- Flood Risk Data
- Mapping data of the area produced by the Geological Survey of Ireland (GSI) as follows:
    - Quaternary subsoil geology;
    - 100k bedrock geology;
    - Karst features;
    - Geological heritage features;
    - Aggregate potential;
    - Landslide susceptibility;
    - Physiographic Units;
- Datasets from the EPA
- Peat Landslide Hazard and Risk Assessments, Best Practice Guide for Proposed Electricity Generation Developments (2nd Edition)

8.4.4 Desk Study – Site Walkovers

As part of the geotechnical assessment site walkovers were undertaken by Fehily Timoney and Company (FT) in May 2022, April 2023 and February 2024 to determine the baseline characteristics of the proposed development site.

The site assessment works undertaken comprised the following:

- Walkover inspections of the proposed development site with recording of salient geomorphological features at proposed infrastructure locations.
- Peat depth probing and slope stability assessment at proposed infrastructure locations and where peat deposits were encountered.
- Recording of GPS co-ordinates of site investigation locations using a hand-held GPS.

8.5 Description of the Baseline Environment

8.5.1 General

The existing environment is described hereunder. This includes descriptions of the underlying quaternary and bedrock geology, areas of geological heritage, areas of economic interest with respect to geological resources, and landslide susceptibility. This section also includes a summary of site-specific information obtained during site walkovers undertaken as part of the baseline assessment works.

The proposed development site (EIAR Site Boundary) is located approximately 5.5 kilometres south-west of Ballycastle, Co. Mayo. The site setting is upland blanket bog. The site is accessible via a network of existing tracks. The intended underground electricity export connection cabling route will connect the on-site substation to the existing Tawnaghmore ESB Substation or a Large Energy User at Killala Business Park. The underground electricity export connection route being screened measures approximately 22.8km and runs within proposed access tracks and local and public roads (within the EIAR Site Boundary) for its entire length.

Soils along the underground electricity export connection are mapped largely as acidic mineral poorly drained mineral soils (AminPD) and cutover peat in the west, and basic deep well drained mineral soils (BminDW) and basic poorly drained mineral soils (BminPD) in the east (www.gsi.ie). Meanwhile, mineral alluvium is mapped along many of the watercourses along the underground electricity export connection including the Ballinglen and Cloonaghmore rivers.

The published subsoils map shows that the underground electricity export connection will be underlain largely by cutover raised peat and limestone derived tills in the east, and tills derived from Devonian and

Carboniferous sandstones in the west (www.gsi.ie). The GSI also map mineral alluvium along the main watercourses along the underground electricity export connection.

The western section of the underground electricity export connection will be underlain by the Dowpatrick Formation and the Moyny Point Limestone Member. Further to the south and east, the underground electricity export connection will be underlain by the Ballina Limestone Formation, which consists of dark fine-grained limestone and shale.

There are no active quarries or pits mapped along the western section of the underground electricity export connection. Meanwhile, Mullafarry Quarry is mapped immediately to the north of the underground electricity export connection in the townland of Mullafarry. This bedrock quarry supplies limestone based aggregates, extracting from the Ballina Limestone Formation.

The GSI online Aggregate Potential Mapping Database (www.gsi.ie) shows that the crushed rock aggregate potential along the underground electricity export connection ranges from 'Very Low' to 'Very High'. The greatest potential is found in the east of the underground electricity export connection in the vicinity of Mullafarry Quarry and Killala Business Park.

The majority of the underground electricity export connection is not mapped in an area for granular aggregate potential. However, areas along the Ballinglen and Cloonaghmore rivers are mapped as having 'Moderate' and 'Very Low' potential for gravel reserves.

The eastern section of the underground electricity export connection is located within the Killala Area County Geological Site (CGS) (Site Code: MO068). This CGS comprises an extensive area of ridges and glacial features on the western side of the Moy Estuary.

All elements of the proposed development (as described in Chapter 3) have been considered in this assessment.

8.5.2 Quaternary Geology

GSI 1:50,000 Quaternary Subsoil mapping (Figure 8.1) indicates the proposed development site is predominantly underlain by Blanket Peat, with some pockets of Till derived from Devonian and Carboniferous sandstones and Alluvium, both associated with the river channel within the site.

Peat depths recorded across the site by FT and Hydro Environmental Services (HES) varied from 0.1m to 4.6m, with an average of 1.85m. Approximately 95 percent of peat depth probes recorded peat depths of less than 3.0m. The peat depths recorded at the turbine locations varied from 0.5 to 3.3m with an average depth of 1.9m.

8.5.3 Bedrock Geology

The GSI online 1:100,000 scale bedrock geology mapping (Figure 8.2) indicates the proposed development site is underlain by Downpatrick Formation, a cross-bedded sandstone and siltstone. There are no karst features on the site or within 10km of the site.

8.5.4 Geological Heritage

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

The GSI Online Irish Geological Heritage database indicates that the proposed development is not located in an area of specific geological heritage interest. There are no audited or unaudited geological heritage areas within the proposed development site boundary. The nearest designated area is "*Brookhill Delta*", 5km to the northeast of the site. The heritage site has been described by GSI as *'a raised glaciomarine delta* deposit exposed in two sand and gravel quarries.

