11 GEOLOGY, SOILS AND PEAT

11.1 Introduction

This Chapter of the Environmental Impact Assessment (EIA Report) evaluates the effects of Ladyfield Renewable Energy Park (the Development) on Geology, Soils and Peat in the local environment and provides a preliminary geological assessment on the existing ground conditions while considering peat instability and management. This assessment was undertaken by ERM.

This geological assessment identifies areas of geological interest and features of note. The information and data collated from the peat and geological assessments have informed the site layout to minimise the potential impacts on peat and geology as a result of the Development.

This Chapter of the EIA Report includes the following elements:

- Legislation, Policy and Guidance;
- Assessment Methodology and Significance Criteria;
- Baseline Conditions;
- Assessment of Potential Effects;
- Cumulative Effect Assessment;
- Mitigation and Residual Effects;
- Summary of Effects; and
- Statement of Significance.

This Chapter of the EIA Report is supported by the following figures provided in Volume 2a:

- Figure 11.1: Superficial Soils
- Figure 11.2: Bedrock Geology;
- Figure 11.3: National Soils Map of Scotland;
- Figure 11.4: Extract from Carbon and Peatland Mapping (SNH, 2016); and
- Figure 11.5: Interpolated Peat Depths

This Chapter is supported by the following Technical Appendix documents provided in Volume 3: EIA Report Technical Appendices:

- A11.1: Peat Slide & Risk Assessment (PSRA);
- A11.2: Outline Peat Management Plan (oPMP);
- A11.3: Preliminary Borrow Pit Assessment (BPA); and
- A11.4: Outline Construction Environmental Management Plan (oCEMP).

The following terms are used within this Chapter to describe the Development and various associated study areas:

- The Development: the whole physical process involved in the development of Ladyfield Renewable Energy Park, including wind farm construction, operation and decommissioning (i.e., not a piece of land or an area); and
- The Study Area: the entire area within the redline boundary.

11.2 Legislation, Policy And Guidance

Consideration was given to the National Planning Framework 4 (NPF4)[328] and sets out the Scottish Government's policy on how nationally important land use planning matters should be addressed. Policy 5 within this document details the approach to Soils, and includes some of the following key points relating to developments on peatlands:

"*Development proposals on peatland, carbon rich soils and priority peatland habitat will only be supported for:*

[328] The Scottish Government (2023) National Planning Framework 4 [Online] Available at: National Planning Framework 4 (www.gov.scot) (Accessed 02.10.23)

- *Essential infrastructure and there is a specific locational need and no other suitable site;*
- *The generation of energy from renewable sources that optimises the contribution of the area to greenhouse gas emissions reductions targets;*
- *Small-scale development directly linked to a rural business, farm or croft;*
- *Supporting a fragile community in a rural or island area; or*
- *Restoration of peatland habitats.*

Where development on peatland, carbon-rich soils or priority peatland habitat is proposed, a detailed site specific assessment will be required to identify:

- *the baseline depth, habitat condition, quality and stability of carbon rich soils;*
- *the likely effects of the development on peatland, including on soil disturbance; and*
- *the likely net effects of the development on climate emissions and loss of carbon.*
- *This assessment should inform careful project design and ensure, in accordance with relevant guidance and the mitigation hierarchy, that adverse impacts are first avoided and then minimised through best practice. A peat management plan will be required to demonstrate that this approach has been followed, alongside other appropriate plans required for restoring and/ or enhancing the site into a functioning peatland system capable of achieving carbon sequestration."*

In addition to the NPF4, guidance of relevance to this Chapter includes:

- NatureScot (formally Scottish Natural Heritage (SNH[329]) (2019)) 4th Edition, Good Practice During Wind Farm Construction[330];
- The Scottish Government (2017), Peat Landslide Hazard and Risk Assessments – Best Practice Guide for Proposed Electricity Generation Developments[331];
- Scottish Government, SNH, SEPA (2017) Peatland. Guidance on Development on Peatland, on-line-version-only[332];
- The Scottish Government (2009), The Scottish Soil Framework[333];
- The Construction Industry Research and Information Association (CIRIA) (2015), Environmental Good Practice on Site (C741)[334]; and
- Planning Advice Note PAN 50 Controlling the Environmental Effects of Surface Mineral Workings[335].

11.3 Assessment Methodology And Significance Criteria

11.3.1 Scoping Responses and Consultations

Consultation for this EIA Report topic was undertaken with the organisations shown in Table 11.1.

[329] Scottish Natural Heritage (SNH) rebranded in August 2022 as NatureScot. Where relevant reference is still made to SNH within this chapter in respect of guidance which remains valid and is yet to be republished etc.
[330] SNH (2019) Good practice during windfarm construction, 4th Edition [Online] Available at: https://www.nature.scot/guidance-good-practice-during-wind-farm-construction (Accessed 02.10.23)
[331] The Scottish Government (2017) Peat Landslide Hazard and Risk Assessments - Best Practice Guide for Proposed Electricity Generation Developments Guidance [Online] Available at: http://www.gov.scot/Resource/0051/00517176.pdf (Accessed 02.10.23)
[332] Scottish Government, Scottish Natural Heritage, SEPA (2017) Peatland Survey. Guidance on Developments on Peatland, on-line version only Available at: Guidance+on+developments+on+peatland+-+peatland+survey+-+2017.pdf (www.gov.scot) (Accessed 02.10.23)
[333] The Scottish Government (2009) The Scottish Soil Framework [Online] Available at: http://www.gov.scot/Publications/2009/05/20145602/0 (Accessed 02.10.23)
[334] The Construction Industry Research and Information Association (CIRIA) (2015) Environmental Good Practice on Site Guide (C741), CIRIA: London. (Accessed 02.10.23)
[335] Scottish Government (2017) Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments. Available at: http://www.gov.scot/Publications/2017/04/8868/0 (Accessed 02.10.23)

