8 Soils and Geology

8.1 Introduction

This chapter assesses the impacts of the Development (**Figure 1.2**) on soils and geology. Where negative effects are predicted, the chapter identifies appropriate mitigation strategies therein. The assessment will consider the potential effects during the following phases of the Development:

- Decommissioning of the Operational Barnesmore Windfarm (initial phase of the Development)
- Construction of the Development (likely to occur in tandem with the above phase)
- Operation of the Development
- Decommissioning of the Development (final phase)

The decommissioning of the Operational Barnesmore Windfarm and the construction of the Development are likely to occur partly in tandem and would have a greater effect than if the two processes were to arise at different times. This represents a worst-case scenario for assessment purposes. Any effects arising as a result of the future decommissioning of the Development, are considered to be no greater than the effects arising when these two phases are combined. As a result, the final decommissioning phase has not been considered further in this assessment.

The Development refers to all elements of the application for the repowering of the Operational Barnesmore Windfarm (**Chapter 2: Development Description**). The repower design layout has provision for the retention and re-use of existing footprint locations, in part, of the Operational Barnesmore Windfarm.

Common acronyms used throughout this EIAR can be found in **Technical Appendix 1.4**.

This chapter of the EIAR is supported by Figures provided in Volume III and by the following Technical Appendix documents provided in Volume IV of this EIAR:

- **Technical Appendix 8**.1 Photographs
- **Technical Appendix 8.2** Mapped Subsoils, Mapped Bedrock
- **Technical Appendix 8.3** Slope Stability Risk Assessment Database & Maps
- **Technical Appendix 8.4** Mapped Impacts

An Outline Construction and Environmental Management Plan (CEMP) is appended to the EIAR in **Technical Appendix 2.1**. This document will be developed into a Site-Specific Barnesmore CEMP post consent/pre-construction once a contractor has been appointed and will cover both the decommissioning of the Operational Barnesmore Windfarm and the construction of the Development. It will include all of the mitigation recommended within the EIAR. For the purpose of this application, a summary of the mitigation measures is included in **Technical Appendix 15.1**.

8.1.1 Assessment Structure

In line with the revised EIA Directive and current (draft) EPA guidelines the structure of this Soils and Geology chapter is as follows:

- Assessment Methodology and Significance Criteria
- Description of baseline conditions at the Site
- Identification and assessment of impacts to soils and geology associated with the Development, during the construction, operational and decommissioning phases of the Development
- Mitigation measures to avoid or reduce the impacts identified
- Identification and assessment of residual impact of the Development considering mitigation measures.
- Identification and assessment of cumulative impacts if and where applicable.

8.2 Assessment Methodology and Significance Criteria

8.2.1 Assessment Methodology

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

- Characterise the topographical, geological and geomorphological regime of the Site from the data acquired through desk study and onsite surveys.
- Undertake preliminary materials budget calculations in terms of volumetric peat / subsoil excavation and removal associated with Development design.
- Consider ground stability issues as a result of the 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 European Directive 2014/52/EU which requires Environmental Impact Assessment for certain types of major development before development consent is granted. This assessment was undertaken in accordance with the following Irish legislation (transposition of the aforementioned directive):

- SI No. 296 of 2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018.

In addition to this planning legislation, environmental legislation relevant to geological, geotechnical, hydrological and hydrogeological aspects of the environment were referred to, such as:

- SI No. 30 of 2000: Planning and Development Act 2000 (e.g. Sections 212 (1) f; Part IV, 6; Fifth Schedule Condition 21).
- SI No. 600 of 2001: Planning and Development Regulations 2001,
- SI No. 4 of 1995: The Heritage Act 1995,
- SI No. 33 of 2000: The Wildlife (Amendment) Act, 2000.

The Donegal County Development Plan (2018-2024) was also consulted as part of the EIA process.

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

- Department of the Environment, Heritage and Local Government (DEHLG) (2006) Wind Energy Development Guidelines
- Environmental Protection Agency (EPA) (2015) Advice Notes for Preparing Environmental Impact Statements – DRAFT September 2015 (Supersedes 2003 version)
- EPA (2017) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports – DRAFT May 2017 (Supersedes 1997 and 2002 versions)
- 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 Wind Energy Association (IWEA) (2012) Best Practice Guidelines for the Irish Wind Energy Industry
- 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
- CIRIA (2006) Control of Water Pollution from Linear Construction Projects – Technical Guidance
- BSI (1999) Code of Practice for Site Investigations - BS 5930
- NPWS (2017) Best practice in raised bog restoration in Ireland
- NPWS (2015) National Peatlands Strategy

- DHPLG (2017) Interim Guidelines for Planning Authorities on Statutory Plans, Renewable Energy and Climate Change and Wind Energy Development Guidelines 2006

8.2.3 Desk Study

Minerex Environmental Limited (MEL) undertook desk study assessments of the soils and geology aspects of the Site before and after field investigations. This involved the following components:

- Acquire and compile all available maps of the Development.
- Study and assess the proposed locations of turbines and Site tracks relative to available data on Site topography and slope gradients.
- Study and assess the proposed locations of turbines, Site tracks, substation and Energy Storage Unit relative to available data on Site soils, subsoil and bedrock geology.
- Overlay Ordnance Survey of Ireland (OSI) 1:250,000, 1:50,000 and 1:10,560 (6") maps with AutoCAD plan drawings.
- Overlay 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.
- Overlay Geological Survey of Ireland (GSI) Groundwater Resources (Aquifers), Groundwater Vulnerability, and Groundwater Recharge maps to determine Site sensitivity in terms of groundwater.
- Overlay Geological Survey of Ireland (GSI) Landslide Susceptibility maps to determine Site landslide susceptibility risk classification.
- Overlay 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 geochemical origin for the Study Area (the Site and areas directly adjacent to the Site equating to c. 1km distance outside of the Development Boundary (**Figure 1.2**).
- Search of the GSI databases and publications in relation to geological extractive resources and mineral localities of Co. Donegal.
- Search of the GSI landslide database for records of landslide mass movement events at and near the Study Area.
- Search of the GSI karst database for records of karst features at and near the Study Area.
- Search of the GSI wells and springs database for records of wells or springs at and near the Study Area.
- Search of National Parks and Wildlife Service designated sites of Co. Donegal.

8.2.4 Field Work

MEL carried out field investigations at the Site between April and September 2019 (A total of 13 calendar days, with the number of field operatives ranging from one to three per day). These works consisted of the following:

- Bedrock and mineral subsoil outcrop logging and characterisation.
- Confirmation of the presence of Peat at or near any Development turbines and infrastructure 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 (BSI, 1999) and Von Post Humification scale (von Post L., Granlund L.E., 1922).
- Sampling of peat cores, preparing and sending samples to an accredited laboratory for analysis.
- Hand shear vane testing to determine un-drained shear strength of homogeneous substrates (peat where applicable).
- Slope measurements at proposed turbine locations to determine slope gradient.
- Recording of GPS co-ordinates for all investigation and monitoring points in the assessment.
- Digital photography of significant features, for example; rocky outcrops, erosion indicators etc.
- Onsite design workshop meetings with the Applicant (SPR), the Consultant (JOD) and Subconsultants to discuss the Development with input from all disciplines associated with the EIA.

8.2.4.1 Site Walk Over and Observations

Initial Site walk overs were carried out to assess general ground conditions including topographical characteristics, and to observe the Operational Barnesmore Windfarm including visual assessment of the receiving environment in terms of impacts arising from the existing infrastructure and practices at the Site.

8.2.4.2 Peat Sampling Plan and Design

Random regular sampling patterns were employed when carrying out peat surveys. This implies that sampling points were chosen at random but also spread relatively evenly over each survey area (survey area implies local area for proposed infrastructure unit). This approach facilitates obtaining sufficient data for the survey area in general in order to give a high level overview of peat depth, condition and substrate topology. If / when anomalous data is observed at any particular sampling point/s, for example: deep peat at one or a small number of sampling points, an increased number of judgemental sampling points are carried out to increase the data resolution in that particular area. This sampling approach is done in accordance with relevant Site investigation and sampling plan guidance including; Code of Practice for Site Investigations - BS 5930 (BSI, 1999).

8.2.4.3 Peat Depth Probing Surveys

Peat depth probing and gouge coring surveys were undertaken at each proposed turbine location, and at proposed locations for other infrastructure units including for example; Energy Storage Unit. 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. A high number of peat depth survey points were carried out to ensure sufficient data was obtained in relation to peat or slope stability risk assessment, and to assist in the design phase of the Development (following on from a conceptual layout driven predominantly by existing infrastructure (Operational Barnesmore Windfarm), wind take and turbine turbulence). A key design principle for the Development is to utilise and reuse as much of the Operational Barnesmore Windfarm infrastructure and proposed infrastructure has been located with this in mind. As a result, avoiding areas of deep peat, severe inclines and other sensitive features such as artificial or natural drainage.

8.2.4.4 Gouge Coring Surveys

Gouge coring surveys were undertaken at each proposed turbine location. Peat cores were obtained by means of a handheld gouge core for the purpose of observing, logging, qualifying (Von Post Scale) and sampling peat across the entire peat depth profile.

At each survey point the depth of peat, the degree of humification and fibre content (Von Post Scale), the moisture content observed, colour and grid reference (Irish Grid) were recorded. Photos and samples of each 0.5 m core were also taken and samples were sent to an accredited laboratory to analyse (pH and moisture content).

Gouge coring survey points were limited to approximately four points per proposed infrastructure location, which is considered an adequate number of sampling points to determine peat condition at a particular proposed infrastructure location on the Site. This is based on professional experience regarding spatial variance of blanket peat, that is; peat condition is unlikely to vary significantly within a limited spatial area. In contrast, peat condition naturally varies with depth, therefore condition of peat may vary in correlation with significant variability of peat depth within a limited spatial area.

If peat condition is observed to be variable within a limited area being surveyed, MEL procedures included carrying out additional judgemental sample points to enhance the resolution of the data obtained. Variability can also be considered an indicator for historical mass movements.

In situ, undrained shear strength of the peat was also undertaken at several locations across the Site using a shear vane tester. However, results of same are used as an indicator only and are not considered reliable in determining actual peat shear strength (**Technical Appendix 8.3**).

8.2.4.5 Limitations

The Development will utilise the public highway leading to, and the existing access track associated with the Operational Barnesmore Windfarm, therefor no intrusive site surveys (for example; depth probing) were conducted at these locations.

8.2.5 Evaluation of Potential Effects

8.2.5.1 Sensitivity

Sensitivity is defined as the potential for a receptor to be significantly affected by a proposed development (EPA, 2017). The EPA provides guidance on the assessment methodology, including defining general descriptive terms in relation to magnitude of impacts however, in terms of qualifying significance of the receiving environment the EPA guidance also states that;

> "*The value of the superficial/ solid geology should be identified to allow an assessment of the impact of the proposed development to be considered adequately*" (EPA, 2015)

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. To facilitate the qualification of geological attributes, guidance specific to land and soils as set out by National Roads Authority (NRA), and guidance specific to landscape as set out by Scottish National Heritage (SNH) has been used in conjunction with EPA guidance.

The following table presents rated categories and criteria for rating site attributes (NRA, 2008).

Table 8.1: 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 (SNH, 2013).

Table 8.2: 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**.

8.2.5.2 Magnitude

The magnitude of potential impacts arising as a product of the Development are defined in accordance with the criteria provided by the EPA, as presented in the following table (EPA, 2017). These descriptive phrases are considered general terms for describing potential effects of the Development, and provide for considering baseline tends, for example; a *Moderate* impact is one which *is consistent with the existing or emerging trends*.

Table 8.3: Describing the Magnitude of Impacts

Magnitude of Impact	Description
Imperceptible	An impact capabale of meassurement but without noticeable consequences.
Slight	An impact that alters the character of the environment without affecting its sensitivities.
Moderate	An impact that alters the chacater of the environment in a manner that is consistent with the existing or emerging trends.
Significant	An impact, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.
Profound	An impact which obliterates all previous sensitive characteristics.

In terms of soils and geology, magnitude is qualified in line with relevant guidance, as presented in the following table (NRA, 2008). These descriptive phrases are considered development specific terms for describing potential effects of the Development, and do not provide for considering baseline tends and therefore are utilised to qualify impacts in terms of weighting impacts relative to site attribute importance and scale.

Table 8.4: 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.

8.2.5.3 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 which in effect a risk matrix.

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 Soils and Geology, the general terms for describing potential effects (**Table 8.3: Describing the Magnitude of Impacts**) are not linked directly with the Development specific terms for qualifying potential impacts (**Table 8.4: Qualifying the Magnitude of Impact on Hydrological Attributes** and **Table 8.5: Qualifying the Magnitude of Impact on Hydrogeological Attributes**) therefore, both descriptive (**Table 8.3**) and qualifying (**Table 8.5**) terms are used in describing potential impacts of the Development. This is largely driven by the likely localised characteristic of potential effects arising as a product of the Development in terms of Soil and Geology, and the separation of land areas based on baseline conditions (**Section 8.4**).

Table 8.5: Weighted Rating of Significant Environmental Impacts

Sensitivity (Importnace of Attribute)		Magnitude of Impact			
		Negligible (0-2%)	**Small (2-15%)**	**Moderate (15-50%)**	**Large (>50%)**
Extremely High		Slight / Moderate	Significant	Profound	Profound
Very High		Slight	Significant / Moderate	Profound / Significant	Profound
High		Slight / Imperceptible	Moderate / Slight	Significant / Moderate	Profound / Significant
Medium		Imperceptible	Slight	Moderate	Significant
Low		Imperceptible	Imperceptible	Slight	Slight / Moderate

8.2.5.4 Scoping Responses and Consultation

Information has been provided by a number of consultee organisations during the assessment, and this is summarised in **Table 8.6**. The response to each point raised by consultees is also presented within the table, demonstrating where the Development design has changed in response to specific issues indicated by respective consultees.