8.5.5 Economic Geology

The GSI online Aggregate Potential Mapping Database shows that the proposed development site is located within an area mapped as being typically Very Low in terms of granular aggregate potential and with Very Low to Moderate potential for crushed rock aggregate potential. Aggregate Potential is included as Figure 8.3.

The GSI Online Minerals database shows no mineral (metallic and non-metallic) occurrences within the proposed development site. A record of chalcopyrite in calcite veins is recorded approximately 1km to the east of the site.

8.5.6 Landslide Susceptibility

From a review of the GSI Landslide Susceptibility database, the proposed development and proposed infrastructure locations are generally located within areas of '*Low*' to '*High*' susceptibility, with the higher susceptibility areas corresponding to the river channel running through the site. This is to be expected due to the steeper slopes present along the river channel.

A summary of the GSI landslide susceptibility with respect to the proposed development is provided in Figure 8.4.

There are two recorded peat failures within 1km of the site. A failure to the west of the site is believed to have occurred in 1954-1955. This failure is described locally as a bog burst, with peat entering the Keerglen River and being transported a significant distance downstream following the failure. The failure to the south is undated. Both failures are relatively small in scale.

8.5.7 Baseline Monitoring and Site Investigation

As outlined in Section 8.4.4 site walkovers and peat stability assessments were undertaken by Engineering Geologists working for FT during May 2022, April 2023 and February 2024 to determine the baseline characteristics of the proposed development site. Intrusive site investigations were undertaken by Irish Drilling Ltd (IDL) during April 2023. Further ground investigation in form of geophysics and trial pits was undertaken by Whiteford Geoservices Ltd. in August 2023 to investigate the potential for a borrow pit within the site (see Appendix 8.3: Keerglen Borrow Pit Potential Assessment).

Intrusive investigations were undertaken at proposed turbine locations, and along the proposed access tracks and at a the proposed borrow pit. The purpose of the intrusive works was to confirm the geological succession underlying the site. The site investigations comprised the excavation of a total of 22 no. trial pits to a maximum depth of 5.1m bgl. These locations are considered representative of the ground conditions on the site and will be supplemented by additional confirmatory ground investigation prior to construction.

Peat was recorded in all trial pits across the site during the intrusive investigations. The peat deposits were found to generally overlie cohesive glacial deposits, typically described as soft blue grey slightly sandy gravelly Silt. In the area of the borrow pit the peat was underlain by a brown silty clayey gravelly Sand.

Weathered Bedrock of the Downpatrick Formation and Minaun Formation was encountered during site investigations at a depth of between 0.2 and 3.6m bgl, recorded in three of the trial pits where it was described as angular cobble and boulder sized clasts of Sandstone.

During trial pit excavations shallow groundwater seepage at moderate ingress was noted below the peat deposits in trial pits. Table 8.4 shows the groundwater strikes encountered during the intrusive site investigations. The remainder of site investigation locations were noted as being dry during the works. A site walkover assessment summary is displayed below in Table 8.5.

Table 8.4 Summary of Groundwater Encountered

Location	Depth (m bgl)
WTG01	2.80
WTG02	2.70

Table 8.4 Summary of Groundwater Encountered	
Location	**Depth (m bgl)**
WTG03	2.50
WTG04	0.50/1.30/3.40
WTG09	3.75

Table 8.5 Summary of Ground Conditions

ID	Ground Conditions	Peat Depth Range (min-max)(m)	Average Peat Depth	Slope (degrees)	Depth to bedrock
T1	Peat overlying sandy silty Gravel.	1.8-2.3	2.1	5	NP
T2	Peat overlying very soft slightly sandy gravelly Silt.	2.0-3.0	2.5	6	NP
T3	Peat overlying sandy silty Gravel.	0.9-1.5	1.3	7	NP
T4	Peat overlying silty Sand and very soft slightly sandy gravelly Silt.	0.9-1.2	1.1	10	NP
T5	Peat over soft slightly sandy gravelly Silt.	1.7-2.5	2.1	4	NP
T6	Peat overlying firm Silt.	1.6-2.0	1.8	7	NP
T7	Peat over soft slightly sandy gravelly Silt.	1.5-1.8	1.7	4	NP
T8	Peat overlying silty Sand and firm slightly sandy gravelly Silt.	0.8-1.6	1.1	10	NP
Substation	-	1.8-2.1	1.9	3	-

Note: NP – Not Proven

In summary, site investigations to address the land, soil and geology section of the EIAR included the following:

- A total of 295 no. peat probe depths were carried out by FT, in May 2022, April 2023 and February 2024, and HES in March 2022, to determine the depth and geomorphology of the blanket peat at the site;
- A geotechnical assessment of peat stability by FT (February 2024);
- Excavation of 22 no. trial pits across the site (April and August 2023) and laboratory testing of bulk samples from trial pits;
- Logging of bedrock outcrops and subsoil exposures; and,
- Mineral subsoils and peat were logged according to BS: 5930 and Von Post Scale respectively.

The Geotechnical and Peat Stability Assessment Report prepared by FT is included as Appendix 8.1 of this EIAR.