Table 11.1 Consultation Responses

Consultee	Type and Date	Summary of Consultation Response	Response to Consultee	Section Addressed
NatureScot	Scoping Response 31/08/2021	There are Class 1 and 2 Peatlands underlying the development, so peat probing is required in order to confirm the extent of peat on the Site.	Peat probing was completed.	Section 11.4.3.1.
		There is a requirement for a complete peat probing survey to be undertaken, and an associated NVC survey, to ascertain the quality and distribution of peatland and priority habitats across the site as per NatureScot guidance. The EIA Report should demonstrate that any significant effects have been substantially overcome by siting, design or other mitigation. Details of all mitigation, including a peatland management plan and a habitat management plan should be included in the EIAR.	Detailed NVC and peat depth surveys have been undertaken for the Development. The peat surveys include Phase One probing and probing of proposed infrastructure areas to full depth (Phase Two probing). These surveys have been considered in the iterative design process and are presented within this EIA Report. The survey data has also been used in the Peat Management Plan (PMP) and Habitat Management Plan (HMP) that form part of the EIA Report.	A11.1: Peat Slide Hazard & Risk Assessment (PSRA), and A11.2: Outline Peat Management Plan (oPMP).
RSPB	Scoping Response 09/08/2021	Turbines 6, 7, 8, 19, and 22 are located in areas that would be situated on Class 2 Peat. A full assessment of the carbon implications should be undertaken using the Scottish Government's Carbon Calculator.	A carbon balance assessment has been carried out using the Scottish Government's Carbon Calculator. The turbine locations have been changed since the scoping layout to reduce the impact on peat.	Chapter 16: Climate Change and Carbon Balance.
Argyll and Bute Council	Scoping Response	ABC's Local Biodiversity Officer (LBO) - welcomes that the applicant is to carry out a Peat depth survey so as to inform positioning of works and access in light of this the LBO asks that a Peat Management Plan is submitted with this mapping process for approval. The LBO also notes that Borrow pits have yet to be identified, in view of this, the LBO would like the locations mapped and a Restoration Plan included and submitted for approval.	A peat depth survey was completed, which informed the Peat Management Plan (included in Appendix 11.2). A borrow pit assessment has also been completed mapping the locations and potential impacts for the borrow pit included in Appendix 11.3.	A11.2: Outline Peat Management Plan (oPMP), and A11.3: Preliminary Borrow Pit Assessment (BPA).
		The applicants should consider the potential for dust emissions from the site and access roads/tracks during the construction	The dust management and other environmental considerations during construction have been addressed within the outline	A11.4: Outline Construction Environmental Management Plan (oCEMP)

Consultee	Type and Date	Summary of Consultation Response	Response to Consultee	Section Addressed
		phase on any nearby sensitive properties and provide details of any proposed mitigation measures within the proposed construction environmental management plan.	construction environmental management plan submitted with the application.	
SEPA	Scoping Response 04/08/2021	Should the development disturb peat, Carbon dioxide emissions should be assessed and minimised. The planning submission should also demonstrate how the layout minimises the disturbance of peat.	A carbon balance assessment has been carried out using the Scottish Government's Carbon Calculator. This is shown in Chapter 16: Climate Change and Carbon Balance. The submission will include a peat interpolation map that indicates peat depths throughout the Site as well as how the layout avoids the Site infrastructure. The outline Peat Management Plan submitted with the application also addresses the distribution of peat across the Site and how the infrastructure has been located in order to minimise the disturbance of peat.	Chapter 16: Climate Change and Carbon Balance, A11.2: Outline Peat Management Plan (oPMP), and Chapter 3: Site Selection and Design.
		The submission must include: • A peat depth map; • Reuse and reinstatement values for acrotelmic, catotelmic and amorphous peat; • A Peat Management Plan might be required; and • Proposals must be in accordance with the Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and Minimisation of Waste.	The peat depth map and reuse values for peat are included in the outline Peat Management Plan. These proposals are all in line with the Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and Minimisation of Waste.	A11.2: Outline Peat Management Plan (oPMP)
		Scottish Planning Policy states (Paragraph 243) that "Borrow pits should only be permitted if there are significant environmental or economic benefits compared to obtaining material from local quarries, they are time-limited; tied to a particular project and appropriate reclamation measures are in	There is an existing quarry located on the Site that will be extended in order to form a borrow pit. This policy statement has been addressed and supported with the Preliminary Borrow Pit Assessment, submitted with the application.	A11.3: Preliminary Borrow Pit Assessment (BPA).

Consultee	Type and Date	Summary of Consultation Response	Response to Consultee	Section Addressed
		place." The submission must provide sufficient information to address this policy statement.		
		A Site Management Plan should be submitted in support of the application.	A separate Site Management Plan will not be submitted with the EIA application, but all the information that is required from the Site Management Plan will be included in the CEMP.	A11.4: Outline Construction Environmental Management Plan (oCEMP)
		For each borrow pit the following should be submitted: • A map with the location, size, depths, and dimensions; • A map showing the distance of the borrow pits from any rocks, overburden, soils, and temporary and permanent infrastructure; • Justifications for the locations of the borrow pits should be provided; and • A site map showing drainage infrastructure.	This information has been included in the Preliminary Borrow Pit Assessment, submitted with the application. There is further information on the Geomorphology Map, Bedrock Geology Map and Superficial Soils Map included within this Chapter and the PSRA.	A11.3: Preliminary Borrow Pit Assessment (BPA), and A11.1: Peat Slide & Risk Assessment (PSRA).