Table 8.6: Scoping Responses and Consultation

Consultee	Type and Date	Consultee Scoping Response and associated EIAR Chapter
Department of Agriculture, Environment and Rural Affairs	Letter in response to Scoping Report received 30/09/19	*The foundations of wind turbines have the potential to impact on the groundwater environment. An assessment of the development's potential risk to impact on the groundwater environment is required. This typically consists of a Water Features Survey as part of the Hydrogeological Assessment. Further information is provided within "Environmental information required" and Baseline environmental information". This information is required either through an EIA or in support of a full planning application* • Concrete, in particular fresh / wet concrete or lean mix material has the potential to impact on water which comes into contact with it, that is; the pH will be elevated, and there is also the potential for other contaminants such as sulphates etc. This is considered a potential adverse impact on the Environment. The sensitivity of groundwater and the management of cementitious material is addressed as part of **Chapter 9: Hydrology and Hydrogeology**.
Department of Culture, Heritage and the Gaeltacht	Letter / email in response to Scoping Report received 25/06/19	Concerns regarding: *Nature Conservation* • Generally related to Ecology i.e. Chapter 6: Biodiversity *EIAR: Ecological survey* • Generally related to Ecology i.e. Chapter 6: Biodiversity *EIAR: Hedgerows and related species* • Generally related to Ecology i.e. Chapter 6: Biodiversity *EIAR: Watercourses and wetlands* • Generally related to Ecology i.e. Chapter 6: Biodiversity *A 10m riparian buffer on both banks of a waterway is considered to comprise part of the otter habitat. Therefore, any proposed development should be located at least 10m away from a waterway.* • This is specific to the protection of otter habitat, for information relating to ecology refer to Chapter 6: Biodiversity. Surface water bodies are identified as being sensitive in their won right, therefore a series of risks are mitigated for as detailed in **Section 9.5 Mitigation Measures – Chapter 9: Hydrology and Hydrogeology**. *EIAR: Bats* • Generally related to Ecology i.e. Chapter 6: Biodiversity *EIAR: Alien invasive species* • Generally related to Ecology i.e. Chapter 6: Biodiversity *EIAR: Bird surveys* • Generally related to Ecology i.e. Chapter 6: Biodiversity *EIAR: Impact assessment* *The positions, locations and sizes of construction infrastructure and mitigation such as settlement ponds, disposal sites and construction compounds may significantly affect European and other designated sites, habitats and species in their own right and could have an effect for example on drainage, water quality, habitat loss, and disturbance. If these are undetermined at time of the assessment all potential effects of the development on the site are not being considered.* • Generally related to Ecology i.e**. Chapter 6: Biodiversity**, however items such as land take and water quality are addressed in **Chapter 8: Soils and Geology** and **Chapter 9: Hydrology and Hydrogeology** respectively**.** Land take (of the Barnesmore NHA) and quality of surface water runoff intercepted by the NHA or associated drainage and surface water networks is assessed and mitigation measures prescribed set out to minimise impact is so far as practical, and to legislative refence limits e.g. water quality of associated surface water network. *EIAR: Construction Management Plans* *Construction work should not be allowed to impact on water quality and measures should be detailed in the EIAR to prevent sediment and/or fuel runoff from getting into watercourses which could adversely impact on aquatic species. See EIAR: Flood Plains for details with regard to flooding risk.* • Generally related to Ecology i.e. **Chapter 6: Biodiversity** i.e. impact to fish species etc, however **Chapter 9: Hydrology and Hydrogeology** identifies risk to water quality and **Section 9.5** prescribes mitigation measures with a view to minimising impacts to the receiving surface water network. Flood risk is also assessed. *EIAR: Cumulative and ex situ impacts* • Cumulative impacts in relation Soils and Geology (**Section 8.5.5 - Chapter 8: Soils and Geology**) and Water (**Section 9.6 - Chapter 9: Hydrology and Hydrogeology**) are considered. *Appropriate Assessment*

Consultee	Type and Date	Consultee Scoping Response and associated EIAR Chapter
		• Considered separately to both **Chapter 8: Soils and Geology** and **Chapter 9: Hydrology and Hydrogeology.** *Post construction monitoring* • *Monitoring principals are described in* ***Section 8.5*** **Chapter 8: Soils and Geology** and **Section 9.5 - Chapter 9: Hydrology and Hydrogeology** *Licences* • Generally related to Ecology i.e. **Chapter 6: Biodiversity** *Baseline data* • Generally related to Ecology i.e. **Chapter 6: Biodiversity**
Inland Fisheries Ireland (IFI)	Email in response to Scoping Report received 08/07/19	Concerns regarding: *Storage of fuel, bunded and 100m from any watercourse.* • The requirement for a bunded fuelling station is identified and included in mitigation measures, the CEMP, and will be specified in the Site Specific CEMP. The location of same will be positioned in the contractors' yard (**Figure 1.2**). Unfortunately, given the restrictive nature of the Site in terms of layout and the drainage network being close proximity to same, a 100m buffer zone from significant drainage or surface water features is not a viable approach, however mitigation measures to address the potential for hydrocarbon contamination incidents, including emergency responses are described in the Mitigation Measures sections of **Chapter 8: Soils and Geology** and **Chapter 9: Hydrology and Hydrogeology.** *Watercourse crossings.* • Addressed in this EIAR. 3 no. new watercourse crossings associated with the Development are to be planned and designed adequately, and consent will be sought from the Office of Public Works (OPW) (**Chapter 9: Hydrology and Hydrogeology).** *Erosion and entrainment of suspended solids and management of same.* • Entrainment of SS is considered an unavoidable impact of the Development due to excavation activities required. However precautionary and mitigation measures described in **Section 8.5 Mitigation Measures and Residual Effects** will significantly reduce the potential impact. *Existing drainage channels should remain untouched* • Given the constrained nature of the Site in terms of layout design limitations i.e. restricted to the foot print of the Operational Barnesmore Windfarm and it's relationship with topography and existing natural and artificial drainage etc. some drainage features will be impacted including being rerouted or upgraded as a product of the Development, however this conforms to baseline and ongoing practices on the Operational Barnesmore Windfarm. Furthermore, some of the mitigation measures outlined in **Chapter 9: Hydrology and Hydrogeology** require the modification or construction of in line drainage infrastructure e.g. stilling ponds, check dams, etc. Furthermore, in some places infrastructure associated with both the Operational Barnesmore Windfarm and the proposed Development will be within surface water body buffer zones, in such unavoidable instances additional attention will be given including additional mitigation measures with a view to minimising any impact to those water bodies. The application of such measures will be detailed in the Site Specific CEMP and SWMP. *Cement and wet concrete must be kept out of all watercourses and drains.* • Mitigation measures to address this potential issue are described in **Section 8.5** *Track ruttings by machinery movement must be kept to a minimum and no discharge or run off containing high sediment loads must occur from the Site*. • It is recommended in the mitigation measures of this Chapter of the EIAR that no vehicular movements over peat should occur. If vehicular movement over peat needs to occur it will be limited to the footprint of the Development. *Any stockpiling of peat or other Site materials will require careful management to ensure that slippage or collapse to any adjacent watercourses will not occur*. • Management of stockpiles is addressed in this Chapter of the EIAR *The monitoring of all surface flows during construction is essential and remote sensing equipment should be considered as a normal precaution and extended into the post construction phase* • Monitoring of surface water quality is addressed. Remote sensing telemetry equipment is recommended. *Consideration should be afforded to the likely increase in surface water flow from the Site which has the potential to alter the downstream prevailing hydrological regime and impact on the fisheries resource.* • Increased hydro loading is addressed in this EIAR. Net increase in surface water runoff is considered negligible / imperceptible. (**Chapter 9: Hydrology and Hydrogeology).**

Consultee	Type and Date	Consultee Scoping Response and associated EIAR Chapter
		Recommended that a suitably qualified person be onsite for the duration of works to ensure: *(a) All mitigation measures identified are implemented prior to and during the construction phase, as appropriate.* *(b) Continual assessment to ensure the mitigation measures are effective including assessment of adjacent peats for cracking/instability.* *(c) Cessation of works should slippage indicators develop and/or settlement arrangements are inadequate for suspended solid removal in surface waters.* *(d) Peat reinstatement is completed according to a detailed restoration plan.* *(e) Arrangements are established in relation to a contact protocol for the relevant statutory bodies on progress of works.* • It is recommended that suitably qualified person/s be in attendance, particularly during significant works e.g. excavation activities. Other particulars are addressed and will be included in the Site Specific CEMP.
An Taisce	Email in response to Scoping Report received 14/06/19	Concerns in relation to Peat Displacement. • The Development will require peat, subsoil and bedrock removal by excavation, this is addressed in this Chapter of the EIAR.
Geological Survey Ireland	Letter in response to Scoping Report dated 08/07/19	*The Donegal County Audit is due to be published later this year, but I can confirm now that there are no County Geological Sites within the area of the proposed work. There are two sites close to the area to the north and we would appreciate if these were included in the report, but with the current plans, there is no envisaged impact on the integrity of County Geological Sites by the development.* • Geological sites, including mineral localities, and the Barnesmore Gap, are considered in the Baseline Section/s of this Chapter of the EIAR (Soils & Geology). The Development will not impact on same. *Groundwater - The area is a poor aquifer as it is mainly rock at the surface but it is considered extremely vulnerable to groundwater contamination. The River Finn to the north is part of a €14m INTERREG CatchmentCARE cross-border project and should be included in your report as such but it is not envisaged that the proposed works will be of concern*. • Groundwater is not considered to be at significant risk due to (a) the aquifer is poor with low productivity except for local zones (b) the recharge coefficient for the area is low which implies much of the water / rainfall landing on the Site will be intercepted by drainage and surface water network (c) risk to groundwater is limited to mobile contamination e.g. hydrocarbons, the risk for which is considered low provided precautionary and mitigation measures are adhered to, and (d) the risk conforms to baseline conditions and practices associated with the Operational Barnesmore Windfarm. Sensitive, designated sites downstream of the Development are considered. All waters (groundwater and surface water) associated with the Site are considered as being highly sensitive and in turn of high importance – mitigation measures are described accordingly.
HSE	Letter in response to Scoping Report dated 08/07/19	*Water Quality – The proposed development has the potential to have a significant impact on both surface water and groundwater quality. All drinking water sources, both surface and groundwater must be identified. Any potential impacts to these drinking water sources should be assessed. Details of bedrock, overburden, vulnerability, groundwater flows, catchment areas etc. should be considered when assessing the potential impacts and any proposed mitigation measures. It is strongly recommended that a Site survey is undertaken to gather all necessary information as desk top studies cannot be relied upon to reflect current accurate use of water resources.* • Water quality, importance as a resource, and its vulnerability to being impacted by the Development is assessed as normal procedure carrying out this EIA. Works included both desk and Site based assessments. The potential for the Development to impact on sources of drinking water is considered negligible. **Chapter 9: Hydrology and Hydrogeology** *Geological Impacts – A detailed assessment of the current ground stability of the Site for the proposed windfarm development together with the necessary mitigation measures should be included in the EIS. The assessment should include the impact construction work will have on the future stability of ground conditions taking into account extreme weather event, Site drainage and the possibility for soil erosion.* • A detailed slope stability assessment has been carried out as part the EIA process (**Technical Appendix 8.3).** The risk for slope stability issues to arise as a product of the Development is considered negligible to low, furthermore all potential receptors are surface water features i.e. no immediate risk to populations / communities.
Irish Water	Letter in response to Scoping Report	*Irish water suggests a site investigation be carried out prior to the beginning of construction and proposals outlined for dealing with situations where works would interfere with existing water services infrastructure* • Site surveys have been carried out, including peat depth probing and peat gouge coring as part of this EIA, no impacts to water services on the Site are identified or envisaged.

Consultee	Type and Date	Consultee Scoping Response and associated EIAR Chapter
	dated 06/08/19	Furthermore, no trade effluent will be discharged to sewer, or any surface water body. Full details are included with this chapter of the EIAR. A detailed Site Investigation will be carried out prior to construction.
Office of Public Works	Letter in response to Scoping Report dated 27/08/19	*The footprint of the Barnesmore Windfarm does not coincide with any existing or proposed OPW Drainage of Flood Relief Scheme.* • Regardless, the net increase in surface water runoff as a product of the Development is considered imperceptible (**Chapter 9: Hydrology and Hydrogeology)** *Construction or alteration of any watercourse crossing will require Section 47/50 consent as per the Arterial Drainage Act of 1945* • Consent will be sought for 3 no. new watercourse crossings. This will be specified in the Site Specific CEMP, that is; consent will be sought post planning application review. *The development shall follow The Planning System and Flood Risk Management: Guidelines for Planning Authorities.* • Flood Risk has been considered as part of the Baseline Assessment and in terms of net increase of surface water runoff (imperceptible) associated with the Development (**Chapter 9: Hydrology and Hydrogeology - Section 9.3.8).**

8.3 Baseline Description

8.3.1 Introduction

The Development is defined as the repowering of the Operational Barnesmore Windfarm and titled the Barnesmore Windfarm Repower. The Operational Barnesmore Windfarm was installed c. 1997 and consists of twenty-five c. 61 m wind turbines with associated Site tracks, hardstands and other infrastructure. The repowering of the Operational Barnesmore Windfarm entails the removal of the existing wind turbines and replacing them with a lower number of larger, higher power generation capacity turbines.

8.3.2 Site Description

The Site is situated in an area named Barnesmore Bog, located on the south west limits of the Bluestack Mountains, Co. Donegal, and in turn the south west limits of the North Western Caledonian Province – an area underlain by ancient Precambrian rocks which have been folded into mountains. The underlying rock types are hard, e.g. granites and quarzitic peaks which were rounded but not destroyed by ice movements during the ice age. The soils however, were generally stripped from the region and thus, the region is agriculturally poor (Johnston, ND).

The existing turbines are sited on elevated moorland adjacent to Barnesmore Gap between the N15 and the Irish national border. The Site boundary is wholly within the Republic of Ireland. A Site Location Map showing the Site boundary outline is appended as **Figure 1.1** and a copy of the Operational Windfarm layout is outlined in **Figure 3.2**

The land around the Operational Barnesmore Windfarm, which is wholly owned by SPR, was designated as an NHA in 2005 owing to the peatland habitat (Barnesmore Bog NHA 002375). This designation was subsequent to the construction of the Operational Barnesmore Windfarm and the designated boundary sought to exclude the Operational Barnesmore Windfarm infrastructure from the NHA. However, the map contained within the NHA site synopsis indicates that this exercise has not been completed accurately; although the NHA Site Synopsis confirms that this exclusion was the intention when the boundaries were drawn "*A wind power installation and associated Site tracks, which occupies part of Croaghakeadew Mountain (398 m) on the west and extends eastwards to Loughnaweelagh, northwards to Lough Namaddy, and southwards to just north of Lough Allegheny, has been excluded from the Site."*

Barnesmore Bog NHA covers an area of 2,183 ha. The footprint of the Operational Barnesmore Windfarm covers an area of c. 7.26 ha (this allows for a 3 m buffer along the NHA exclusion zone (as per the NHA definition), and factors in backfill associated with the Operational Barnesmore Windfarm which has been vegetated over the operational phase of same).