8.5.8 Proposed Borrow Pit

The proposed borrow pit location is shown in the site plans. The method of extraction of materials at the borrow pit will be by excavator, and if required, a hydraulic hammer mounted on a hydraulic excavator (rock-breaker) will also be used locally. Bedrock may be crushed or screened at the borrow pit to ensure that the sandstone and siltstone is suitable for use directly from excavation. Blasting is unlikely to be required at the site. Due to the elevated topography of the borrow pit site and low permeability of the rock, groundwater is not expected to be encountered within the borrow pit.

8.5.9 Peat Stability Assessment

This section summarises the report on assessment of peat stability undertaken by FT. The peat stability assessment report is included as Appendix 8.1of this EIAR.

Stability of a peat slope is dependent on several factors working in combination. The main factors that influence peat stability are slope angle, shear strength of peat, depth of peat, pore water pressure and loading conditions. The slope angle and peat depth from site observations are used in combination with a lower-bound shear strength value to undertake the assessment. It is noted that the GSI mapping indicates the possible presence of faults within the site, however these are not considered to be a significant factor in peat stability.

The hand vane results indicate undrained shear strengths in the range 1 to 40kPa, with an average value of about 15kPa. The strengths recorded would be typical of well-drained peat as is present on the Keerglen site.

Peat strength at sites of known peat failures (assuming undrained (short-term stability) loading failure) are generally very low, for example, the undrained shear strength at the Derrybrien failure (AGEC, 2004) as derived from essentially back-analysis, though some testing was carried out, was estimated at 2.5kPa. The recorded undrained strengths at the Keerglen site are generally greater than the lower bound values for Derrybrien indicating that there is no close correlation to the peat conditions at the Derrybrien site.

An adverse combination of the factors listed above could potentially result in peat sliding. An adverse condition of one of the above-mentioned factors alone is unlikely to result in peat failure. The infinite slope

model (Skempton and DeLory, 1957) is used to combine these factors to determine a factor of safety for peat sliding. This model is based on a translational slide, which is a reasonable representation of the dominant mode of movement for peat failures.

To assess the factor of safety for a peat slide, an undrained (short-term stability) and drained (long-term stability) analysis has been undertaken to determine the stability of the peat slopes present on-site where development is proposed. In both conditions below the groundwater level is taken to be at ground level, in other words the peat layer is fully saturated.

- The undrained loading condition applies in the short-term during construction and until construction induced pore water pressures dissipate.

- The drained loading condition applies in the long-term. The condition examines the effect of, in particular, the change in groundwater level as a result of rainfall on the existing stability of the natural peat slopes.

The minimum required Factor of Safety (FoS) is 1.3 based on BS6031:1981: Code of Practice for Earthworks (BSI, 2009). The assigned probability of instability associated with a given FoS value is described in Table 8-6 below.

Table 8.6 Summary of Groundwater Encountered

Scale	Factor of Safety	Probability
1	1.30 or greater	Negligible/None
2	1.29 to 1.20	Unlikely
3	1.19 to 1.10	Likely
4	1.09 to 1.00	Probable
5	<1.00	Very Likely

For the stability analysis two load conditions were examined, namely:

- Condition (1): no surcharge loading
- Condition (2): surcharge of 10 kPa, equivalent to 1m of stockpiled peat assumed as a worst case.

8.5.9.1 Peat Stability – Lessons Learned

This peat stability assessment has been undertaken taking into account peat failures that have occurred on peatland sites (such as recent failures at Shass Mountain 2020, Co. Leitrim and Meenbog 2020, Co. Donegal). The lessons learned from both peat slide events have been incorporated into the design of this project and the construction methodologies to be implemented. The Meenbog failure occurred during the construction of a section of floating road on sidelong ground in an area of weak peat. This construction technique is not proposed on the Keerglen site. It is important that the existing site drainage is maintained

during construction to avoid a similar failure to that on Shass Mountain, which occurred following heavy rainfall, and this is referenced in the Risk Assessments for the turbines/access roads (FT, March 2024).

8.5.9.2 Peat Stability Assessment Results

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

The analysis of peat stability was carried out at the turbine locations, roads, substation compound, construction compounds and met mast for both the undrained and drained conditions. The purpose of the analysis was to determine the Factor of Safety (FoS) of the proposed peat slopes during construction and operation.

The undrained loading condition applies in the short-term during construction and until construction induced pore water pressures dissipate. For the undrained stability assessment, a peat shear strength of 5kPa has been used.

The drained loading condition applies in the long-term. The condition examines the effect of in particular, the change in groundwater level as a result of rainfall on the existing stability of the natural peat slopes. The results in Table 8.7 and 8.8 below are based on a groundwater level at ground level, which is a worst-case as it assumes that the peat is fully saturated.

Undrained analysis results are presented in Table 8.7. As outlined above the undrained loading condition applies in the short-term during construction and until construction induced pore water pressures dissipate.

Table 8.7 Factor of Safety results (undrained condition)

Turbine/Waypoint	Easting	Northing	Factor of Safety for Load Condition	
			Condition (1)	Condition (2)
T1	505565	832360	**2.50**	**1.75**
T2	505470	831909	**1.92**	**1.44**
T3	505827	831743	**2.76**	**1.65**
T4	505920	832214	**2.44**	**1.33**
T5	506383	832271	**2.87**	**2.05**
T6	506344	831817	**2.07**	**1.38**
T7	506978	831969	**3.99**	**2.57**
T8	507325	832404	**2.19**	**1.35**
Substation	506358	832101	**4.56**	**3.09**

Drained analysis results are presented in Table 8.8. As outlined above, the drained loading condition applies in the long-term. The condition examines the effect of in particular, the change in groundwater level as a result of rainfall on the existing stability of the natural peat slopes.