11.3.2 Scope of Assessment

The following effects on peat and geology resources related to the Development will be considered within the EIA due to the potential for significant effects as agreed during Scoping consultation, as summarised in Section 11.3.1.

- Potential for peat destabilisation and peat slide risk;
- Potential effects relating to peat disturbance and the subsequent effects from excavated peat and management of peat and peaty soils;
- Potential for compaction of superficial soils; and
- Potential for loss of important geological minerals.

This is assessed through technical assessment in the form of a Peat Slide Risk Assessment (PSRA), which is supported by an outline Peat Management Plan (oPMP) and outline engineering design of the site layout, as detailed in Chapter 2: Development Description and Chapter 3: Site Selection and Design. The PSRA and oPMP are included in Appendix A of this Chapter as A11.1 and A11.2.

The key sensitive receptors in the assessment are:

- Soil type and associated land use are highly sensitive (e.g., deep peat [Peat where depth is greater than 1.0 m] and blanket bog);
- Class 1 or 2 priority peatland, carbon-rich and peaty soils cover >20% of the development area;
- Areas containing geological or geomorphological features considered to be of national importance (e.g., geological SSSIs); and
- Receptors which contain areas of regionally important economic mineral deposits.

11.3.3 Elements Scoped Out of Assessment

Desk studies have not identified any areas of contaminated land within the Study Area. Should potentially contaminated land be encountered during excavations, appropriate action would be taken in accordance with The Environmental Protection Act 1990. Appendix A of the Outline Construction Environment management Plan outlines construction management best practice for the Site and should also be consulted should any contaminated land be encountered on the Site. As a result, potential effects arising from contaminated land have been scoped out of this assessment.

11.3.4 Study Area / Survey Area

For the Geology, Soils and Peat assessment, the Site area is the same as the Study/Survey area. Only the soils, geology and peat elements that fall within the Site itself will be affected by the development.

The Development is situated approximately 4.7 km north of Inveraray, centred on National Grid References (NGR) 210197, 715498. The Site covers an area of approximately 790 hectares (ha) with the extent and location shown on Figure 1.1 as the Site boundary. The Site lies wholly within the administrative boundary of Argyll and Bute Council (the Council).

The elevation of the Site ranges from 470 metres (m) Above Ordnance Datum (AOD) in the east of the Site and falls to around 100 m AOD in the west of the Site. There are a number of notable hilltops and ridges within and surrounding the Site with the ridge Ceann Chreagan located in the south of the Site. Hills in the vicinity of the Site include Stuc Scardan (487 m AOD) directly east of the Site, and Tom an Fheidh (237 m AOD) directly north to the Site.

The predominant land use within the Site consists of private forestry plantation used for commercial purposes with areas of upland moorland also present in the south and east of the Site.

No public roads are located within the Site. Nearby major roads include the A819 directly to the West of the Site and the A83 to the south. The B840 also joins the A819 approximately 4.9 km to the north of the Site.

The path C201 – Dun Na Cuaiche is the nearest Core Path to the Site and is located approximately 2.7 km to the south.

As noted above, the nearest settlement is Inveraray, approximately 4.7 km to the south. While there are a number of dispersed residential properties surrounding the Site, there are no residential properties within the Site and no properties within 1 km of the proposed turbine locations. The closest residential property to the proposed turbine locations is Ladyfield Farm, which lies 1.1 km northwest of the nearest turbine (Turbine 11).

11.3.5 Design Parameters

The parameters of the design that will influence the peat and geology assessment in relation to physical effects has been based on the turbine layout and associated infrastructure. No additional design parameters, other than those set out in Chapter 2: Development Description of this EIA Report, are required for the assessment presented in this Chapter.

As set out in Chapter 2: Development Description, a 50 m micro-siting allowance in any direction for turbines and all other infrastructure is applied to the Development, where constraints allow. Such relocations have been considered when undertaking the assessment, and mitigation recommended, where appropriate.

11.3.6 Baseline Survey Methodology

The assessment of peat and geology has included the review of publicly available information in relation to the current condition of the soils at the Site and the information is detailed in the baseline description. This was supported by detailed site walkover surveys. The information has been reviewed in the context of the Development to evaluate both short and long-term impacts.

The assessment has involved a review of information included within Appendices A11.1 – A11.4, including but not limited to the following data sources:

- National Soils Map of Scotland;
- Carbon and Peatland 2016 Map;
- British Geological Survey (BGS) Geoindex – Superficial Soils; and
- BGS Geoindex – Solid Geology.

Soil types are considered to be of high sensitivity where they are categorised as peat soils of high moisture content, such as those found in blanket bog.

The methodology employed for the PSRA is in accordance with Scottish Government guidance. Using experience from other wind farm projects, the assessment endeavours to assess the effects on geology and soils either affected directly or indirectly by construction or operation of the Development.

11.3.6.1 Stage One Peat Probing

Initial stage one peat probing was carried out in accordance with Scottish Government guidance with a 100 m by 100 m grid carried out across the Site and the information gathered to inform the Public Consultation Layout 2, as described in Chapter 3: Site Selection and Design. This stage of peat probing consisted of 1,047 probes with an average depth of 0.41 m.

11.3.6.2 Stage Two Peat Probing

Following design freeze of the layout, targeted peat probing was carried out in February 2023. This probing was generally at 50 m intervals along the centre line of the tracks with probes at 10 - 25 m on either side of the tracks to provide a corridor for micro-siting. In addition, probing at turbine locations were recorded at 10 m intervals and detailed probing also took place at the proposed substation compound. This stage of peat probing consisted of 2,098 points, which along with the phase one probing finds the average peat depth to be 0.5 m.