NHAs are sites that support elements of our natural heritage which are unique or are of outstanding importance at a national level, therefore for the purpose of assessing the Development and its potential impact on the receiving environment, the Site is regarded as being of Very High Importance, and is Highly Sensitive. Note: This does not apply to any part of the Operational Barnesmore Windfarm.

The Site covers an area of 423.35 ha within the Barnesmore NHA. The area within the Site Boundary is mountainous with variable elevations ranging from c. 290 mOD to c. 390 mOD (Digital Land Surveys, 2018). Within the Site Boundary there are several lakes, the most significant of which is Lough Golagh which is central relative to the Site, however there are several other smaller lakes within the Site Boundary including; Lough Nabrackboy, and other minor unnamed lakes. Lough Slug, Lough Namaddy and Loughnoweelagh are located on or adjacent to the Site Boundary (EPA, ND). Surface water features including lakes and rivers are covered in depth in **Chapter 9: Hydrology & Hydrogeology** of this EIAR.

With reference to **Chapter 6: Biodiversity**, the land cover of the Site is a mosaic of different habitats including, inter alia; active blanket bog, mountain heath, acid grass land, and turbary areas (areas where the practice of peat cutting is evident or ongoing), however for the purpose of this chapter and in regard to soils and geology, the area is defined as comprising of blanket bog with rocky outcrops, some naturally degraded areas, and some turbary areas (EPA, ND).

8.3.3 Bedrock Geology

The Site is situated in the North Western Caledonian Province which is an area underlain by ancient Precambrian rocks, the oldest geology in Ireland. The Site is mapped as being underlain by Precambrian Dalradian rock (Jackson P.W., Simms M., 2009). The Dalradian is a sequence of marine sediments deposited on the rifting margin of the Lapetus Ocean and later deformed at the closing of the ocean (GSI, ND). Consultation with Geological Survey Ireland Spatial Resources indicates that the bedrock at 1:1,000,000 scale the Site is underlain by *Neoproterzoic Metasedimentary rocks – Dalradian*, and at 1:100,000 scale the Site is underlain by the *Lough Mourne Formation*, described succinctly as; *Quartz and feldspar pebbles, green matrix, which occurs chiefly in the western limb of the major Ballybofey Nappe fold structure*. The lithological description states; *Typically comprises of coarse feldspathic pale pink psephites in a pale green chloritic matrix.* (GSI, ND).

The Dalradian rocks in the region experienced multiple episodes of intense deformation during the Grampian Orogeny (Cooper, M.R., Johnston, T.P., 2017). Each deformation event produced its own characteristic folds, schistosities and lineations, resulting in a complex cumulative set of structures. In Ireland, the Dalradian is fragmented into five inliers; NW Mayo, Donegal and the Sperrin Mountains, the Central Ox Mountains, Connemara, and NE Antrim (Chew, D.M., 2009). The resulting geological landscape is one of numerous significant geological features, such as; the Ballybofey Nappe to the east / northeast, the Lough Derg Slide to the southeast, and the Central Donegal Slide to the north (Alsop, G.I., Hutton, D.H.W., 1990), however the Site is mapped as being situated between two major faults; the Barnesmore Fault to the north west (south west – north east orientation) and the Laghy Fault to the southeast (southwest – northeast orientation), there are no mapped faults underlying the Site otherwise (GSI, ND), and in addition the Site is mapped as underlain by a formation which is undivided i.e. during the deformation of the Dalradian (Cooper, M.R., Johnston, T.P., 2017), although there is evidence of this to the southwest in the form of a tertiary dolerite dyke to the southwest (southeast – northwest orientation, perpendicular to the aforementioned faults) (GSI, ND). There are however, indications of strike and dip of bedding in the vicinity of the Site, ranging from 22 degrees to 35 degrees (GSI, ND).

There has been no laboratory analysis or geotechnical testing of rock carried out as part of this study, however a high number of rocky outcrops were observed, photographed and recorded during Site visits. Observations of rock encountered coincided with the findings of the desk based study of the local geology as stated in the preceding paragraphs, that is; rock observed generally consisted of granular green matrix, or granular white / pinkish white matrix rock types, with several occurrences of quarzitic vanes and pockets observed also (**Technical Appendix 8.1**).

Plate 8.1: Example of Rocky Outcrop with Quarzitic Vain (Scale: Orange depth probe in shot = 1.9m, Orientation: Looking east, Lough Golagh in background)

8.3.4 Seismic Activity

The island of Ireland does indeed experience, monitor and record seismic activity, although the magnitude of such occurrences are generally low and do not generally pose any 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 of the most recent earthquakes detected include; an M2.4 earthquake which occurred on 01/04/19, the epicentre for which was located within Donegal Bay, and at a depth of 4 km, and an M2.0 earthquake which occurred on 29/04/19, the epicentre for which was located approximately midway between Donegal Town and Lough Derg, or approximately 7 km south of Barnesmore Bog, and at 16 km depth (INSN, ND). Although earthquakes are considered a triggering mechanism for landslides, given the low magnitude experienced in Ireland earthquakes are not considered an important triggering factor (Creighton, R, 2006).

8.3.5 Soils and Subsoils

Consultation with available maps (GSI, ND) indicate that the soil type across the entire Site, and the general area is Blanket Peat (GSI/Teagasc ref. = BktPt), with several significant areas mapped as being Bedrock at Surface (Rck). The nearest mapped variance of these two classifications include Metamorphic Till (TMp), Granite Till (TGr) and Alluvium (A) within Barnesmore Gap approximately 1.2 km northwest of the Site Boundary, and minor area of Alluvium (A) approximately 1.5 km southwest of the Site Boundary. Mapped soil types are presented in **Technical Appendix 8.2**.

Observations and data obtained during Site surveys coincide with the findings of the desk study as stated in the preceding paragraph. Blanket peat covers the vast majority of the Site, and significant rocky outcrops were observed across the Site. Furthermore, many minor rocky outcrops were also observed across the Site, particularly at higher elevations. Thin peat and exposed rock were observed at numerous existing cut and fill locations along the existing Site tracks and hardstands associated with the Operational Barnesmore Windfarm. Exposed rock observed indicated only minor degrees of weathering in relation to bedrock and similarly, only thin layers of weathered fractured bedrock and/or till were observed at these locations.

There is no available environmental data in relation to the environmental assessment carried out ahead of the construction of the Operational Barnesmore Windfarm, however considering the layout of the existing infrastructure and the data obtained for the purposes of this assessment, it can be inferred that the layout design of the Operational Barnesmore Windfarm is aligned with areas of thin peat / shallow bedrock wherever possible. This approach is also evident in relation to mapped landslide susceptibility.

Plate 8.2: Example of Exposed Rock and Peat Adjacent to Existing Track (Scale: Road approx. 6m width, Orientation: Looking north, Site track leading to proposed T1 location)

8.3.5.1 Peat Depth

The results of the Peat Depth Probing and Gouge Coring surveys are presented in **Technical Appendix 8.3**.

Peat depths at survey points (666 no.) range from 0.00 m to 5.70 m. Peat depths were generally shallow, particularly at higher elevations, the deepest peat at these locations being c. 2.0 m, whereas extreme peat depths (up to 5.7 m) were observed at lower elevations and within valleys / troughs or on relatively level ground at the foot of hills / mountains only. The following graph illustrates the peat depth distribution observed onsite:

Table 8.7: Peat Depth Distribution by Category

Peat Depth Category	Number of Survey Points
A - Rock (0.0m)	69
B - Very Shallow (0.01-0.5m)	192
C - Shallow (0.5-2.0m)	289
D - Moderately Deep (2.0-3.5m)	89
E - Deep (3.5-5.0m)	24
F - Extremely Deep (>5m)	3
Total	666

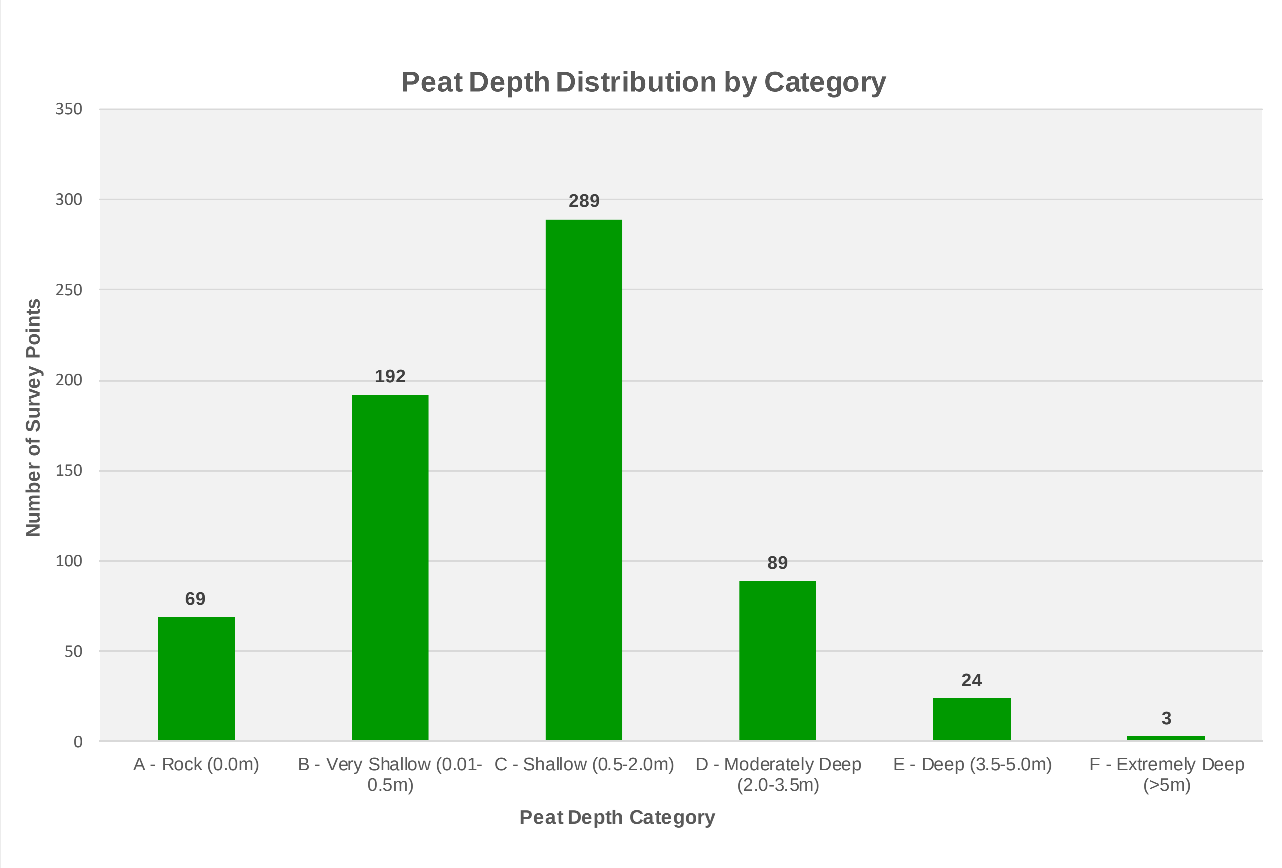


Chart 8.1: Peat Depth Distribution by Category

Peat depths have been mapped by category which is presented in **Technical Appendix 8.3**.

8.3.5.2 Peat Condition

Graphical logs and photographs of cores are presented in **Technical Appendix 8.3**.

Observations of exposed peat at existing cut and fill locations, as seen in **Plate 8.2**, and at existing degraded areas as seen in **Plate 8.3**, indicate dark, near black in colour, highly humified peat with low fibre content. Peat observed and logged during Gouge Core surveys coincide with these observations. Peat assessment results indicate that peat is highly humified with Von Post values ranging from H7 to H10 across the Site, most values recorded were H8, and naturally, lower Von Post values were observed in the shallower peat and increased with depth. The peat observed, in particular peat with Von Post values of H7 to H8, was moderately fibrous however, the vast majority of the fibrous material observed was classified as roots / rootlets belonging to the vegetation living currently, some roots extended relatively deeply into the peat, and the actual peat itself was highly humified with high Von Post values. The peat acrotelm layer was observed to be relatively thin (c. 0.1 m) across the Site.

At several locations across the Site naturally degraded peat was observed, as seen in **Plate 8.3** and **Plate 8.4**. Such occurrences are likely a gradual function of erosion caused by surface water runoff, which potentially is enhanced in some areas by the presence of the Operational Barnesmore Windfarm and associated infrastructure, whereby surface water flow and drainage have been modified by the presence of hardstands and tracks. Occurrences of degradation are most prevalent at higher elevations, at or near peaks and ridges.

Plate 8.3: Example of Degraded Peat, with Obvious Natural Drainage Channel

Plate 8.4: Example of Degraded Peat, Potentially Influenced by the Operational Barnesmore Windfarm

8.3.6 Geological Resource Importance

There are no mapped Mineral Localities or Quarries within or directly adjacent to the Site. There are several mapped Mineral Localities associated with the Barnesmore Granite to the northwest of the Site, the closest locality being c. 1.8 km from the Site Boundary.

8.3.7 Features of Geological Significance

Other than the NHA itself, that is; Barnesmore Bog and underlying geology, there are no other features of geological significance within the Site Boundary.

8.3.8 Slope Stability

The Site is mapped as having areas ranging from Low Risk (LR), Moderately Low Risk (MLR), Moderately High Risk (MHR), and High Risk (HR) in terms of Landslide Stability, the full spectrum of slope stability risk categories (GSI, ND). The infrastructure associated with the Operational Barnesmore Windfarm is within areas mapped as being LR, MLR and MLR, no existing infrastructure is within HR areas.