Table 8.8 Factor of Safety results (drained condition)

Turbine/Waypoint	Easting	Northing	Factor of Safety for Load Condition	
			Condition (1)	Condition (2)
T1	505565	832360	**2.00**	**3.01**
T2	505470	831909	**1.33**	**2.14**
T3	505827	831743	**2.20**	**2.84**
T4	505920	832214	**1.95**	**2.27**
T5	506383	832271	**2.30**	**3.55**
T6	506344	831817	**1.65**	**2.37**
T7	506978	831969	**3.19**	**4.43**
T8	507325	832404	**1.46**	**1.92**
Substation	506358	832101	**3.64**	**5.34**

The findings of the peat stability assessment showed that the site has an acceptable margin of safety and is suitable for the proposed development. The findings include recommendations and specific control measures (Section 13 of Appendix 8.2 of this EIAR) for construction work in peatlands to ensure that all works adhere to an acceptable standard of safety.

An undrained analysis was carried out, which applies in the short-term during construction. For the undrained condition, the calculated FoS for load conditions (1) & (2) for the locations analysed, show that all locations have an acceptable FoS of greater than 1.3, indicating a low risk of peat failure. The undrained analysis would be considered the most critical condition for the peat slopes.

The peat stability risk assessment (Appendix 8.1) at each infrastructure location (as listed above) identified a number of specific mitigation/control measures to reduce the potential risk of peat failure. Sections of access roads to the nearest infrastructure element will be subject to the same mitigation/control measures that apply to the nearest infrastructure element.

In summary, the findings of the peat stability assessment showed that the site has an acceptable factor of safety, is suitable for the proposed development and is at low risk of peat failure, provided appropriate control measures for construction work in peatlands are implemented in full to ensure that all works adhere to an acceptable standard of safety.

8.6 Characteristics of the Proposed Development

8.6.1 Proposed Wind Farm

The proposed works require construction of eight wind turbines, internal access tracks, hard standings, internal electrical and communications cabling, a temporary construction site compound, drainage

infrastructure and all associated works related to the construction of the proposed development. Refer to Drawing Ref. No. KGL1.101 of this EIAR for the general arrangement of the Proposed Wind Farm.

Aggregate for construction will be sourced from an onsite borrow pit. The Spoil Management Plan (see Appendix 8.2) estimates that 145,000m^3 of usable rock and granular overburden can be excavated from the borrow pit. Additional crushed rock for construction will be imported from local, authorised quarries.

Estimated volumes of peat, subsoil and bedrock to be removed are shown in Table 8.9 and Table 8.10 respectively. Not all of the peat and soil excavated will be sent to the borrow pit and repository areas for reinstatement, the remaining portion will be locally cast to one side and used for reinstatement and landscaping works around the site. Any bedrock excavated during cut and fill works will be used for filling along the development footprint. Further details are provided in the Peat and Spoil Management Plan for the works which is included as Appendix 8.2 of this EIAR.

Table 8.9 Estimated Peat and Mineral Excavation Volume

Infrastructure Element	Peat Volume (m3)	Spoil (non-peat) Volume (m3)
Turbines and Hardstands	55,000	12,000
Access Roads	90,000	6,500
Borrow Pit	47,500	22,000
Substation Temporary Met Mast Temporary Construction Compound	5,000	600
Sub-total	197,500	41,100
Total Peat and Spoil Volume	238,600	

Table 8.10 Estimated Borrow Pit Rock Resource Volume

Borrow Pit No.	Volume (m3)
1	145,000

Table 8.11 Summary of Peat and Spoil Placement Areas on Site

Location	Peat and Spoil Volume (m3)	Comment
Borrow Pit	195,000	Backfill of borrow pit with excavated peat and spoil. Includes peat and spoil stripped from borrow pit footprint that will be backfilled into the borrow pit.
Peat storage areas at turbines/along roads	36,500	1m in height, 15m in width across specific areas upslope of roads and around turbines, see

Table 8.11 Summary of Peat and Spoil Placement Areas on Site		
Location	**Peat and Spoil Volume (m3)**	**Comment**
		Section 5.3 of the Peat & Spoil Management Report (Appendix 8.2).
Landscaping	16,000	It is estimated that 2,000m^3 of peat will be required for landscaping purposes at each of the. turbines
Total	247,500	Storage volume to exceed volume of peat/spoil generated from the proposed development.

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

8.7 Statement of Potential Impacts

The potential impacts on the underlying soils, geology and hydrogeology at the proposed development site are assessed in the following sections for the activities associated within each phase (Construction, Operation and Decommissioning) for the proposed development as described in Chapter 3.

The potential impacts are assessed in accordance with the evaluation criteria outlined in Section 8.2 The unmitigated potential impacts are summarised in the following sections. The proposed mitigation measures are then considered to reduce or eliminate potential impacts.