It should be noted that the oPMP and PSRA was undertaken on the findings of all phases of probing with focus on the stage two peat probe data, as this was within the proposed infrastructure envelope. Details of these assessments are included in Appendix A11.1 and A11.2 respectively.

The turbine locations have been micro-sited since the Phase Two probing took place in order to avoid the deeper areas of peat. The turbines are still located within probed areas since a buffer zone was employed for probing over the turbines. This was done in order to minimise peat disturbance across the Site.

11.3.7 Methodology for the Assessment of Effects

The assessment of effects is based on the final design of the Development detailed in Chapter 2: Development Description of this EIA Report. The assessment considers the sensitivity of the receptor and the magnitude of any potential change, to conclude whether the effect is significant.

11.3.7.1 Sensitivity of Receptors

The sensitivity of the baseline conditions, including the importance of environmental features on or near to the Site or the sensitivity of potentially affected receptors, will be assessed in line with best practice guidance, legislation, statutory designations and / or professional judgement.

Table 11.2 details the framework for determining the sensitivity of receptors.

Table 11.2 Framework for Determining Sensitivity of Receptors

Sensitivity of Receptor	Definition
Very High	The receptor has little or no ability to absorb change without fundamentally altering its present character, is of very high environmental value, or of international importance.
High	Soil type and associated land use are highly sensitive (e.g., peat/blanket bog);

Sensitivity of Receptor	Definition
	Class 1 or 2 priority peatland, carbon-rich and peaty soils cover >20% of the development area; Areas containing geological or geomorphological features considered to be of national importance (e.g., geological SSSIs); and Receptor contains areas of regionally important economic mineral deposits.
Medium	Soil type and associated land use are moderately sensitive (e.g., commercial forestry); Class 1 or 2 priority peatland, carbon-rich and peaty soils cover <20% of the Development Area; Class 3 and 5 peatland areas, carbon rich and peaty soils; Receptor contains areas of locally important economic mineral deposits; and Areas containing geological features of designated regional importance including Regionally Important Geological/geomorphological Sites (RIGS), considered worthy of protection for their historic or aesthetic importance.
Low	Geological features or geology not protected and not considered worthy of specific protection. Soil type and associated land use not sensitive to change in hydrological regime (e.g., intensive grazing); and Receptor contains Class -2, -1, 0, and 4 non-peatland areas, with no carbon-rich and/or peaty soils.
Negligible	The receptor is resistant to change and is of little environmental value.

11.3.7.2 Magnitude of Effect

The magnitude of potential effects will be identified through consideration of the Development, the degree of change to baseline conditions predicted as a result of the Development, the duration and reversibility of an effect and professional judgement, best practice guidance and legislation.

The criteria for assessing the magnitude of an effect are presented in Table 11.3.

Table 11.3 Framework for Determining Magnitude of Effects

Magnitude of Effects	Definition
High	Major or total loss of or alteration to peatland resource such that post development characteristics or quality will be fundamentally or irreversibly changed; Long term/permanent change to human or environmental health; Catastrophic failure of site infrastructure due to ground instability; Long term/permanent change to baseline resource; and Major or total loss of a geological site or mineral deposit, where the value of the site would be severely affected.
Medium	Loss of, or alteration to the baseline resource such that post development characteristics or quality will be partially changed; Mid-term/permanent change to human or environmental health; Ground failure that requires remediation but does not cause catastrophic failure of site infrastructure; Mid-term/permanent change to baseline resource; and Partial loss of a geological site or mineral deposit, with major effects to the settings, or where the value of the site would be affected.
Low	Small loss of soils or peatland, or where soils will be disturbed but the value not impacted; Short-term change to human or environmental health; Ground settlement/subsidence that does not adversely affect site infrastructure or require remedial action;

Magnitude of Effects	Definition
	Short-term change to baseline resource; and Small effect on a geological site or mineral deposit, such that the value of the site would not be affected.
Negligible	Minimal or no change to soils or peatland deposits; Minimal or no change to human or environmental health; Minimal or no change to ground stability; A very slight change from the baseline conditions. The change is barely distinguishable, and approximates to the 'no-change' situation; and Minimal or no change to a geological site or mineral deposit.

11.3.7.3 Significance of Effect

The sensitivity of the asset and the magnitude of the predicted effects will be used as a guide, in addition to professional judgement, to predict the significance of the likely effects. Table 11.4 summarises guideline criteria for assessing the significance of effects.

Table 11.4 Framework for Assessment of the Significance of Effects

Magnitude of Change	Sensitivity of Resource or Receptor				
	Very High	**High**	**Medium**	**Low**	**Negligible**
High	Major	Major	Moderate	Moderate	Minor
Medium	Major	Moderate	Moderate	Minor	Negligible
Low	Moderate	Moderate	Minor	Negligible	Negligible
Negligible	Minor	Minor	Negligible	Negligible	Negligible

Effects predicted to be of major or moderate significance are considered to be 'significant' in the context of the EIA Regulations, and are shaded in light grey in the above table.

11.3.8 Assessment Limitations

During the Phase One and Phase Two peat probing surveys the south western area was not subject to probing. No infrastructure was proposed in this area and the peat depths in the surrounding areas are shallow and in low and negligible peat slide risk zones. Therefore, the area was not deemed to be a risk to the Development.

The desk-based assessments are based on large scale mapping which does not necessarily consider the localised environment. Due to this, field surveys were completed to inform the occurrence of soils and geology on the Site.

Notwithstanding the above, it is considered that a robust assessment has taken place.

11.3.9 Embedded Mitigation

Embedded mitigation comprises best practice methods and works outlined in the publication 'Good Practice During Wind Farm Construction'. These are established and effective measures to which the applicant will be committed through the duration of the Development.