There are no recorded landslide events within or directly adjacent to the Site (GSI, ND). The closest recorded landslide event, as mapped by GSI, is located approximately 2 km northwest of the Site within the Barnesmore Gap. Details of the event include slope gradient; 45 degrees (Event ID: GSI_LS14-0036). The second closest recorded landslide event, as mapped by the GSI, is located approximately 4 km north of the Site. Details of the event include; Name: Barnesmore 1963 (13/11/1963), Landslide Mechanism: Flow, Material: Peat, Human Factors: Road cutting, "The flow began at a marked break in slope where morainic sands and gravels beneath the peat had recently been moved for road work" (GSI, ND).

Mapped Landslide Susceptibility (GSI), and Site-specific results and maps for the peat / slope stability assessment carried out with respect to the Development are presented in **Technical Appendix 8.3**. The infrastructure associated with the Development utilises as much of the existing infrastructure as possible but proposed turbine locations and hardstands have been positioned to both utilise existing infrastructure and avoid higher risk areas in terms of landslide susceptibility. As a result, proposed wind turbine locations and hardstands are situated in areas mapped as LR and MLR predominantly, with limited margins of hardstands crossing into areas mapped as MHR in terms of landslide susceptibility.

Indications of soil creep were observed and noted during Site visits, for example, along existing Site tracks associated with the Operational Barnesmore Windfarm as seen in **Plate 8.5**. No indications of significant or recently formed peat cracks, for example tension cracks, or evidence of mass movement, were observed during Site visits. Some linear features (parallel or nearly parallel to slope contours) were observed in some areas of the Site, as seen in **Plate 8.6** and **Plate 8.7**. Such features are likely indicative of gradual soil creep and degradation (similar to degradation described in previous sections) rather than explicit recently formed tension cracks.

Plate 8.5: Example of soil creep evident along existing Site track i.e. overhanging peat

Plate 8.6: Linear features indicating potential for soil creep (Looking south at proposed location for T1)

Plate 8.7: Linear features indicating potential for soil creep (Looking north / north east, existing met mast)

With reference to **Chapter 9: Hydrology and Hydrogeology**, weather conditions and rainfall which occurred on the Site in 2018 can be viewed as a natural stress test in terms of slope stability. A prominent landslide trigger mechanism for peat in Ireland is the sudden onset of high rainfall events after prolonged dry periods. Whereby, prolonged periods of dry weather cause the peat to dry and contract causing tension cracks and newly introduced fissures and pores, when rainfall increases, particularly during heavy rainfall events, said cracks, fissures and pores accelerate the infiltration of water into the peat, potentially lubricating failure plains, increasing pore water pressure and triggering sudden mass movement in the form of landslides. In 2018, Ireland experienced absolute drought conditions at 21 stations at various times between the 22 May and 14 July. As per **Chart 9.2** – **Rainfall Trends** (**Chapter 9: Hydrology and Hydrogeology)** the region associated with the Development experienced generally drier than average conditions between March and July 2018, with wetter than average conditions in the following months, August and September

2018. This can be viewed as a natural “stress test” for slope stability given that such conditions are indicative triggering mechanisms for peat failure and landslides (Lindsay, R, et al, 2005; Creighton, R, 2006; MET, 2018).

It is important to note that there have been no recorded incidents in terms of landslides on the Site, including during the construction of the Operational Barnesmore Windfarm. This is important to note when considering the potential risk associated with the Development.

Table 8.8 summarise the slope stability risk with respect to the proposed turbines and other infrastructure units associated with the Development. Scenario B has been used in the assessment of peat and slope stability, that is; peat depth plus one metre fill (assessment worst case scenario). Note: in all instances, ‘receptor’ refers to the closest surface water feature downgradient of the proposed infrastructure location. For greater detail, results and comprehensive methodology on peat and slope stability, refer to the Slope Stability & Risk Assessment Report presented in **Technical Appendix 8.3**.

Table 8.8: Stability Risk Assessment Conclusion Table

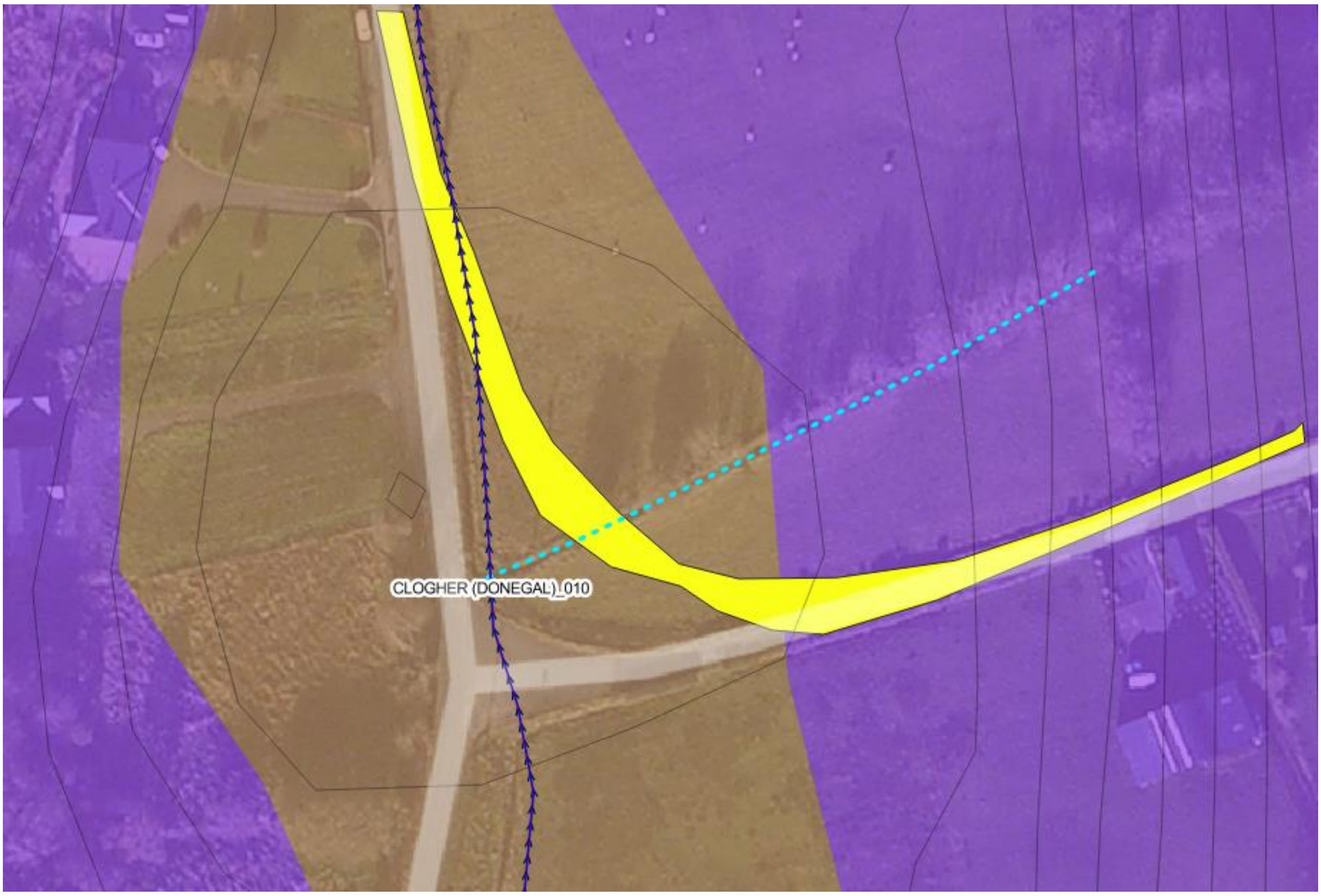
Turbine No. / Unit	RR_{SF} (Ranked Risk Considering Sensitive Receptor)	RR_D (Ranked Risk Considering Distance to Sensitive Receptor)
1	The risk of stability issues arising at this location is NEGLIGIBLE (with a degree of LOW risk)	The risk of significant impact on receptor in the UNLIKELY event of stability issues at this location is NEGLIGIBLE (with a degree of LOW risk)
2	The risk of stability issues arising at this location is NEGLIGIBLE (with a degree of LOW risk)	The risk of significant impact on receptor in the UNLIKELY event of stability issues at this location is LOW (with a degree of MODERATE risk)
3	The risk of stability issues arising at this location is NEGLIGIBLE	The risk of significant impact on receptor in the UNLIKELY event of stability issues at this location is MODERATE
4	The risk of stability issues arising at this location is NEGLIGIBLE	The risk of significant impact on receptor in the UNLIKELY event of stability issues at this location is LOW
5	The risk of stability issues arising at this location is NEGLIGIBLE (with a degree of LOW risk)	The risk of significant impact on receptor in the UNLIKELY event of stability issues at this location is NEGLIGIBLE (with a degree of LOW risk)
6	The risk of stability issues arising at this location is NEGLIGIBLE (with a degree of LOW risk)	The risk of significant impact on receptor in the UNLIKELY event of stability issues at this location is NEGLIGIBLE (with a degree of LOW risk)
7	The risk of stability issues arising at this location is NEGLIGIBLE (with a degree of LOW risk)	The risk of significant impact on receptor in the UNLIKELY event of stability issues at this location is NEGLIGIBLE (with a degree of LOW risk)
8	The risk of stability issues arising at this location is NEGLIGIBLE	The risk of significant impact on receptor in the UNLIKELY event of stability issues at this location is NEGLIGIBLE
9	The risk of stability issues arising at this location is NEGLIGIBLE (with a degree of LOW risk)	The risk of significant impact on receptor in the UNLIKELY event of stability issues at this location is NEGLIGIBLE (with a degree of LOW risk)
10	The risk of stability issues arising at this location is NEGLIGIBLE	The risk of significant impact on receptor in the UNLIKELY event of stability issues at this location is NEGLIGIBLE
11	The risk of stability issues arising at this location is NEGLIGIBLE (with a degree of LOW risk)	The risk of significant impact on receptor in the UNLIKELY event of stability issues at this location is NEGLIGIBLE (with a degree of LOW risk)
12	The risk of stability issues arising at this location is NEGLIGIBLE	The risk of significant impact on receptor in the UNLIKELY event of stability issues at this location is LOW

Turbine No. / Unit	RR_{SF} (Ranked Risk Considering Sensitive Receptor)	RR_{D} (Ranked Risk Considering Distance to Sensitive Receptor)
13	The risk of stability issues arising at this location is NEGLIGIBLE	The risk of significant impact on receptor in the UNLIKELY event of stability issues at this location is MODERATE
Met Mast	The risk of stability issues arising at this location is NEGLIGIBLE (with a degree of LOW risk)	The risk of significant impact on receptor in the UNLIKELY event of stability issues at this location is NEGLIGIBLE (with a degree of LOW risk)
Energy Storage Unit	The risk of stability issues arising at this location is NEGLIGIBLE	The risk of significant impact on receptor in the UNLIKELY event of stability issues at this location is LOW

8.3.9 Haul Route & Access Track

The Haul Route and existing Site Access Track associated with the Operational Barnesmore Windfarm will be utilised as part of the Development. The route is in good condition and in use currently, therefore no intrusive geological surveys were carried out in this respect however, the Haul Route and Site Access Track will require some localised upgrading in terms of widening for the increased turbine dimensions primarily. The most significant works in this regard are in relation to one particular junction (Irish Grid: 199226.5, 380418.6) whereby the Haul Route will require the construction of a minor portion of new roadway, which will include the culverting of a tributary of the Clogher River (Ref. Name: CLOGHER (DONEGAL)_010. Illustrated by dark blue line)) and a drainage ditch (illustrated by light blue dashed line) in the vicinity, as presented in **Map 8.1** below (approximate). The new section of roadway will be privately owned by ScottishPower Renewables and will not be used by the public.

The area is mapped as being underlain by both Blanket Peat (**Map 8.1**; brown area) and Metamorphic Till (**Map 8.1**; purple area). However, considering the land use (pastures) and the infrastructure present (including national roads and dwellings), if peat is present it is envisaged to be superficial. Furthermore, the topography at this location is relatively flat. As a result, it is considered that there is negligible risk in terms of slope stability. It should also be noted that although the Haul Route, and Site Access Track are excluded from the Barnesmore Bog NHA designation, the Haul Route, and in particular the area discussed in this section (**Map 8.1**) is not adjacent or encompassed by the NHA designation (, that is; construction activities and land take impacts on land qualified as being of Low Sensitivity and Low Importance. Designated areas are mapped and presented in **Technical Appendix 9.4** (**Chapter 9: Hydrology and Hydrogeology**)



Map 8.1: Haul Route and Required Culverting (incl. Mapped Subsoils)

8.4 Assessment of Potential Effects

8.4.1 Localised Effects

Localised effects arising from the Development are assessed and described using the criteria set out in **Section 8.2.5.2 - Table 8.3: Rating the Magnitude of Impacts** (EPA, 2017).

8.4.2 Weighted Effects

The Site is encompassed by the Barnesmore Bog NHA and therefore any impact arising from the Development must be assessed relative to the integrity of the NHA as a whole. Therefore, weighted significance will be used to describe impacts of the Development as a whole on the NHA itself.

The receiving environment associated with the Development within the footprint of the Operational Barnesmore Windfarm is not within the NHA designation area and therefore considered as being of Low Importance and Low Sensitivity. The classification of any potential impacts associated with the Development which impacts any area within the footprint of the Operational Barnesmore Windfarm will be limited to magnitudes associated with Low Importance, as presented in **Table 8.9**.

Table 8.9: Weighted Rating of Significant Environmental Impacts – Within Footprint of Operational Barnesmore Windfarm

Sensitivity (Importnace of Attribute)		Magnitude of Impact			
		Negligible (0-2%)	**Small (2-15%)**	**Moderate (15-50%)**	**Large (>50%)**
Low		Imperceptible	Imperceptible	Slight	Slight / Moderate

The above also applies to any area of the Development which is not associated with or encompassed by the Barnesmore Bog NHA designation, for example; Haul Route, as discussed in **Section 8.3.9**.

The receiving environment associated with the Development outside of the footprint of the Operational Barnesmore Windfarm and is within the NHA designation and therefore considered as being of Very High Importance and Highly Sensitive, and therefore classification of any potential impacts associated with the Development which impacts any area outside of the footprint of the Operational Barnesmore Windfarm will be limited to Magnitudes associated with Very High Importance, as presented in **Table 8.10**, however it should also be noted that the presence of the Operational Barnesmore Windfarm is considered in terms of assessing magnitudes of impacts where by development within the Barnesmore NHA is consistent with existing or emerging trends.