8.7.1 Do nothing Impacts

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

8.7.2 Construction Stage Impacts

The following on-site activities have been identified as the sources of potential impacts on the existing geological and hydrogeological conditions during the construction phase of the Proposed Wind Farm:

8.7.2.1 Earthworks

The Proposed Wind Farm will require construction phase earthworks associated with the excavation of turbine bases, removal of overburden deposits for the construction of turbine foundations, temporary site compound, substation, turbine hard standings, borrow pit, internal access roads and a future temporary met mast (subject of a subsequent separate planning application).

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

The following earthworks excavations will be required:

- Excavation of Peat deposits;
- Excavation of Glacial Till to bedrock (as required);
- Excavation of bedrock at the borrow pit.

The following filling and material deposition operations will be required:

- Deposition of surplus topsoil and spoil in berms for reinstatement purposes around turbine bases hardstands, borrow pit and along access roads. Material placed alongside access roads will not exceed 1m in height and will be shaped and sealed to prevent the ingress of water.
- Importation and filling of site won and imported General Fill and Engineering Aggregates.

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

The proposed borrow pit location has been identified as a source of site won general fill for construction activities. The location was selected as potential sources of general fill (Class 1 material) for the Proposed Project using the criteria of shallow peat deposits, low landslide susceptibility and proximity to existing access tracks and proposed infrastructure.

Surplus Peat and Glacial Till recovered from excavations will be used for the reinstatement proposed around turbine bases, hardstands and the temporary construction compound. All associated quantities have been calculated in Section 8.4 and no excavated material will leave the Proposed Wind Farm site.

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

- Soil compaction may occur due to movement of construction traffic. This will occur particularly within areas of highly compressible soft deposits which are left in-situ during the construction phase. This could lead to an increase in surface water runoff due to reduced

infiltration of rainfall and subsequently to an increase in erosion of overburden deposits left in-situ.

- The use of plant and machinery during construction will require the storage and use of fuels and oils. Their storage and use present potential for spills and leaks which could contaminate underlying exposed soils.
- During construction, imported engineering fill and excavated soils will be exposed in excavations and in temporary stockpiles. These soils will be subject to erosion by wind and rain which could deposit silt in streams with an indirect impact on surface water quality.
- The extraction of rock from off-site quarries will represent a reduction in the availability of an exhaustible resource. Imported crushed rock will be required for material such as 6F2 (capping), 6N1 (Fill to structures) and 6N2 (fill below structures).

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

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

- Potential for groundwater pollution from the removal of overburden deposits particularly at proposed turbine locations. The aquifer underlying the proposed development site is classified by the GSI as ranging from '*High'* to *'Extreme'* with areas of exposed bedrock also present. It is proposed to remove the overlying soft ground and Glacial Till deposits as outlined in the proposed design.
- The vulnerability of the aquifer to groundwater pollution particularly during construction stage will be increased as overburden is removed thus reducing the level of protection from groundwater pollution.
- Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Soil erosion as a result of exposure of soils in open excavations and temporary storage of excavated materials represents a potential impact to the underlying groundwater aquifer.
- Reduction in groundwater levels from dewatering of excavations as required during the construction stage if high groundwater is encountered. This impact is most likely during the excavation of turbine foundations and at the proposed borrow pit location. There are no groundwater supply wells recorded in the immediate vicinity of proposed turbine locations. It is considered that other excavations associated with the Proposed Substation will not extend into the underlying bedrock aquifers. It is possible however that perched groundwater may exist locally within overburden deposits or weathered bedrock. Upon

completion of the construction phase, it is considered that groundwater levels will revert to the pre-construction situation when there is no longer a requirement to control groundwater levels.

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

8.7.2.2 Peat Stability

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

Peat instability or failure refers to a significant mass movement of a body of peat that would have an adverse impact on the proposed development, proposed construction access road and the surrounding environment. Peat failure excludes localised movement of peat that could occur below an access road, creep movement or erosion type events. The consequence of peat failure at the study area may result in:

- Death or injury to site personnel;
- Damage to machinery;
- Damage or loss of access tracks;
- Drainage disrupted;
- Site works damaged or unstable;
- Contamination of watercourses, water supplies by soil particulates;
- Degradation of the environment.

The findings of the peat stability assessment showed that the proposed development has an acceptable margin of safety, is suitable for the proposed wind farm development and is considered to be at low risk of peat failure provided appropriate control measures are introduced. The findings include control measures which will be implemented for construction work in peatlands to ensure that all works adhere to an acceptable standard of safety.

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

8.7.2.3 Internal Access Roads, Hardstands and Temporary Construction Compound

There will be approximately 7.2km of internal access tracks associated with the proposed development site. This will be a combination of existing track upgrade and construction of new tracks; approximately 3.7km of new track construction and approximately 3.5km of existing track upgrade. Hardstand areas will be provided at each turbine location.

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

The following filling and material deposition operations will be required:

- Deposition of surplus peat and overburden in berms for reinstatement purposes alongside access roads and around hardstands.
- Importation and Filling of site won and imported General Fill and Engineering Aggregates.