Chapter 2: Development Description and Chapter 3: Site Selection and Design, provide further details of the mitigation undertaken through embedded design of the site layout avoiding key environmental constraints including avoidance of deepest peat (i.e., no turbines sited in peat > 1 m average depths for 50 m around the turbines) or limiting the impacts on deep peat where

possible, as well as taking cognisance of hydrological and ecological features and associated buffers.

Further embedded mitigation measures undertaken to date are set out within Appendix 11.4 oCEMP. These measures will be further defined in the pre-construction phase in a detailed CEMP (to be submitted post-consent under condition of s36 consent) which sets out specific mitigation which relates to this Development. The detailed CEMP would comprise good practice methods and works that are established and effective measures to which the Applicant will be committed through the planning consent. This detailed CEMP will be prepared by the Contractor appointed for the construction on the development.

11.4 Existing Baseline Conditions

11.4.1 Published Geology

The following sections summarise the findings of the published mapping review. The published data is based on large scale mapping which does not necessarily consider the localised environment.

Further work is detailed in Section 11.4.3 which documents the field survey and peat probing, providing a more detailed geological context of the local environs within the Site. Further details of baseline peatland habitats are also included in Chapter 8: Ecology.

11.4.1.1 Superficial Soils

Published geological mapping[336] indicates that there are localised pockets of Devensian-Diamicton Till, Hummocky Glacial deposits of Diamicton, sand and gravel, and raised marine deposits of clay silt and sands in isolated areas on the Site. There are no recorded superficial peat deposits on the Site.

Superficial Soils within the context of the Site are conveyed on Figure 11.1.

11.4.1.2 Bedrock Geology

Published bedrock geology mapping[337] indicates that the Site is underlain by various sedimentary and igneous groups.

Throughout the majority of the Site the main bedrock geology is Quartzite from the Crinan Grit Formation. There are smaller areas of Metagabbro and Metamicrogabbro from the Daldrian Supergroup in the central and north western portions of the Site.

Throughout the Site there are isolated occurrences of the following bedrock geology:

- Mafite from the North Britain Siluro-Devonian Calc-Alkaline Dyke Suite;
- Metalimestone and Pelite from the Argyll Group;
- Phyllitic Semipelite and Quartzite from the Ardshaig Phyllite Formation;
- Quartz-Microgabbro from the Central Scotland Late Carboniferous Tholeiitic Dyke Swarm;
- Felsite from the Scottish Highland Siluro-Devonian Calc-Alkaline Minor Intrusion Suite;
- Graphitic Pelite from the Tayvallich Slate and Limestone Formation.

Bedrock Geology within the context of the Site is conveyed on Figure 11.2 and forms part of Appendix A.

[336] British Geological Survey Mapping Website GeoIndex - British Geological Survey (bgs.ac.uk) Accessed 02.10.23)
[337] British Geological Survey Mapping Website GeoIndex - British Geological Survey (bgs.ac.uk) Accessed 02.10.23)

11.4.1.3 National Soils of Scotland

The following information is a summary of the information on soil units within Scotland's Soils, Scotland's Environment Website[338]. Figure 11.3 of this Chapter illustrates an extract from the 'National Soils of Scotland' map.

National Soils Map of Scotland mapping indicates a varied soil composition as the survey area is large. The majority of the Site is underlain by Peaty gleys. In the eastern areas of the Site there is an isolated occurrence of Montane soils. The western portion of the Site has occurrences of Mineral Podzols. Towards the southern portions of the Site there are occurrences of Peaty Podzols.

When evaluating a soil profile, the soil is divided into different horizons. There are six major horizons that define the different layers of the soil, the O, A, E, B, C, and R horizons which are defined as follows[339]:

- O Horizon: This layer is made up of organic matter.
- A Horizon: This layer is the topsoil, made up of a combination of organic matter and mineral material.
- E Horizon: This layer consists mostly of mineral particles that cannot be leached away. This horizon is often found in older, undisturbed soils.
- B Horizon: This layer is the subsoil layer, formed of leached materials, minerals and salts.
- C Horizon: This layer is the parent material layer, this layer would have been formed from the earth's surface deposits.
- R Horizon: This layer is the bedrock.

In addition to the layers above, letters can be added to these horizons to indicate any special features that the horizon may show[340]. These suffixes are indicated in Table 11.5 below.

Table 11.5 Suffixes to soil horizons

Suffix	Definition	Suffix	Definition
a	Highly decomposed organic matter	o	Accumulation of oxides of iron and aluminium
b	Buried horizon	p	Plowing or other anthropogenic disturbance
c	Concretions or hard nodules (iron, aluminium, manganese, or titanium)	q	Accumulation of silica
e	Organic matter of intermediate decomposition	r	Weathered or soft bedrock
f	Frozen soil	s	Accumulation of metal oxides and organic matter
g	Gray colour with strong mottling and poor drainage	t	Accumulation of clay
h	Accumulation of organic matter	v	Plinthite (hard, iron-enriched subsoil material)
j	Slightly decomposed organic matter	w	Development of colour or structure
k	Accumulation of carbonate	x	Fragipan character (high-density, brittle)
m	Cementation or induration	y	Accumulation of gypsum
n	Accumulation of sodium	z	Accumulation of salts

[338] Scotland's Environmental Website: http://soils.environment.gov.scot/ (Accessed 02.10.23)
[339] SoilErosion.com, 2019. [online] Available at: The Ultimate Guide to Soil Horizons - SoilErosion.com (Accessed 05/03/2023)
[340] Balasubramanian, A (2017). *Characteristics of Soil Profile*. University of Mysore. Available at: (PDF) CHARACTERISTICS OF SOIL PROFILE (researchgate.net) (Accessed 05/03/2023)