Table 8.10: Weighted Rating of Significant Environmental Impacts – Outside of Footprint of Operational Barnesmore Windfarm

Sensitivity (Importnace of Attribute)		Magnitude of Impact			
		Negligible (0-2%)	**Small (2-15%)**	**Moderate (15-50%)**	**Large (>50%)**
Very High		Slight	Significant / Moderate	Profound / Significant	Profound

In terms of determining and assessing the magnitude of impacts, categories of magnitude (Negligible to Large) relate to the scale of the attribute, that is; the attribute driving the classification of sensitivity is the Barnesmore NHA, and therefore scale is relative to the area of the NHA itself (c. 2183 ha) however, for the purposes of this assessment the relative area is limited to the area of the Site. This is considered a conservative approach.

For example, the area of the Site is c. 423.35 ha, and the area of the footprint of the Operational Barnesmore Windfarm within the Site is c. 7.26 ha, therefore the area of the footprint of the Operational Barnesmore Windfarm equates to approximately 1.7% of the area of the Site, and therefore represents an existing Small magnitude impact to an attribute of very high importance, and therefore is considered to have Slight weighted significance as an impact of baseline conditions (pre-existing baseline conditions, that is; before the construction of the Operational Barnesmore Windfarm).

Considering the above limitations to weighting of magnitudes of impacts, driven by the importance of the attribute being impacted, and considering the Development will utilise existing infrastructure associated with the Operational Barnesmore Windfarm, the magnitude of impacts in terms of the Development as a whole is likely limited to <2%. This is assessed in greater detail in the following sections of this report.

8.4.3 Do Nothing Impact

Site investigations of the baseline geological and geotechnical conditions of the Site indicate the following;

- The Site in general has already experienced impacts to baseline conditions due to the installation of the Operational Barnesmore Windfarm, that is; installation of Site tracks and hardstands, excavation of peat/soils and rock, installation of turbine foundation pads, installation or enhancement of drainage features. The presence of the existing infrastructure has potentially enhanced erosion in some areas. There are no indications that the presence of the Operational Barnesmore Windfarm has had adverse impacts with regard to ground stability. This represents a moderate / significant, negative, long term / permanent impact to the area.
- The southern region of the Site has already experienced impacts to baseline conditions due to turbary activities, that is; peat cutting and harvesting. There are no indications that the peat cutting activities on Site has had adverse impacts with regard to ground stability. This represents a moderate / significant, negative, long term / permanent impact to the area.

Should the Development not proceed, the existing land-use practices of renewable energy production and peat cutting will continue, therefore the current status of the Site is considered baseline for the purposes of the assessment.

8.4.4 Initial Decommissioning and Construction Phase Potential Effects

8.4.4.1 Subsoil and Bedrock Removal

Details relating to specific elements of the Development in terms of subsoil and bedrock removal are presented in the following sub-sections.

8.4.4.1.1 Land Take

The Development will require c. 14.36 ha in total, considering the area of the Operational Barnesmore Windfarm (7.26 ha) the Development will require an additional 7.1 ha of land take to facilitate the construction of hardstands, widening

Site tracks, and cut and fill associated with same. This implies that, relative to the area of the Site, the magnitude of the impact of land take equates to approximately 1.68% (**Small**), that is; this is considered a likely, direct, negative, localised, permanent effect of the Development, however 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**.

Any and all direct impacts on soils and bedrock arising from the Development 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 Development as a whole. Therefore, impacts assessed and classified in the following section/s are considered at the localised scale.

Note: If considering the effect on the Barnesmore Bog NHA (2183 ha), the classification of the impact will remain the same, that is: a likely, direct, negative, localised, permanent effect of the Development, effect conforms to baseline therefore significance is classified as **moderate** at a localised scale, however the magnitude of the impact will equate to 0.33% (**Negligible**) and therefore the weighted significance equates to **Slight**.

8.4.4.1.2 Excavations

Excavation of soils and bedrock will be required for the construction of; turbine foundations, cut and fill for the construction and upgrading of hardstands and Site tracks, and for drainage and ducting infrastructure.

The approach and methodology in which excavation of in-situ peat and earth materials is undertaken is very important for ground stability in blanket bog environments. Peat is 80-90% water and if it is not sufficiently drained prior to excavation, or alternatively supported during excavation works (e.g. where deep peat exists or high slopes exist), excavation has the potential to cause slippage or mass failure under the right prevailing geotechnical and hydrological conditions (Feehan et al, 1996).

There are no severe slopes within the footprint of the Development. However, the degree of slope steepness should be considered when excavating material i.e. sidewalls of open excavations.

Generally, the peat on the Site is shallow (2 m depth or less), however there are some areas of the Site which contain deeper peat. The area required for a given excavation will be directly proportional to the depth of peat, that is; the deeper the excavation, the more significant the area required for excavation batter back, and the higher the risk of excavation sidewall collapse.

It should be noted that the Site contains many localised pockets of deep peat that are surrounded by thin peat and shallow bedrock or rocky outcrops, such areas are low risk in relation to excavation of same. However, areas with extensive deeper peat are higher risk in relation to excavations, similarly excavation boundaries which are within areas of deeper peat are higher risk in relation to excavations. The hazard posed includes side wall collapse during excavation activities.

Facilitating a safe angle of repose during excavation activities will minimise the potential for side wall collapse, this is discussed further in the following sections of this report, however it should be noted that this will be a driver for the extent which excavations will impact the surrounding environment, for example; the safe angle of repose for peat is approximately 15° (Cobb, 2009), and therefore the horizontal distance required to facilitate a safe angle of repose in a 2.5 m depth excavation is c. 10 m, however considering the quality and low shear strength of the peat on the Site, the safe angle of repose will likely be less than 15°, particularly in undrained conditions.

Notable areas with relatively significant extents of deeper peat include proposed locations for turbines T4 and T11. Furthermore, the proposed location for T5 is adjacent to an area of deeper peat however the existing, proven existing Site track and hardstand will be utilised at this location. Peat depths are mapped and presented in **Technical Appendix 8.3**.

The excavation of subsoils and bedrock to facilitate the installation of turbine foundations is considered a likely, direct, negative, localised, permanent effect of the Development, however considering the effect conforms to baseline the significance is classified as **moderate**.

The worst case scenario in relation to the excavation of subsoils and bedrock is that said activities compromise ground stability leading to mass movement, of peat in particular. As stated in **Section 8.3.8 Slope Stability** and as presented in the **Technical Appendix 8.3**, the risk of mass movements or landslides occurring is negligible to low, however there is an inherent risk associated with the excavation of peat considering the quality of same, that is; peat with high von Post values, low fibre content, high water content or pore water pressure and corresponding low shear strength. Peat quality will also influence the actual safe angle of repose for open excavations.

8.4.4.1.3 Hardstanding areas

The Development will require hardstand areas for the purpose of; delivery and setting down turbine construction materials and equipment, and establishing compound area hardstands including the Energy Storage Unit. Generally, existing hardstand areas associated with the Operational Barnesmore Windfarm will be utilised and enlarged where required.

Construction of proposed infrastructure is required in some areas where previously there was no infrastructure related to the Operational Barnesmore Windfarm. However, minimising additional infrastructure has been a key design principle of the Development and any additional hardstands will be located adjacent to the Operational Site tracks to utilise same in the construction where possible. New hardstands include those for proposed turbines T4, T10, T11, T12 and T13.

Establishing relatively level hardstand areas will require cut and fill, where subsoils and bedrock will be excavated to reduce levels, and fill, where bedrock / rock is deposited to elevate levels.

The effects of enhancing existing hardstands, and establishing new hardstands is considered a likely, direct, negative, localised, permanent effect of the Development, however considering the effect conforms to baseline the significance is classified as **moderate**.

8.4.4.1.4 Site Tracks

The Development will require the upgrading of portions of the existing Site track associated with the Operational Barnesmore Windfarm, and the construction of minor distances of new Site tracks (for example; access to T13 (**Figure 1.2**)). Areas requiring upgrading or establishment of Site tracks are presented in **Technical Appendix 8.4 – Mapped Impacts**. Upgrade works will likely include excavation of soils and bedrock, particularly in areas where cut and fill are required (**Section 8.4.4.1.2**).

8.4.4.1.5 Site Haul Route & Access Track

The Development will utilise the ‘public highway’ for the transport of materials onto the Site. Due to the scale of the proposed turbines, particularly turbine blades, the Development will require the upgrading of minor portions, and the construction of c. 100m of new private roadway to bi-pass a ‘public highway’ junction (**Map 8.1**). Upgrade works will likely include earthworks, particularly in areas where fill is required, but will also require some excavation works e.g. construction of 2 no. watercourse crossings. Some existing watercourse crossings along the Haul Route will also require widening (For specific details relating to the construction of new water course crossings refer to **Chapter 9: Hydrology and Hydrogeology**).

8.4.4.1.6 Bedrock Reuse

Significant volumes of bedrock will require excavation relative to total volumes of earth materials to be excavated when considering that peat is thin and bedrock shallow across much of the Development footprint. Broken bedrock excavated and removed will be suitable for reuse as backfill generally, however no geo-technical analysis of the bedrock underlying the Site has been carried out as part of this EIA, therefore the ‘quality’ for use as engineering fill, for the purpose of load bearing trafficked areas has not been determined as part of this assessment.

Using substandard material, particularly for final running surfaces of hardstands and Site tracks, will result in the material breaking down more rapidly, in turn leading in increased potential to fine sediments being entrained by surface water runoff (**Chapter 9: Hydrology and Hydrogeology**), and increased frequency of maintenance.

The rock type underlying the Site is likely suitable (similar to granite in character, i.e. hard), however there is also the potential for the ‘raw’ materials arising from excavation activities to not conform to standards in terms of structure (size and shape of particles) and will require further processing (for example: breaking or crushing) to render the material satisfactory in terms of reuse onsite for the construction of load baring Site tracks or hardstands.

Use of material which does not conform to relative appropriate standards in relation to quality or indeed structure where appropriate has the potential to give rise to ground stability issues. This is considered a potential significant, localised, negative, impact of the Development which is in contrast to baseline, however with the appropriate precautions and mitigation measures the risk associated with the use of sub-standard material can be significantly reduced.

8.4.4.1.7 Site Cable Trenches

The excavation of subsoils to facilitate underground power cables will be minimal considering that there is an existing established network of buried power cable connecting the infrastructure associated with the Operational Barnesmore Windfarm. None the less, considering the proposed layout of the Development, some excavation of cable trenches is considered likely to facilitate the connection of the Development to the existing power cable network.

The effects associated with the installation of underground cables are similar to that of other excavations, however less significant than that of excavations for foundations and hardstands. None the less, the effects are characterised similarly and will require similar mitigation measures.

It should be noted that the Operational Barnesmore Windfarm contains two existing significant lengths of buried cable which traverse the Site (**Technical Appendix 8.4: Mapped Impacts**). It is envisaged that these cable lengths may be used as is, that is; in situ, and will not require any alterations outside of the main footprint of the Development.

8.4.4.1.8 Grid Connection Cable

Considering the Operational Barnesmore Windfarm is already connected to the grid, there is no additional significant impact arising in terms of Grid Connection cabling, with the exception of the replacement of a portion of overhead power cable with underground cable, which will be run within Development footprint. The portion of overhead cable to be replaced is situated between the western Site boundary and the existing Site compound and is required to facilitate the erection of proposed turbines T10 and T12. The replacement buried cable will be situated within the footprint of the Site access track. Effects are characterised similarly to those related to other excavations; however, it should be noted that the area associated with the current overhead cable includes areas of deep peat which will be considered in the design phase of the decommissioning of overhead cable and the installation of buried cable, in relation to access in particular. The area and indicative cable route are mapped and presented in **Technical Appendix 8.4**.

8.4.4.1.9 Energy Storage Unit

The Development includes a new Temporary Construction Compound that will be established for the purpose facilitating temporary storage of equipment and materials. After the construction phase is complete the same compound will be used for the permanent housing of an array of Energy Storage Units (**Figure 1.2**). The collective Energy Storage Unit will be established adjacent to the Substation and associated with the Operational Barnesmore Windfarm and can be considered an extension of same.

The effects arising from establishing the Energy Storage Unit are similar to those related to the establishment hard standing areas, and excavations if required. Note: There will be a need to redirect drainage features to facilitate the construction of the Energy Storage Unit. Therefore, excavation is considered a requirement, however redirecting of drainage is addressed in **Chapter 9: Hydrology and Hydrogeology.**

8.4.4.1.10 Temporary Decommissioning and Temporary Construction Compound

There is currently an operational compound associated with the Operational Barnesmore Windfarm. As discussed in **Section 8.4.4.1.9**, the Energy Storage Unit will be used as the Temporary Construction Compound during the construction phase of the Development. There are no additional temporary compounds envisaged as part of the Development. The temporary storage of equipment of materials will be limited to the aforementioned compounds, turbine hardstands and portions of access track which are made redundant following the decommissioning of the Operational Barnesmore Windfarm.

8.4.4.1.11 Cut and Fill

As stated in the preceding sections, cut and fill operations will be required for some aspects of the Development, in particular establishing hardstand areas and Site tracks widening in places.

Hardstand areas when established will be relatively level (flat). To achieve this, considering the area of the proposed hardstands and the variable topography of the Site, a relatively significant amount of cut and fill will be required. The extent of cut and fill required is mapped and presented in **Technical Appendix 8.4**.

Cut and fill activities will generate spoil (subsoils and bedrock), which will be temporarily stockpiled on the Site before being reused as backfill, deposited elsewhere on the Site with a view to restoration, or removed offsite and reused or disposed of appropriately. Effects of stockpiling are discussed in the following sections of this chapter.

8.4.4.1.12 Volumes of Material to be Excavated

The amounts of different types of material to be excavated, including peat, subsoils and bedrock to be removed will depend on the results of bedrock geotechnical testing that has not been carried out as part of this EIA however, Development Specific Site Investigations are envisaged, including borehole drilling and related geotechnical testing.