It is anticipated that the stone required for the construction of the internal access roads, hardstands, temporary construction compound and the Proposed Substation will be sourced from the on-site borrow pit. Suitable material for the finishing layer on the access roads, hardstands and upfill for turbine bases will be imported from quarries in the vicinity.

The likely off-site, source quarries for the supply of imported crushed rock aggregate during the construction phase of the proposed development are presented in Table 8.12.

Table 8.12 Source Quarries

Quarry	Volume (m3)
Killala Rock, Mullafarry, Killala, Co. Mayo	10,000

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

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

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

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

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

8.7.2.4 Internal Cabling

The internal cabling is outlined in Chapter 3 of this EIAR and will comprise a medium voltage (20kV) internal circuit of buried cables following on-site access tracks.

Connection works will involve the installation of ducting, joint bays, drainage and ancillary infrastructure and the subsequent running of cables along site access tracks. For cable trenches located along access tracks the contractor will excavate cable trenches and then lay high density polyethylene (HDPE) ducting in the trench in a surround of cement bound material (CBM). Cable-ducts will generally be laid when the track is being constructed and will follow the edge of the site access tracks. The trenches within these locations will generally be backfilled using the excavated material.

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

- Trench excavations and ducting may present a preferential pathway for the movement of groundwater and/or contamination in the subsurface. However, the subsoil at the proposed development is predominantly Glacial Till, which has a low permeability.

- The excavations for the cable trenches and joint bays can have a direct impact on the exposed soils and rock in the form of increased erosion from surface water ingress.
- Where the material excavated from the internal cabling excavations are not suitable for reuse as backfill or deposition on site this material will be disposed of at a facility licenced (subject to environmental testing and classification) to accept this waste type.

The Magnitude of the impact from these works on the soils and geology receptors is considered to be *'Small Adverse'* in nature.

The importance is considered to be '*Medium'.* The rating of these potential impacts, prior to mitigation, is considered to be of Slight significance. The Impact Classification is negative, permanent, direct and will have likely effects.

8.7.3 Operational Stage Impacts

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

8.7.3.1 Potential Direct Impacts

Very few potential direct impacts are envisaged during the operational phase of the proposed development. These are:

- Some construction traffic may be necessary for maintenance of turbines, hardstands and access tracks which could result in minor accidental leaks or spills of fuel/oil.
- The grid transformer in the Proposed Substation and transformers in each proposed wind turbine will be oil cooled. There is potential for spills / leaks of oils/battery fluids from this equipment resulting in contamination of soils and groundwater.

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

8.7.3.2 Potential Indirect Impacts

A small amount of granular material may be required to maintain access tracks during operation which will place intermittent minor demand on local quarries listed in Section 8.7.2.3.

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

8.7.4 Decommissioning Stage Impacts

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

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

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

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

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

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

8.8 Cumulative Impacts

8.8.1 Large Scale Developments within 20km of the Site

As part of the assessment of cumulative impacts, planning searches were undertaken using the following online planning enquiry portals to search for large scale developments within 10km of the site:

- Mayo County Council;
- An Bord Pleanála.

Relevant projects, that are likely to have an impact on the Soils and Geology, in proximity to the Proposed Project including the enabling TDR works are listed in Table 8.13:

Table 8.13 Developments within 20km

Name	Location	Notes
Oweninny Wind Farm	Oweninny, Co. Mayo	Use of crushed rock from nearby quarries for the construction of access roads and hardstands
Glenora Wind Farm *	Glenora Co. Mayo	Use of crushed rock from nearby quarries for the construction of access roads and hardstands

*Submitted to ABP, no decision.

The proposed developments summarised in Table 8.12 have been consented with the exception of Glenora Wind Farm. If construction of this wind farm overlap or run concurrently with the proposed development, there may be a supply issue with local quarries providing imported aggregate.

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

7.1.1 Enabling TDR Works

The proposed turbine delivery route (TDR) will be via the Killybegs Port, N26, N59 and R315, as described in more detail in Chapter 3 and 14. Key elements of the Enabling TDR Works are summarised below.

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

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

8.9 Mitigation and Monitoring Measures

The following section outlines appropriate mitigation measures by design and best practice to avoid or reduce the potential impact of the proposed development. Further details are given in Section 4.3 of the EMP, which is contained in Appendix 3.5 of Volume 2.

8.9.1 Mitigation by Design and Best Practice

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

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

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

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

The following will also be implemented:

- Any excavation and construction related works will be subject to a design risk assessment at detailed design stage to determine risk levels for the construction, operation and maintenance and decommissioning of the works. Identified impacts will be minimised by the application of principles of avoidance, prevention and protection. Information on residual impacts will be recorded and relayed to appropriate parties.
- A detailed method statement for each element of the works will be prepared by the Contractor prior to any element of the work being carried out.

- Given that the works comprise a significant proportion of excavation and earthworks, suitably qualified and experienced geotechnical personnel will be required on site to supervise the works.
- The Contract will require programming of the works such that earthworks are not scheduled during severe weather conditions.

8.9.2 Construction Stage

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

8.10 Environnemental Management Plan (EMP)

An Environmental Management Plan (EMP) has been prepared for the proposed project and is included in Volume 2, Appendix 3.5. The EMP defines the work practices, environmental management procedures and management responsibilities relating to the construction phase of the proposed development.