A brief description of the characteristics and formation of component soil groupings is detailed below, described by Scotland's Soils Map, although these do not include information on depths or engineering properties:

- Peaty Gleys, "*which have no free calcium carbonate in the upper horizons of the profile. There is often a gleyed pale grey Eg horizon below an organic O horizon (which is less than 50cm thick). Below the Eg there are gleyed subsoil horizons (Bg and Cg). Where the gleying is more intense in the Bg horizon than the Cg, then the soils are generally more affected by poor drainage of surface water but in those soils where the Cg is more intensely gleyed (grey and bluish grey colours can be present), then the soils are more likely to be affected by fluctuating groundwater*";
- Peaty Podzols, "*which have an organic surface layer (O or H horizon) up to 50cm thick overlying a grey, leached E Horizon. There may be a dark brown to black Bh horizon where translocated organic matter has accumulated and a strong brown sesquioxide-rich Bs or a combination of both (Bhs). Some peaty podzols may have some degree of waterlogging, generally in the lower horizons resulting in weak gleying with ochreous mottling and grey patches*."

11.4.1.4 Carbon-rich Soils, Deep Peat and Priority Peatland Habitats

The carbon and Peatland Map 2016[341] details that the Site is mostly underlain by class 5 peat. Limited parts of the eastern areas of the Site are underlain by portions of class 2 and class 3 peat, on the steep slopes located in the south eastern portions of the Site.

The different peat classes that are recorded on the Site are classified as follows:

- Class 5 Peat: "*Soil information takes precedence over vegetation data. No peatland habitat recorded. May also include areas of bare soil. Soils are carbon-rich and deep peat*."
- Class 3 Peat: "*Dominant vegetation cover is not priority peatland habitat but is associated with wet and acidic type. Occasional peatland habitats can be found. Most soils are carbon-rich soils, with some areas of deep peat."*
- Class 2 Peat: "*Nationally important carbon-rich soils, deep peat and priority peatland habitat. Areas of potentially high conservation value and restoration potential*."

11.4.2 Peat (Site Specific Environs)

Peat is a sedimentary material, which is dark brown or black in colour, and comprises partially decomposed remains of plants and organic materials preserved in anaerobic conditions, essentially within a waterlogged environment. There are two principal types of peat:

- Acrotelm is the upper layer, quite fibrous and contains plant roots. Acrotelmic peat is relatively dry, generally lying above the groundwater table and has some tensile strength; and
- Catotelm is the lower layer of peat which is highly amorphous and has a very high water content. Catotelm generally lies below the ground water table and has a very low tensile strength.

Deep peat is defined as being a surface layer of peat soil greater than 1.0 m deep by the Scottish Government (Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments, 2017). Peat depth surveys were carried out to determine the extent and depth of the peat present at the Site, these are summarised in Section 11.4.3.1 and the details are included in Technical Appendix A11.2: oPMP. The oPMP provides Site-specific peat depth information which informed the design of the layout of the Proposed Development and the subsequent assessment of effects.

[341] Scotland's Environment, Carbon & Peatland 2016. Available at: https://map.environment.gov.scot/Soil_maps/?layer=10 (Accessed 02.10.23)

11.4.3 Field Surveys

11.4.3.1 Field Survey Results

A total of 3,145 peat probes were taken throughout the peat surveys. Recorded peat depths of 0.5 m or less accounted for 73.9% of the total probing results with a further 15.8% of probes recording depths of 1.0 m or less. Appendix A11.2, Figure 11.2.2 Recorded Peat Depths shows the distribution of peat throughout the Site. This figure shows that the majority of the Site does not have deep peat and indicates the isolated areas of deeper peat.

The deepest pocket of peat, up to 7.2 m, is located in a naturally low lying area to the south west of Turbine 1. There is another deeper pocket of peat located adjacent to the south western portion of Turbine 8, with maximum depths of 4.0 m. There are also deep pockets of peat (up to 2.5 m depths) to the north of T2 and both north and south east of T5. These deeper pockets of peat are located in areas of flatter topography. The steeper areas of the Site generally all have shallower peat coverage.

A more detailed representation of peat within the Site is available in Appendix A11.1: PSRA and Appendix A11.2: oPMP.

Table 11.6 indicates the average peat depths within a 50 m radius of the proposed wind turbines. The table indicates that 7 of the 13 turbines will be located in areas with 0.5 m or less of peat where the other 6 turbines will be located in areas with average peat depths ranging from 0.53 m to 0.83 m. All of the turbines are located in areas where the average peat depth within 50 m of the turbine location is less than 1.0 m deep.

Table 11.7 indicates the average peat depths within 50 m of the other Site infrastructure.

Table 11.6 Peat Depths Recorded at Turbines

Proposed Turbine No.	Average Peat Depths at 50 m Radius (m)
T1	0.41
T2	0.47
T3	0.41
T4	0.40
T5	0.54
T6	0.63
T7	0.57
T8	0.83
T9	0.36
T10	0.57
T11	0.65
T12	0.50
T13	0.30

Table 11.7 Peat Depths Recorded at Site Infrastructure

Proposed Site Infrastructure	Average Peat Depths within 50 m of Infrastructure (m)
BESS	0.26
Substation Compound	0.26
Construction Compounds	0.15
Access Tracks	0.45
Borrow Pit	0.00

11.4.3.2 Peat Stability and Peat Management

The PSRA and oPMP have been undertaken by Environmental Resources Management Ltd.

The PSRA found that the majority of the Site lies within areas of low risk, with smaller areas of medium and negligible risk. All of the Site infrastructure lies within areas of low risk. There are two high risk points located on the Site, both of these points are located in areas avoided by infrastructure.