Indicative total volumes, allowing for turbine foundations (13 no. 25 m diameter and 2.5 m depth – c. 16,000 m^3) and 1 m average depth for cut and fill for hardstand areas (13 no. 1 m depth, 30 m width, and 70m length – c. 27,000m^3) equates to approximately 43,000 m^3 of material which will need to be excavated. However, much of the total volume of material excavated will be reused onsite as fill material. More accurate volume estimates are listed in **Table 2.3** of this EIAR. **Table 2.3** indicates that the total volume of material to be excavated and managed equites to c. 39,032 m^3.

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

8.4.4.1.13 Summary of Effects of Subsoil and Bedrock Removal

The Development will require the excavation and removal of subsoils (including peat, and glacial till) and bedrock, and the importation and deposition of engineering materials to facilitate the construction of proposed infrastructure including; turbine foundations, turbine hardstand areas, compound area hardstands, Energy Storage Unit, upgrading of existing and/or construction of new Site tracks and upgrading and/or construction of new drainage and ducting infrastructure features.

The removal of peat, glacial till, and bedrock, and the land take required for turbine foundations and associated hardstand is a likely, direct, negative, localised impact of the Development, with **moderate** significance at a localised scale, and with **Slight** weighted significance at the scale of the Site (or Barnesmore NHA) as a whole.

The Site has already been impacted by peat harvesting and the development of the Operational Barnesmore Windfarm, and therefore the impact of removal of subsoils and bedrock conforms to established baseline conditions.

Due to the nature of the works involved, for example; the excavation of soils and bedrock for the establishment of turbine foundations, the impacts are considered permanent, however establishment of tracks and hardstands are reversible in theory, that is; established windfarm infrastructure can be decommissioned and the Site restored (removal of fill materials and reinstatement of natural materials), however the benefit of such restoration activities versus the potential impact of the restoration activity itself would likely need to be assessed on a case by case basis, hence the impact is reversible in theory. This is discussed in greater detail in the following sections of this chapter.

Table 8.11: Impact Summary – Subsoil and Bedrock Removal

Impact Description	Type	Quality	Significance	Weighted Significance	Extent	Context	Probability	Duration / Frequency
Land Take	Direct	Negative	Moderate	Slight	Localised	Conforms to baseline	Likely	Permanent
Subsoil and bedrock removal	Direct	Negative	Moderate	n/a	Localised	Conforms to baseline	Likely	Permanent

8.4.4.2 Storage and Stockpiles

8.4.4.2.1 Overview

Of significance during the initial decommissioning and construction phase of the Development are the excavated materials handling, storage and reuse. There is potential for direct and indirect negative impacts on ground stability and water quality. However, such impacts are considered temporary and reversible. For example, slope failure due to excessive loading (surcharge) and the release of peat washings and suspended solids to the surface water system (potentially transboundary, discussed in **Chapter 9: Hydrology & Hydrogeology**).

8.4.4.2.2 Spoil Management

Excavated materials will require temporary stockpiling during construction of the Development. Furthermore, any imported material will likely require temporary stockpiling.

In the context of soils and geology, the stockpiling of material has the potential to impact on ground stability by increasing the loading in terms of bulk unit weight for the area the stockpile covers, particularly when dealing with peat. Increased loading will lead to increased potential for mass movement of peat, particularly in areas where relatively steep inclines exist or where peat is deep.

The storage of stockpiles, with no other associated subsequent effect, is in itself an impact of the Development, characterised as follows; a direct, negative, slight significance, localised impact.

There are no stockpiles of material onsite currently, however temporary stockpiling has occurred at some locations on the Site in relation to Site track repair during the operational phase of the Operational Barnesmore Windfarm, furthermore stockpiling would have been required for the construction of the Operational Barnesmore Windfarm. Therefore, temporary stockpiling is considered to conform to baseline, however permanent stockpiling is considered to be in contrast to baseline. Temporary stockpiling is considered a temporary and reversible impact of the Development.

The potential worst-case impact of stockpiling materials is slope failure, however the risk of mass movement or landsides occurring on the Site is negligible to low. There remains a risk for stability issues to arise at a localised scale.

With appropriate mitigation measures the potential for serious or worst-case impacts arising due to stockpiling can be significantly reduced.

8.4.4.2.3 Summary of Effects of Storage and Stockpiles

The management and storage (stockpiling) of materials onsite has the potential to give rise to the following effects.

Table 8.12: Impact Summary – Storage of Stockpiles

Impact Description	Type	Quality	Significance	Weighted Significance	Extent	Context	Probability	Duration / Frequency
Storage of stockpiles (general)	Direct	Negative	Slight	n/a	Localised	Conforms to baseline	Likely	Temporary
Slope failure arsing from stockpiling (worst case)	Indirect / Secondary	Negative	Signifcant	Significant / Moderate	Localised / Potentially transboundary	Contrast to baseline	**Unlikley**	Perminant

8.4.4.3 Vehicular Movement

8.4.4.3.1 Overview

During the construction phase of the Development, vehicles will be required to progress the Development and construct infrastructure in areas adjacent to, or outside the footprint of the existing Site tracks and hardstands associated with the Operational Barnesmore Windfarm within blanket peatland and cut over peat areas.

Observations during peat surveys indicate that the general peat profile across the Site consists of; a thin (c. 10cm) acrotelm layer, underlain by peat which is highly humified (Von Post Scale – H6 to H10 recorded), has low fibre content, and relatively high moisture content with a corresponding low shear strength value.

Vehicular movement on established tracks and hardstands associated with the Operational Barnesmore Windfarm is not likely to give rise to adverse effects considering there is no evidence of stability issues arising as a product of the construction, and operation of the Operational Barnesmore Windfarm. However, this should be assessed in terms of delivery of the proposed turbine materials and equipment, that is; the increased size in the proposed turbine compared to the existing wind turbines in place indicates that the vehicles required for transport of materials will be of significant size and weight.

The potential impacts and effects of vehicular movement activities are described in the following sections.

8.4.4.3.2 Compaction, erosion and degradation

Trafficking over peat has the potential to compact the peat, including the acrotelm. Compaction of peat can lead to changes in the hydrological characteristics of the peat, including exposing non-vegetated peat to surface water runoff leading to peat solids being entrained in same which has the potential to be intercepted by the Site drainage infrastructure and in turn the surface water network associated with the Site.

Compaction and shear forces put upon the acrotelm may damage and reduce the productive capacity of the bog in the area impacted. Furthermore, considering quality and low shear strength of the peat across the Site, the potential for compaction and erosion of peat is high.

Degradation of peat due to vehicular movement is considered a potential impact characterised as follows; a direct, negative, moderate to significant, localised impact.

There are areas of the Site, in particular areas of cutaway peat, where damage caused by vehicular movement is evident, therefore this potential impact conforms to baseline (moderate impact) in those areas.

In contrast there is no evidence of damage due to vehicular movement in areas where peat cutting is not evident, therefore this potential impact contrasts to baseline (significant impact) in those areas.

Given time and depending on the severity of impacts, peat will naturally restore itself, but if the severity of the impact is significant it can be classified as potentially ranging from long term to permanent, but with restoration measures is also reversible.

8.4.4.3.3 Stability and slope failure

Vehicular movement on blanket bog has the potential to negatively influence peat and slope stability. As discussed in the Peat Stability Risk Assessment report presented in **Technical Appendix 8.3**, the risk of mass movement of peat or a landslide occurring is negligible to low, however considering the quality of the peat, stability issues from vehicular movements are likely at a localised level, that is; if vehicular movements occur on peat.

The potential impact of vehicular movement effecting peat and slope stability is characterised as follows; an indirect negative, significant, localised impact, with potential transboundary implications if surface water receptors are impacted.

There are no indications, or any history of slope stability issues on the Site currently and therefore this potential impact is in contrast to baseline conditions, however the establishment of hardstand areas and Site tracks associated with the Operational Barnesmore Windfarm has given rise to some incidents of soil creep and collapse along cut peat, subsoils and bedrock.

Given time, the bog will naturally restore itself, but depending on the severity of the impact it can be classified as ranging from long term to permanent, but with restoration measures is also theoretically reversible. However, the benefit of such restoration activities versus the potential impact of the restoration activity itself would likely need to be assessed on a case by case basis, hence the impact is reversible in theory.

The potential worst-case impact of vehicular movement is slope failure or landslide. Slope failure is discussed in the following sections of this report.

With appropriate mitigation measures the potential for serious or worst-case impact arising due to vehicular movements can be significantly reduced.

8.4.4.3.4 Haul Route and Site Tracks

Minor upgrading to the Haul Route and Site tracks is planned as part of the Development. This is to facilitate the relatively large transport and construction vehicles required for the construction phase of the Development. On newly established or enhanced Site tracks or considering the increased size of the vehicles associated with the proposed initial decommissioning and construction phase, there is the potential for subsidence or displacement of Site tracks to impact on the receiving environment.

Subsidence or displacement of earth materials by trafficking construction vehicles has the potential to impact similarly to that of the aforementioned effects described in relation to vehicular movement on peat, that is; compaction, erosion and degradation, stability issues and slope failure at a localised level, and at a more significant scale (landslide). As stated in **Section 8.4.4.1.5 Bedrock Geology**, the suitability of construction materials is an important consideration in terms of Site tracks, hardstands or trafficked areas in general.

In relation of the establishment of new Site tracks on peat, or enhancement of existing Site tracks on peat, a degree of subsidence or settlement is expected and normal (FCESNG, 2010).

8.4.4.3.5 Summary of Effects of Vehicular Movement (Site)

Vehicular movement onsite has the potential to give rise to the following effects:

Table 8.13: Impact Summary – Vehicular Movement (Site)

Impact Description	Type	Quality	Significance	Weighted Significance	Extent	Context	Probability	Duration / Frequency
Compaction, erosion and degradation of peat arising from vehicular movement	Direct	Negative	Moderate or Significant	n/a	Localised	Conforms to baseline Or Contrast to basline	Likely	Long term / permenant
Stability issues and slope failure arising from vehicular movement (Localised displacement)	Direct or Indirect / Secondary	Negative	Signifcant	n/a	Localised / Potentially transboundary	Contrast to baseline	Likley	Long term / permenant
Stability issues and slope failure arising from vehicular movement (Landslide – worst case)	Indirect / Secondary	Negative	Signifcant	Significant / Moderate	Localised / Potentially transboundary	Contrast to baseline	**Unlikley**	Permenant

8.4.4.3.6 Summary of Effects of Vehicular Movement (Haul Route and Site tracks)

Vehicular movement on Haul Route and Site tracks has the potential to give rise to the following effects.

Table 8.14: Impact Summary – Vehicular Movement (Haul Route and Site tracks)

Impact Description	Type	Quality	Significance	Weighted Significance	Extent	Context	Probability	Duration / Frequency
Subsidence and settlement of newly established and upgraded Site tracks	Direct	Neutral	n/a	n/a	Localised	Conforms to baseline. Normal	Likely	Permenant
Compaction, erosion and degradation araising from vehicular movement (Localised displacement)	Direct or Indirect /Secondary	Negative	Moderate	n/a	Localised	Contrast to basline	Likely	Long term / permenant
Stability issues and slope failure arising	Indirect / Secondary	Negative	Signifcant	Significant / Moderate	Localised / Potentially transboundary	Contrast to baseline	**Unlikley**	Permenant

Impact Description	Type	Quality	Significance	Weighted Significance	Extent	Context	Probability	Duration / Frequency
from vehicular movement (Landslide – worst case)								

8.4.4.4 Ground Stability

Construction developments on any area of peat land or bog have the potential to give rise to stability issues, and potentially mass movements or landsides (worst case).

Peat and slope stability assessments in relation to the Development (**Technical Appendix 8.3**) indicate that the risk of a mass movement or landslide is negligible to low, however the risk of peat stability issues arising at a localised scale is higher.

Due to the nature of peat, in particular the high moisture content and corresponding low shear strength, construction activities have the potential to give rise stability issues at a localised scale.

Construction activities related to the Development, as discussed in previous sections of this chapter, have the potential to give rise to stability issues at a localised scale leading to adverse impacts.

8.4.4.4.1 Summary of Effects of Ground Stability (the Site)

Ground stability onsite has the potential to be negatively impacted by the Development. The following is an indicative scale of potential adverse impacts:

Table 8.15: Impact Summary – Vehicular Movement

Impact Description	Type	Quality	Significance	Weighted Significance	Extent	Context	Probability	Duration / Frequency	Reversible
Localised stability issues arising during construction activites (Localised displacement)	Direct or Indirect / Secondary	Negative	Slight to Moderate	n/a	Localised	Conforms to baseline	Likely	Long term / Permanent	Yes
Stability issues and slope failure arsing during construction (Landslide – worst case)	Direct or Indirect / Secondary	Negative	Signifcant	Significant / Moderate	Localised / Potentially transboundary	Contrast to baseline	**Unlikley**	Permanent	No
Stability issues and slope failure arsing during operation (Landslide – worst case)	Indirect / Secondary	Negative	Signifcant	Significant / Moderate	Localised / Potentially transboundary	Contrast to baseline	**Unlikley**	Permanent	No

8.4.4.5 Soil Contamination

8.4.4.5.1 Overview

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

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

The Energy Storage Unit is also theoretically a potential source of contaminants however, the units are sealed and the potential for this source to lead to contamination will only occur under catastrophic failure conditions, therefore the likelihood is considered very low, in turn the risk is low.

8.4.4.5.2 Hydrocarbons

The Development has the potential to result in the accidental leakage of hydrocarbons into the soils and subsoils, and potentially into the hydrological network during the construction phase of the project. The plant equipment to be used during the construction stage are run on hydrocarbons. This implies that mobile equipment will require regular refuelling from a fuelling station, which is likely to be stored onsite OR will be supplied by a truck / tanker that will be scheduled to re-fuel the plant machinery directly. There is also the risk of hydrocarbon leakages from plant equipment. This poses the potential for spillage and leakage of hydrocarbons from plant equipment and associated transfer stations during the construction phase of this project.

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 absorb (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.