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

Reference to relevant sections of the EMP with respect to the mitigation of potential impacts to Soils, Geology and Hydrogeology from the proposed development are outlined below.

8.10.1.1 Earthworks

The proposed development will be constructed in a phased manner to reduce the potential impacts of the Proposed Project on the Soils and Geology. Phased construction reduces the amount of open, exposed excavations at any one time. Given that the works comprises a significant proportion of excavation and earthworks, suitably qualified and experienced geotechnical personnel will be required on site to supervise the works.

Excavation of peat, subsoil and bedrock will be required for site levelling and for the installation of infrastructure and foundations for the access roads and turbines. This will result in a permanent removal of peat, subsoil and bedrock at excavation locations. There is no loss of peat or subsoil, it will just be relocated

within the site. Estimated volumes of peat and bedrock to be removed are shown in Table 8.10 and Table 8.11 above.

Details of the proposed methodology and mitigation measures are summarised below and are also outlined in the EMP in Appendix 3.5 of Volume 2.

One of the primary mitigation measures employed at the preliminary design stage was the minimisation of volumes of excavated materials to be exported off site. All excavated peat/spoil will be retained on-site.

This will include:

- Use of suitable site won material (crushed rock) as general fill in the construction of access tracks, hardstands and in reinstatement around turbine foundations.
- Surplus peat/spoil will be re-used on site in the form of landscaping.

The minimum possible volume of peat and subsoil will be removed to allow for infrastructural work to take place in comparison to the total volume present on the site due to optimisation of the layout by mitigation by design.

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

Some temporary stockpiles (not exceeding 1m in height) of material will be necessary adjacent to the excavation areas prior to reinstatement, however no long-term stockpiles of material will remain after construction and no surplus/waste soil or rock will be removed from the Proposed Project site. Temporary stockpiles will be shaped and sealed to prevent the ingress of water from rainfall and placed away from open excavations, sloping / soft ground as not to create an instability risk during temporary works.

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

To mitigate against erosion of the exposed soil or rock, all excavations will be constructed and backfilled as quickly as possible. Excavations will stop during or prior to heavy rainfall events (>5mm/hour). To mitigate against possible contamination of the exposed soils and bedrock, refuelling of machinery and plant will only occur at designated refuelling areas.

All temporary cuts/excavations will be carried out such that they are stable or adequately supported. Gravel fill will be used to provide additional support to temporary cuts/excavations where appropriate. Unstable temporary cuts/excavations will not be left unsupported. Where appropriate and necessary, temporary cuts and excavations will be protected against the ingress of water or erosion.

8.10.1.2 Erosion of Exposed Subsoils and Peat during Construction Work

There is a high likelihood of erosion of peat and spoil during its excavation and during landscaping works. The main impacts associated with this aspect is to the water environment, and therefore this aspect is further assessed in detail in Chapter 7.

Peat removed from turbine locations and access roads will be used for landscaping, spread within the proposed peat placement areas around certain turbines and used to reinstate the proposed borrow pit. The acrotelm will be stored with the vegetation part of the sod facing the right way up to encourage growth of plants and vegetation at the surface of the stored peat within the borrow pit. Reseeding and spreading/planting of heather and moss cuttings will also be carried out in these areas. These measures will prevent erosion of stored peat in the long term. A full Peat and Spoil Management Plan for the proposed development is included as Appendix 8.2 of this EIAR.

Any excess temporary mounded peat in storage for long periods will be sealed using the back of an excavator bucket. This will minimise erosion of soil. Silt fences will be installed around stockpiles to limit movement of entrained sediment in surface water runoff. The use of bunds around earthworks and mounds will prevent egress of water from the works.

To mitigate against erosion of the exposed soil or rock, all excavations will be constructed and backfilled as quickly as possible, although this will depend on the nature of the excavation – a hardstand excavation can be backfilled immediately, however a turbine base excavation will remain open for a prolonged period of time as the base is constructed. Excavations will stop during or prior to heavy rainfall events. To mitigate against possible contamination of the exposed soils and bedrock, refuelling of machinery and plant will only occur at designated refuelling areas.

In order to minimise erosion of mineral subsoils stripping of peat will not take place during extremely wet periods as defined in the Chapter 7 of this EIAR (to prevent increased silt rich runoff). Drainage systems (as described in Chapter 7 of this EIAR) will be required to limit runoff impacts during the construction phase.

8.10.1.3 Peat Instability

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

Also, the lessons learned from historical peat slide events have been incorporated into the design of this project and the construction methodologies to be implemented. These lessons show that it is important that the existing site drainage is maintained during construction to avoid a similar failure to that on Shass Mountain, which occurred following heavy rainfall, and this is referenced in the Risk Assessments for the turbines/access roads (contained within Appendix 8.1).

Based on the control measures given in the FT Peat Stability Assessment (Appendix 8.1) report being strictly adhered to during construction and the detailed stability assessment carried out for the peat slopes which showed that the site has an acceptable margin of safety, there is a low risk of peat instability/failure at the proposed development site.

The risk assessment at each turbine and infrastructure location identified a number of control measures to reduce further the potential risk of peat failure. Access roads to turbines will be subject to the same relevant control measures that apply to the nearest turbine as detailed in the FT Peat Stability Assessment Report (Appendix 8.1).