Details of mitigation and good construction techniques to reduce the risk of peat slides are detailed in Appendix A11.1: PSRA and in Section 11.7 of this EIA Report.

11.4.3.3 Outline Peat Management Plan

For the oPMP, peat depth data was utilised to calculate estimated peat excavation and re-use volumes based on an outline 3D civil Site layout design. In this, rational options for reuse of excavated material are detailed as well as guidance on good practice for storage and management of excavated material, including peat. Further details are provided in Appendix A11.2: oPMP.

11.5 Assessment of Potential Effects

The effect of the Development on soils and geological receptors has been considered for the duration of the construction and operation phases. Effects occurring during construction are considered to be short term effects, with those occurring as a result of the operational development being considered as long-term.

11.5.1 Potential Construction Effects

11.5.1.1 Disturbance of Deep Peat

Construction activities including excavation of tracks, turbine foundations, crane hardstanding and other infrastructure can lead to disturbance of peat. Beyond the main construction activities, other considerations include the formation of the borrow pit and temporary storage of soils and peat on Site. The details of peat disturbance through excavations and subsequent re-use methods are included in Appendix A11.3: oPMP.

All turbines have been sited in peat depths less than 1.0 m as detailed in Table 11.6.

The assessment of deep peat disturbance has highlighted few areas of deep peat, one area on the access track south of T1 and another to the southwest of T8 (the deep peat located just off the proposed hardstanding, within the 10 x 10 m grid that was probed over the proposed turbine areas).

As stated in Section 11.4.1.4, the Site is underlain by Class 2, 3 and 5 peatland. Only part of the eastern portion of the Site is underlain by Class 2 and Class 3 peat. These areas are located on

steep slopes and there is only one turbine located in this area (Turbine 13). This turbine is underlain by very shallow peat.

On this basis, potential disturbance to deep peat is classified as medium receptor sensitivity. The magnitude of change is low given the findings of the survey works and the embedded design measures taken. Therefore, the Development will result in a potential minor effect that would be **not significant**, in accordance with the EIA Regulations.

11.5.1.2 Peat Stability

Peat instability is generally the result of a combination of causative factors. Several construction activities have the potential to increase the likelihood of peat slides in areas where peat is present at a sufficient depth and where gradients are sufficiently steep to result in a peat slide event.

Construction activities have the potential to increase the likelihood of peat slides by way of locating proposed infrastructure including track networks on sloping ground where peat is present. Construction activities may involve the removal of surface vegetation and excavation of peat and other near surface soils from the bedding surface of the underlying rock which would naturally increase potential for slide.

Peat slides can affect soils, local sensitive habitats and have the potential to affect surface water systems from soil inundation, leading to sedimentation. This can have an effect by slip materials sliding onto areas of sensitive habitat, or causing damage to local surrounding surface soils which can also reduce water quality and/or modify drainage patterns. The receptor criteria for assessing peat slide risk are:

- Non-critical infrastructure (minor/private roads, tracks);
- Watercourses and critical infrastructure (pipelines, motorways, dwellings and business properties etc.);
- Sub-Community (settlement 1-10 residents); and
- Community (settlement of >10 residents).

Peat depths are generally shallow, with depths of 1.0 m or less recorded across a vast majority (89.7%) of the Development. There are localised deep pockets of peat beneath the access tracks to the south west of T1, and in the vicinity of T2, T5, and T8. The PSRA has identified all of the Site infrastructure to be located in low risk zones, with localised areas of negligible and moderate risk zones, identified out with the infrastructure footprint. This is as a result of steep slopes on the Site as well as large areas of sensitive habitat on the eastern portions of the Site.

Appendix A11.1: PSRA concludes that with regards to peat stability there is a negligible to low risk of peat instability over most of the Site although some areas of moderate risk have been identified. For these areas, a hazard impact assessment was completed which concluded that, subject to the employment of appropriate mitigation measures, all these areas can be considered as a low or negligible risk.

Good practice measures are embedded in the design principles and adoption of further best practices, to be detailed in a CEMP with the proposed drainage measures set out in this document. By adopting the measures set out here, the risk of peat instability will be further reduced.

The significance of effect of peat stability is regarded as moderate before the implementation of mitigation measures. This is due to the volume of points on the Site recorded as a medium/high hazard, along with a limited number of medium or high risk points in the factor of safety (FoS) analysis. The outcomes of these assessments can be seen in Technical Appendix 11.2 Peat Slide Risk Assessment. Due to the proposed mitigation measures and their overall effect on the Site the magnitude of change relating to peat stability would be reduced from medium to low.

On this basis, following the implementation of mitigation measures, the assessment of peat stability risk due to the Development could impact on receptors (peat and peaty soils) with medium sensitivity, with low magnitude of change resulting in a potential minor effect that would be **not significant**, in accordance with the EIA Regulations.

11.5.1.3 Impacts on Geology

Desk based research has indicated that the underlying bedrock geology does not represent any local, regional or nationally important minerals.

The Development includes for access tracks negotiating steep and locally very steep slopes to get to the main proposed turbine clusters, which in turn, leads to large areas of earthworks, primarily 'Cut' material, and overall an increased footprint. The design process was iterative and the final track alignments presents the best and optimum practical option for the proposed approach.

One potential borrow pit location has been identified within the Site which would be utilised during construction resulting in a significant reduction in overall material imported to the Site. This borrow pit is located on an existing quarry that will be expanded for the purposes of the Development. The borrow pit will therefore not have a significant new effect on the Site as this area has already been disturbed.