In terms of blanket bog and peat, the hydraulic characteristics of the upper layer (acrotelm) and the deeper more decomposed peat (catotelm) promotes the shallow distribution of both free phase (or non-aqueous phase liquids (NAPL)) or dissolved hydrocarbon plumes. In addition, as the adsorption of organic solutes or NAPLs on soils increases with organic carbon content of soils, and as peat has a high organic content, it can adsorb dissolved or NAPL hydrocarbons and retard their movement. The cumulative retardation, by both structural and chemical processes, determines the spatial distribution and temporal variation of hydrocarbon mass and concentration within a contaminated site, which results in limited movement through peatland, none the less there will be a degree of dispersion and migration of hydrocarbons, primarily driven by hydrological characteristics of the Site, resulting a plume of contamination. Note, the statements made here are based on the well-established knowledge of hydrocarbons and their interaction with mineral soils, while the similar interactions of hydrocarbons in peat are associated with knowledge gaps. As such, the remains the potential for variation particularly in relation to peat permeability which is influenced by porosity and the degree of fissuring etc. (Gharedaghloo, 2018).

The hazard posed by hydrocarbons contamination to soil is significant in terms of adversely impacting on the health of the bog and the flora and fauna it supports; however, the risk is considered limited considering the movement of same is limited. Hydrocarbons, given time, will break down and deteriorate through natural attenuation, however this process can take decades and is dependent on a variety of variables. In terms of the risk to peat on the Site, if volumes are significant free phase hydrocarbons will likely migrate relatively rapidly over the surface of or through the acrotelm. Considering the variable topography and extensive drainage network (natural and artificial) associated with the Site, interception of hydrocarbons by surface water features is likely, and in this sense is considered a transboundary impact (**Chapter 9: Hydrology and Hydrogeology**).

An accidental hydrocarbon spillage would have a significant, long term to permanent, negative impact on soil quality on the Site. However, this potential impact is considered to be localised, naturally reversible (natural attenuation over a relatively medium to long term period of time), or theoretically reversible (through remediation and restoration activities over a relatively short to medium term period of time).

With appropriate environmental engineering controls and measures (**Section 8.5**), the potential risk in relation to hydrocarbons can be significantly reduced. It should also be noted that the risk of hydrocarbon contamination arising due to the Development conforms to baseline due to the inherent risk associated with the Operational Barnesmore Windfarm, although the risk is generally lower during operational phase when compared to the construction phase of windfarm developments.

8.4.4.5.3 Wastewater Sanitation

The Development has the potential to result in the accidental leakage of wastewater or chemicals associated with wastewater sanitation onto soils / peat, and into the drainage network during the construction phase.

There are existing permanent and temporary sanitation facilities associated with the Operational Barnesmore Windfarm, which are located in the Operational Site compound. It is envisaged that this same compound and facilities will be used during the initial decommissioning and construction phase of the Development.

Wastewater sanitation chemicals are a pollutant risk due to their toxicity to all flora and fauna organisms. Wastewater and the natural constituents of same do not pose similar risk to soils and will naturally degrade over a relatively short period of time, however there are associated risks to human health.

The level of risk posed by such facilities is dependent on the condition and upkeep of facilities that are put in place, and the chemical agents used if applicable, and therefore can range from a potentially significant to insignificant impact in direct correlation to the type of sanitation used (e.g. septic tank versus portaloo).

In relation to the Development, the existing sanitation facilities will be used. Considering that these facilities are in good working order with no indication of any leaks observed, the risk of contamination is low, in addition the volume of chemicals used is minor relative to the scale of the Site, and will only be present in the contractors Temporary Construction Compound, the presence of which has already impacted on soils i.e. the removal of peat and/or the establishment of hardstands. None the less, correct precautions and mitigation measures should be implemented.

8.4.4.5.4 Construction Materials

The Development has the potential to result in the accidental spillage or deposition of construction waste onto/into peat soils. Depending on the material in question, the introduction of such materials can lead to a local change in geochemical properties which in turn can impact hydrochemistry and other associated sensitivities e.g. ecology. For example, the introduction of cementitious material (concrete / cement etc) can lead to changes in soil and water pH, and increased concentrations of sulphates and other constituents of concrete. Fresh or wet concrete is a much more significant hazard when compared to older or set concrete which is considered inert in comparison, however it should also be noted that any waste deposited in peat, even if inert, is considered contamination.

Accidental spillage or deposition of construction materials in soil is considered a direct, negative, moderate significance, Significant / Moderate weighted significance, localised and likely impact of the Development.

Considering that no similar contamination associated with Operational Barnesmore Windfarm site has been observed, this effect contrasts to baseline conditions however, the effect is presumed to have occurred to some degree during the construction of the Operational Barnesmore Windfarm, however the current status of the Site in this regard is good, i.e. no indication. In addition, the effect is considered permanent but reversible (depending on the scale of the incident, for example; a large (several tonnes) spillage is considered theoretically reversible.

8.4.4.5.5 General Waste

The Development has the potential to result in the accidental spillage or deposition of general waste onto/into peat soils. For example, packaging waste including plastics and paper can potentially be dispersed anthropogenically or accidentally by wind etc. Depending on the material in question, the introduction of such materials can lead to a local change in geochemical properties which in turn can impact hydrochemistry and other associated sensitivities e.g. ecology.

Accidental spillage or deposition of construction materials in soil is considered a direct, negative, moderate significance, Significant / Moderate weighted significance, localised and likely impact of the Development.

Considering that no similar contamination associated with Operational Barnesmore Windfarm site has been observed, with the exception of discrete/random pieces of waste particularly in relation to peat cutting areas (**Appendix 8.1**), this effect contrasts to baseline conditions. In addition, the effect is considered permanent but reversible (depending on the scale of the incident, for example; a large (several tonnes) spillage is considered theoretically reversible.

8.4.4.5.6 Summary of Effects of Soil Contamination

The Development has the potential to give rise to the following soil contamination effects:

Table 8.166: Impact Summary – Soil Contamination

Impact Description	Type	Quality	Significance	Weighted Significance	Extent	Context	Probability	Duration / Frequency
Hydrocarbon contamination	Direct	Negative	Significant	n/a	Localised*	Contrast to baseline	Likely	Long term / Permanent
Waste Water Sanitation contamination – Waste	Direct	Negative	Slight	n/a	Localised*	Contrast to baseline	**Unlikley**	Temporary
Waste Water Sanitation contamination – Chemicals	Direct	Negative	Significant	n/a	Localised*	Contrast to baseline	**Unlikley**	Long term / Permanent
Construction Material contamination	Direct	Negative	Moderate to Significant	n/a	Localised*	Conforms to baseline	Likely	Long term / Permanent
General Waste contamination	Direct	Negative	Slight to Moderate	n/a	Localised*	Conforms to baseline	Likely	Long term / Permanent

Note:
* Contamination of soils / peat by hydrocarbons is considered a localised impact, however if hydrocarbon contamination is intercepted by surface water features the impact is potentially transboundary (**Chapter 9: Hydrology and Hydrogeology**)

8.4.5 Reinstatement of Redundant Access Track and Hardstand Areas

Portions of access tracks and hardstand areas associated with the Operational Barnesmore Windfarm which will become redundant following the construction of the proposed Development will be reinstated (**Figure 1.2**). This implies;

- Removal of some / top layer of existing hardstand / access track. The underlying Soil / Peat will not be exposed.
- Depositing of acrotelm / vegetated peat over the areas in question. Catotelm peat will not be used as such would be prone to being eroded rapidly.

Reinstatement will not include the total excavation of all hardstand and access track materials, or turbine foundations, that is; the areas of the Operational Barnesmore Windfarm which are made redundant following the construction of proposed Development will not be fully restored to original (pre-existing) baseline conditions. Further details in **Section 8.5.3.3.**

No new impacts are anticipated to arise during the reinstatement phase of the project on the geological, geomorphological and geotechnical environment, however the potential for solids being entrained by surface water runoff is relatively elevated.

Any impacts to the geological, geomorphological and geotechnical environment during reinstatement are likely to be minimal and infrequent, however the mitigation measures and precautions described in this report will be implemented as applicable.

Reinstatement of redundant infrastructure areas following the Development construction phase is considered a positive, or beneficial impact of the development (**Section 8.2.5.2 - Table 8.4**). Although reinstatement will not revert areas in question to pre-existing baseline conditions, it will serve as the foundation and promote the establishment of new blanket bog (landscape character) and associated ecology and biodiversity. For further information, refer to **Chapter 6: Biodiversity** of this EIAR.

Full restoration, which implies the complete removal of hardstand, access track and turbine foundations, will not be carried out as part of the Construction phase of the Development due to the potential for significant adverse impacts arising from same. Further details in **Section 8.5.4**.

8.4.6 Operational Phase

No new impacts are anticipated to arise during the operational phase of the project on the geological, geomorphological and geotechnical environment.

Any impacts to the geological, geomorphological and geotechnical environment during the operational phase are likely to be minimal and infrequent, however the mitigation measures and precautions described in this report will be implemented as applicable.

8.5 Mitigation Measures and Residual Effects

The Development has associated potential impacts as described in the previous sections of this chapter. The following sections describe mitigation measures to be implemented during the design, decommissioning and construction, and operational phases of the Development. Potential residual effects after mitigation measures are implemented are also described.

Mitigation measures will be prescribed in combination where applicable to achieve the principals of the mitigation measures in general, that is; to reduce the potential impacts of the Development entirely where possible, or as far as possible thereafter. Therefore, the prescription and implementation of mitigation measures will be done with a view to achieving the aims of same, and will not be applied as a 'tick box' exercise where by measures are implemented but are in isolations and are inefficient in achieving the aims of the measures, that is; protecting the receiving environment.

8.5.1 Design Phase

A process of "mitigation by avoidance" was undertaken during the design of the Development. A constraints map was produced using the findings of the initial desk study and Site surveys that identified areas where geotechnical constraints could make parts of the Site less suitable for development. The constraints map is presented in **Technical Appendix 8.4**.

Minerex, in consultation with the design team has reviewed the layout plan and has identified it as the best layout design available for protecting the Site's existing geotechnical (and hydrological) regime, while at the same time incorporating and overlaying engineering and other environmental constraints as detailed in this EIAR.

In addition, an important part of the "mitigation by avoidance" procedure was to limit the footprint of the Development to the existing infrastructure associated with the Development in so far as practical, that is; utilise existing infrastructure as far as practical.

8.5.2 Initial Decommissioning and Construction Phase

8.5.2.1 Subsoil and Bedrock Removal

8.5.2.1.1 Mitigation by Avoidance

The removal of peat and mineral subsoil / bedrock is an unavoidable impact of the Development 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 Site. This is done initially through a process of "mitigation by avoidance" whereby the proposed turbines and infrastructure layout has been 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. The aim of which is to minimise the volumes of subsoils to be removed either directly by excavation (turbine foundations) or as a function of cut and fill requirements (hardstands).

8.5.2.1.2 Mitigation by Good Practices

Excavation of peat in areas where there is >1.0m in peat depth should follow appropriate engineering controls such as the drainage of the peat along the proposed Site tracks 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 should be positioned at an oblique angle to slope contours to ensure ground stability. Drains should never be positioned parallel to slope contours. This drainage must be attenuated prior to outfall (**Chapter 9: Hydrology and Hydrogeology**).

In those parts of the Site where excavation may intercept areas of peat that are >1.0m 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 decommissioning and 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 (>2.0 m depth e.g. T4, T5 and T11). Therefore, for excavation in areas of deeper peat (e.g. T4, T5 and T11) it is recommended that excavation supports are incorporated into the Site Specific CEMP for the Development, for example; temporary sheet piling, or similar. This will minimise the effect of excavation to the minimum required.

Adopting good practices, planning ahead and real time monitoring in more sensitive (>1m peat depth) areas will ensure that any excavations associated with the 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.

8.5.2.1.3 Mitigation by Reduction

Apart from the measures taken in the design phase of the 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 Development minimises the impact of subsoil and bedrock removal in so far as practical, without compromising or reducing the Development itself.

8.5.2.1.4 Mitigation by Reuse

Subsoil and bedrock which are excavated as part of the initial decommissioning and construction phase will be reused onsite wherever possible.

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.

Geotechnical testing on the rock arising from excavation/construction activities 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 Windfarm 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)

As per **Section 8.4.4.1.12** of this Chapter, peat material (**Table 2.3** - c. 39,032 m^3) excavated will be reused as backfill in areas previously excavated as much as possible, and/or for reinstatement works (**Table 2.4** - c. 5,884 m^3) elsewhere on the Site. 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).

8.5.2.1.5 Mitigation by Remediation

The mitigation measures listed above, namely backfilling with peat, 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 Site, including areas already impacted by peat cutting activities, eroded or degraded areas, and any other areas impacted by the Development which will not strictly require excavation activities, for example proposed enhancements of the Site tracks.

Mitigation measures outlined here will ensure the impacts arising from excavation activities are minimised to the footprint of the Development, and improve some other degraded areas of the Site, thus offsetting the required adverse impacts of the Development. Locations on the Site with capacity for depositing material, or the potential for restoration are presented in **Technical Appendix 8.4**.

8.5.2.2 Storage and Stockpiles

8.5.2.2.1 Mitigation by Avoidance and Good Practice

As discussed in previous sections, excavation of materials 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.

No permanent stockpiles will remain on the Site. All excavated materials from the Site or introduced materials for construction must be either used or removed from the Site.

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 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 **Chapter 9: Hydrology and Hydrogeology**, stockpiling of material will invariably lead to the entrainment of solids on surface water runoff. Mitigation measures to address same are detailed in said Chapter, however it is recommended that the Site Specific 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.

8.5.2.2.2 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, 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 Site Specific CEMP, will be established 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.

8.5.2.3 Vehicular Movements

8.5.2.3.1 Mitigation by Avoidance and Good Practice

Vehicular movements will be restricted to the footprint of the Development. Furthermore, vehicular movements will be restricted to existing hardstands associated with the Operational Barnesmore Windfarm wherever and whenever possible. Machinery will be kept on established hardstands wherever possible, and no vehicles will be permitted outside of the footprint of the Development, including when advancing excavations beyond existing hardstands, and will not move onto land that is not proposed for the Development if it can be avoided.

Adhering to the mitigation measures set herewith 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 Development will in effect reverse any impact by vehicular movement within the footprint of the Development.

Mitigation measures will be specified in the Site Specific Construction Environmental Management Plan.