The following measures which will be implemented during the construction phase of the project will assist in the management of the risks for this site.

- Appointment of experienced and competent Contractor;
- The site will be supervised by experienced and qualified personnel, including a Project Geotechnical Engineer;
- Allocate sufficient time for the project (be aware that decreasing the construction time has the potential to increase the risk of initiating a peat movement);
- Loading or stockpiling of materials on the surface of soft ground will be avoided. Loading or stockpiling on other deposits will not be undertaken without first establishing the adequacy of the ground to support loads by an appropriately qualified geotechnical engineer experienced in construction within upland conditions. No stockpiling of material shall take place on steep slopes.
- Prevent undercutting of slopes and unsupported excavations. All temporary cuts/excavations will be carried out such that they are stable or adequately supported. Gravel/rock fill will be used to provide additional support to temporary cuts/excavations where appropriate, as determined by the Project Geotechnical Engineer. Unstable temporary cuts/excavations will not be left unsupported. Where

appropriate and necessary, temporary cuts and excavations will be protected against the ingress of water or erosion. Open excavations will be inspected on a daily basis.

- Excavation will be carried out from access roads or hardstanding areas to avoid tracking of construction plant across areas of soft ground/peat.
- Excavations which could have the potential to undermine the up-slope component of an existing slope will be sufficiently supported to resist lateral slippage and careful attention will be given to the existing drainage.
- Blasting of rock will not be permitted.
- Maintain a managed robust drainage system;
- Drainage infrastructure will be put in place in advance of excavations. Drains will divert surface water and groundwater away from excavations into the existing and proposed surface drainage network. Uncontrolled, direct and concentrated discharges of water onto the ground surface will be avoided.
- Prevent placement of loads/overburden on marginal ground as detailed in the peat stability assessment report;
- Set up, maintain and report findings from monitoring systems (as described in the Peat & Spoil Management Plan, Appendix 8.2);
- Undertake strength testing of peat directly prior to access road construction for new access roads.
- Earthworks will not be commenced when heavy or sustained rainfall (orange or red weather warnings) is forecast. A series of rainfall gauges will be installed across the proposed development site to provide a record of rainfall intensity. An inspection of site stability and drainage by the Project Engineer will be carried out on site when a daily rainfall of over 5mm/hr or 25mm/day is recorded on site, works will only recommence after heavy rain with the prior approval of the Project Engineer and/or Geotechnical Engineer following their inspection.
- An emergency plan will be updated at pre-construction stage detailing the action plan which would be implemented in the unlikely event of a landslide/slope failure. Should a landslide/slope failure occur or if signs of instability/ground movement are observed, work will cease immediately.
- Project Engineer and Contractor to ensure that construction method statements are followed; and,
- Revise the Geotechnical Risk Register, as necessary as construction progresses.

Further details are given in the EMP included in Appendix 3.5 of Volume 2 of this EIAR.

8.10.2 Operational Stage

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

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

In relation to indirect impacts a small amount of granular material will be required to maintain access tracks during operation which will place intermittent minor demand on local quarries. Please note the onsite borrow pit will have been reinstated with excavated peat and spoil following the construction stage and will not be available to source aggregate during the operational phase.

None of these potential impacts are considered to be significant, as they are of such small scale and also of an intermittent nature.

8.10.3 Decommissioning Phase

Mitigation measures applied during decommissioning activities will be similar to those applied during construction where relevant.

Some of the impacts associated with reinstatement of the site (excavation of turbine bases, access tracks etc.) will be avoided by leaving these in place where possible. The Irish Wind Energy Association (IWEA) (2012) states that when decommissioning a wind farm *"the concrete bases could be removed, but it may be better to leave them under the ground, as this causes less disturbance*". It is proposed to leave the access tracks in-situ at the decommissioning stage. IWEA also state that "*it may be best*" to leave site tracks in-situ depending on the size and geography of the development.

It is considered that leaving the turbine foundations, access tracks and hardstanding areas in-situ will cause less environmental damage than removing and recycling them. It is proposed to retain these elements of the construction. Turbine bases will be covered with overburden material to allow for re-vegetation of the proposed development site. It is proposed that the internal site access tracks and hard standings will be left in place and the land reinstated at these locations. The electrical infrastructure including substations and ancillary electrical equipment shall form part of the national grid and will be left in-situ.

Removal of this infrastructure would result in considerable disruption to the local environment in terms of increased sedimentation, erosion, dust, noise, traffic and an increased possibility of contamination of the local water table. However, if removal is deemed to be required by the respective local authority all infrastructure will be removed with mitigation measures similar to those during construction being employed.

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

8.11 Residual Effects

Following the implementation of mitigation measures, the residual impact significance to the receiving environment would be imperceptible during the construction period and imperceptible during the operation of the proposed development. Mitigation measures will be monitored throughout the construction, operational and decommissioning phases.

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

8.12 Conclusions

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

The proposed development site is not a sensitive site in terms of soil and geology and poses a low risk of landslide provide appropriate control measures are implemented.

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

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

With mitigation measures, outlined in Section 8.9, put in place during construction, operational and decommissioning stage the proposed development will have imperceptible significance on the soils, geology and hydrogeology.

8.13 References

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