8.5.2.4 Ground Stability

8.5.2.4.1 Mitigation by Avoidance and Good Practice

Peat stability investigations at the Site (**Technical Appendix 8.3**) indicate that the Site has a negligible to low risk probability with respect to slope failure. The investigation includes some key limiting factors and assumptions which should be noted;

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

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

Temporary stockpiles will be limited to one m height and removed for reuse/remediation purposes or disposed offsite as soon as possible. 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 principal, the following procedures will be adopted as best practice mitigation measures at the Site.

- All Site excavations and construction will be supervised by a geotechnical engineer/engineering geologist.
- The contractor's methodology statement (Decommissioning and Construction Environmental Management Plan) will be reviewed and approved by a suitably qualified geotechnical engineer/engineering geologist prior to Site operations.
- Particular attention and pre-construction assessment and mitigation planning should be given to any new infrastructure, for example; the proposed Site tracks, culverted watercourse crossing and hardstand associated with T13 (**Technical Appendix 8.4**)
- 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 Development it is recommended that excavation in peat of >1 m depth be supported by a restraining / support wall during the construction phase.
- All turbine foundations located within the footprint of existing infrastructure will be assessed on a case by case basis, that is; it is recommended that trial pits are carried out and supervised by a suitably qualified geo-scientist at each and any proposed turbine location which is located within the footprint of the existing infrastructure (Note: some may be in very shallow peat or bedrock, thus reducing the mitigation requirements set here).
- In such excavations, pore water pressure will be kept low at all times and careful attention will be given to the existing drainage and how structures might affect it. In particular, ponding of water should not be allowed to occur in recent excavations, particularly in any areas encountered where peat is >1 m. All deliberate or incidental sumps must be drained to carry water away from the sump following rainfall. Otherwise, this water will increase hydraulic heads locally, increase pore water pressure and can potentially lead to instability.
- 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 Site with minimal risk of bog failure as identified by Site investigations can be positioned at a more acute angle to the slope contour in order to reduce the velocity of surface water drainage. It should be noted that for areas with extensive deeper peat (e.g. T4 and T11), draining the excavation area ahead of works will likely be difficult considering the topography of the areas in question (low lying), therefore it is recommended that alternatives are considered and incorporated into the CEMP. For example; sheet piling and advanced dewatering.
- Due to peat's fluid-like properties, all peat excavated will be immediately removed from sloping areas. If peat is required for reinstatement, then acrotelm peat will be stripped off the surface of the bog and placed carefully at the margins of the Development along the Site track and hardstand margins that are characterised by near-horizontal slopes (<6°).
- From recorded evidence (landslides in Donegal i.e. the region) and historic occurrences, it is recommended that construction activities 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 years average data, and in reality 30 year max rainfall events are observed to be significant throughout the year over the 30 year period (**Section 9.3.4 – 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 not be limited to any particular annual period, but will be driven by current metrological 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 initial decommissioning and 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 >25mm/hr), planned responses will be undertaken. These responses will include, inter alia; 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.

Mitigation measures will be specified in the Site Specific CEMP.

8.5.2.4.2 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 Development. This will be achieved by means of appropriate planning and logistical considerations forming part of the Site Specific CEMP, similar to the measures set out in relation to the management of spoil on the Site.

8.5.2.4.3 Mitigation by Remediation

There are no indications of significant issues on the Site in terms of ground stability, and therefore mitigation by remediation is not envisaged. In the unlikely event that a peat or slope stability issue does arise on the Site during the initial decommissioning and 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.

8.5.2.4.4 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 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 Site Specific CEMP before construction works initiate. The following is a non-exhaustive list of potential emergencies and respective emergency responses;

- 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.

Emergency responses will be specified in the Site Specific CEMP.

8.5.2.5 Soil Contamination

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 however, additional detail is provided in the following sections to facilitate linking good practices to the site specific sensitivities of the Development, and to steer the development of the Site Specific CEMP.

8.5.2.5.1 Mitigation by Avoidance

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. Given that any such 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 potentially transboundary effect of contaminates, mitigation measures for contaminants are presented in detail in the Hydrology and Hydrogeology chapter of this EIAR.

As discussed in previous sections of this report, construction activities associated with the Development will be restricted to the footprint of the Development, therefore the potential for contaminants reaching soils is limited to the footprint of the Development.

8.5.2.5.2 Mitigation by Reduction

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

- Excess packaging and other materials will be discarded appropriately at the Temporary Construction Compound before advancing to the destined construction area.
- Any vehicles coming onto the Site will be required to be inspected and cleaned before leaving the original depot, and at the Temporary Construction Compound before advancing to the destined construction area.

8.5.2.5.3 Mitigation by Remediation

Mitigation by remediation 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 (including existing contaminants associated with the Barnesmore Windfarm).

Ongoing remediation measures will be specified in the Site Specific CEMP.

8.5.2.5.4 Emergency Response

Mitigations measures as outlined in the previous sections will reduce the potential for soil contamination during the construction phase of the 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. The following is a non-exhaustive list of potential emergencies and respective emergency responses;

- 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.
- Other construction and general waste – Wastes which are dispersed by construction activities or by natural causes such as wind will be collected and dealt with immediately.

Emergency responses, including methodologies, will be specified in the Site Specific CEMP.

In the event of a significant contamination or polluting incident the relevant authorities will be informed.

8.5.2.6 Material and Waste Management

This section potentially reiterates some points from the previous sections, however it is worthwhile to consolidate and expand on issues relating to Material and Waste Management.

All excavated earth materials must either be re-used in an environmentally appropriate and safe manner e.g. landscaping and bog restoration OR removed from the Site at the end of the construction phase.

Any surplus of natural materials (e.g. peat) to be used as backfill or deposited elsewhere in the Site will not be deposited to above existing ground level for the area in question. This implies 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 Development, or associated restoration activities.

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

Any accidental spillage of solid state introduced materials will be removed from the Site.

A construction phase environmental management plan will be in operation to check equipment, materials storage and transfer areas, drainage structures and their attenuation ability (covered in greater detail in Chapter 09 Hydrology of this report) on a regular 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 revered as 'live' documents, this implies that lessons learned and improvements will be made over course of the Development.

Management of waste arising from the construction phase of the Development will require classification, appropriate transfer, and appropriate disposal. Waste streams will vary and will include the following potential categories;

- Inert Soils & Stones (EWC Code: 17 05 04) – rock is likely to be Inert.
- Non-Hazardous Soils & Stones (EWC Code: 17 05 04) – Peat is likely non-hazardous according to WAC limits due to high Total Organic Carbon concentrations, however peat is a valuable resource and its reuse onsite should be prioritised and facilitated in so far as practical.
- Hazardous Soils & Stones (EWC Code: 17 05 03*) – Soils 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 is recommended.

Materials and waste management practices will be specified and detailed in the Site Specific CEMP.

8.5.2.7 Initial Decommissioning and Construction Phase Residual Impacts

The unavoidable residual impact on the soils and geology environment following the initial decommissioning and construction phase of the Development is that there will be a change in ground conditions at the 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 significance at a local scale, **Imperceptible** weighted significance at the scale of the Site, direct permanent change to the materials composition at the Site, however it should be noted that this conforms to baseline.

Potential impacts which are considered **unlikely** in the effect assessment section of this chapter, for example; slope stability issues or landslide, are not considered here.

Other impacts have the potential to arise as part of the Development, during the construction phase in particular. However, such potential impacts can be mitigated against, and in the best-case scenario can be avoided in terms of impacting on the receiving environment. These potential impacts range in significance from slight to significant.

If the mitigation measures outlined for the geological and geotechnical aspects of the Site are implemented as described in this chapter, the Outline CEMP and specified in the Site Specific CEMP, the resultant predicted impacts of the Development are updated as follows:

Table 8.17: Residual Impact Summary

Impact Description	Type	Quality	Significance	Weighted Significance	Extent	Context	Probability	Duration / Frequency
Land Take	Direct	Negative	Moderate	Slight	Localised	Conforms to baseline	Unavoidable	Permanent
Subsoil and bedrock removal	Direct	Negative	Moderate	n/a	Localised	Conforms to baseline	Unavoidable	Permanent
Storage of stockpiles (general)	Direct	Negative	Slight	n/a	Localised	Conforms to baseline	Likely	Temporary
Compaction, erosion and degradation of peat arising from vehicular movement	Direct	Negative	Moderate Or Significant	n/a	Localised	Conforms to baseline Or Contrast to basline	Avoidable	Long term / permenant
Stability issues and slope failure arising from vehicular movement (Localised displacement)	Direct or Indirect / Seconda ry	Negative	Signifcant	n/a	Localised / Potentially transboun dary	Contrast to baseline	Avoidable	Long term / permenant
Subsidence and settlement of newly established and enhanced Site tracks	Direct	Neutral	n/a	n/a	Localised	Conforms to baseline. Normal	Likely	Permenant
Comapction, erosion and degradation araising from vehicular movement (Localised displacement)	Direct or Indirect /Second ary	Negative	Moderate	n/a	Localised	Contrast to basline	Avoidable	Long term / permenant
Localised stability issues arising during construction activites (Localised displacement)	Direct or Indirect / Seconda ry	Negative	Slight to Moderate	n/a	Localised	Conforms to baseline	Avoidable	Long term / Permanent
Hydrocarbon contamination	Direct	Negative	Significant	n/a	Localised*	Contrast to baseline	Avoidable	Long term / Permanent
Construction Material contamination	Direct	Negative	Moderate to Significant	n/a	Localised*	Conforms to baseline	Avoidable	Long term / Permanent
General Waste contamination	Direct	Negative	Slight to Moderate	n/a	Localised*	Conforms to baseline	Avoidable	Long term / Permanent

Note:
* Contamination of soils / peat by hydrocarbons is considered a localised impact, however if hydrocarbon contamination is intercepted by surface water ffeatures the impact is potentially transboundary (**Chapter 9 – Hydrology and Hydrogeology**)

8.5.2.8 Operational Phase

No new impacts are anticipated during the operational phase of the Development on the geological, geomorphological and geotechnical environment therefore no additional mitigation measures are required.

Maintenance and monitoring during the operational phase of the Development pose 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 principal/s of mitigation measures described in this EIAR chapter will be adopted and implemented by means of an Operational Phase Management Plan – it should be noted that similar measures are currently being implemented at the Operational Barnesmore Windfarm.

8.5.2.9 Operational Phase Residual Impacts

On the basis that an Operational Phase Management Plan will be established, and implemented during the operational phase of the Development, potential issues arising giving cause to residual impacts are likely to be infrequent, imperceptible to slight, localised and reversible.

8.5.3 Development Decommissioning and Restoration Phase/s

8.5.3.1 Decommissioning of Infrastructure

As discussed in **Section 8.1**, no new impacts are anticipated during the decommissioning phase of the project (removal of turbines and similar infrastructure, similar to the initial decommissioning of the Operational Barnesmore Windfarm) on the geological, geomorphological and geotechnical environment therefore no additional 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.

Excavation of material is not anticipated, similarly vehicular movement on peat is not anticipated 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 principal/s of mitigation measures described in this EIAR chapter will be adopted and implemented by means of a Decommissioning Phase Management Plan (DPMP).

8.5.3.2 Decommissioning Phase Residual Impacts

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 permeant effects of the Development, that is; there will remain a change in ground conditions at the 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 significance, Significant / Moderate weighted significance, direct permanent change to the materials composition at the Site, however it should be noted that this conforms to baseline.

8.5.3.3 Reinstatement of Redundant Access Track and Hardstand Areas

No new impacts are anticipated during the reinstatement phase of the Development on the geological, geomorphological and geotechnical environment therefore no additional mitigation measures are required.

Activities during the reinstatement phase of the Development pose similar hazards and risks associated with the construction phase but to a lesser extent, for example; the potential for fuel spills from vehicles, therefore the principal/s of mitigation measures described in this EIAR chapter will be adopted, specified in the Site Specific CEMP and implemented. However, reinstatement of redundant access track and hardstand areas pose unique circumstances in terms of susceptibility soil creep, erosion and entrainment of solids in surface water runoff in comparison to other earthworks associated with the Development, particularly where slope inclines are present, therefore particular attention and planning is required in terms of;

- The preparation of the hardstand surface prior to material being deposited. Due to the quality of peat (highly humified) the potential for soil creep on smooth inclined surfaces is elevated. It is recommended that the hardstand surface is modified prior to material being deposited, for example; forming ‘riffles’ in the subgrade material by excavator, or the use of ‘geocells’. Severe inclines will be avoided in terms of reinstatement.

- The potential for entrainment of solids in surface water runoff will be elevated, therefore mitigation measures will need to be tailored to suit each reinstatement area. Discussed further in **Chapter 9: Hydrology and Hydrogeology**.

The methodologies adopted will be specified in the Site Specific CEMP.

For further information on the envisaged methodology with respect to reinstatement of areas if the Site, in particular regard to the associated sensitivities and habitat management objectives, refer to **Chapter 6: Biodiversity** and **Barnesmore Windfarm Repowering HMP**.

Monitoring and maintenance of the reinstated areas will be carried out at a regular frequency during the initial stages of establishment. This will ensure that the occurrence of excessive surface water runoff eroding deposited material along preferential pathways is minimised.

8.5.3.4 Reinstatement Phase Residual Impacts

Effective reinstatement of redundant areas will lead to beneficial impacts, and passive continuous improvements in the areas in question where by will recover and with time become similar in composition to the surroundings of respective areas. This is considered a positive, localised, permanent impact of the Development.

For further information, refer to **Chapter 6: Biodiversity.**

8.5.4 Decommissioning and Restoration Phase – Physical Infrastructure

Restoration of the Site following decommissioning of the proposed infrastructure is in its own right a phase of the 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).

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 Development is evaluated closer to the time.

8.5.5 Cumulative Effects

Considering the discipline under investigation, soils and geology, and the fact that potential effects of the Development on same are generally localised, the cumulative effects of the Development are not considered to vary dramatically or behave synergistically when considering the Site as a unit, or indeed when considering in conjunction with other developments in the vicinity or down-gradient of the Site.

8.6 Summary of Significant Effects

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

Other potential impacts are considered to range in significance from slight to significant, and can potentially be long term to permanent, however if mitigation measures are applied and proper precautions and planning are executed effectively, the risk of such potential impacts can be significantly reduced, or are considered avoidable.

No new impacts are anticipated during the operational phase of the Development. Similar hazards are identified when comparing the construction and operational phases of the 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.

8.7 References

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