While the sensitivity is assessed as low where 'geological features or geology not protected and not considered worthy of specific protection' the magnitude of change would be medium where 'partial loss of a geological site or mineral deposit, with major effects to the settings, or where the value of the site would be affected'.

On this basis, the Development is considered to result in a potential minor effect and considered **not significant**, in accordance with the EIA Regulations.

11.5.1.4 Loss of Soils

In its regulatory position statement, SEPA states that:

"Developments on peat should seek to minimise peat excavation and disturbance to prevent unnecessary production of waste soils and peat".

The key items of infrastructure which influence this effect are the dimensions, location and type of new access tracks, turbine base foundations and crane hardstanding. Other features which should be considered for excavation requirements include the borrow pit, substation and temporary construction compound facilities.

While the layout design process has sought to avoid most areas where deep peat is recorded, crane hardstand infrastructure associated with three turbines (T2, T5, and T8) located 54 m, 31 m and 22 m from deeper peat respectively. The areas of deep peat are located within the 10x10 m grid that was probed beneath the turbine areas but the deep peat (in both cases peat depths of 3.9 m and 4.0 m were recorded) were not beneath the turbine or crane hardstandings. Outwith areas of deep peat, the remainder of the peat deposits are considered to be thin, in the region of 0.5 m to 1.0 m. Further information on peat excavation is also included in Appendix A11.2: oPMP which details the peat volumes estimated for excavation and re-use possibilities.

Given the majority of soils being affected by the Site are thin deposits, generally classified as either peaty or mineral soils, and soils would be reinstated in the vicinity of origination where possible, the receptor sensitivity is low. The overall magnitude of change is also low, therefore the significance of effects associated with the loss of soils is considered to be negligible and **not significant**, in accordance with the EIA regulations.

11.5.1.5 Loss and Compaction of Peat and Soils

In relation to compaction of soils, investigations at the Site have recorded generally thin soil cover across the majority of the Development, and construction of access tracks and movement of construction traffic, in the absence of construction good practice, could lead to the compaction of soil. This can reduce soil permeability, potentially leading to increased run-off and increased erosion. The superficial soils underlying the Development are of a varying permeability, so the effects of compaction could result in a significant increase in runoff from existing conditions. The total surface area affected by the footprint of the proposed layout equates to approximately 119,600 m^2, just under 1.6% of the total Site area.

On this basis, given the very localised impacts on deep peat throughout the Site, loss and compaction of soils is classified as medium sensitivity with a low magnitude of change. Therefore, the significance of effects associated with the compaction of peat and soils is minor and is **not significant**, in accordance with the EIA Regulations.

11.5.2 Operational Phase

There would be no impacts upon peat and soils during the operational phase, therefore effects will be **not significant**. Peatland restoration is planned on the Site, this is discussed within Technical Appendix A8.4: Outline Biodiversity Enhancement Management Plan.

11.5.3 Decommissioning Phase

During decommissioning, the turbine foundation bases would be broken out to 1m below ground level. All cables would be de-energised, cut off below ground level, and left in the ground. Access tracks would be left in-situ for use by the landowner. . No stone would be removed from the Site. The decommissioning works are estimated to take twelve months. This approach is considered to be less environmentally damaging than seeking to remove foundations, cables and roads entirely.

Therefore, it is considered that decommissioning activities would be less intrusive with infrastructure in place for access meaning no or little requirement for further disturbance of peat, therefore effects are anticipated to be **not significant**.

11.6 Cumulative Effect Assessment

A cumulative effect is considered to be an additional effect on peat and geology resources arising from the Development in addition to the combination of other developments likely to impact the peat and geological environment.

However, peat depths across the Site were generally thin with only localised areas of deep peat (>1.0 m) affected by the Development infrastructure, and all peat excavated during construction will be suitably re-used in reinstatement and restoration as detailed in Appendix A11.2: oPMP. In addition, it is considered that the borrow pit proposed will not impact any regionally important or economically important resources.

Therefore, for the purposes of the assessment of potential cumulative effects, geology and soils is considered as a site-specific consideration, and there will be no cumulative effects.

11.7 Mitigation and Residual Effects

11.7.1 Mitigation Measures

Mitigation in relation to peat disturbance is initiated through embedded mitigation in design and adopting best practices during construction.

Mitigation proposed states that infrastructure associated with turbines which encroaches deep peat will be micro-sited (if possible) outside of these areas in order to reduce the overall effect on peat disturbance, stability and loss of soils. Micro-siting limits are discussed in Chapter 2: the Development Description. Maintenance of existing drainage is critical to avoid compaction of soils, therefore, all existing drainage network channels would be maintained and, where necessary, channelled below the access track construction drainage ditches on the upslope of the track. Further details are provided in Chapter 10: Hydrology and Hydrogeology.

Intrusive site investigations will be undertaken at all turbine locations and other infrastructure prior to construction and at the borrow pit, if required, to assess suitability.

Slope stability monitoring will occur during pre-construction and construction phases of work, including for both peat stability and non-peat related stability. These would focus on locations highlighted as being of risk in Appendix A11.1: PSRA.

Best practice measures for managing excavated peat and peaty soils are detailed in Appendix A11.2: oPMP.

11.7.2 Residual Effects

Following the incorporation of mitigation measures as detailed in Section 11.7.1, residual effects associated with peat disturbance, impact on geology, peat and soil losses will all be negligible, while peat stability has a residual effect of minor, therefore not significant in accordance with the EIA Regulations.

11.8 Summary of Effects

Table 11.8 provides a summary of the effects detailed within this chapter.

Table 11.8 Summary of Effects

Receptor	Potential Effect	Significance of Effect	Mitigation Proposed	Residual Effect
Construction Phase				
Peat	Disturbance of Deep Peat	Minor	Microsisting turbines and tracks in areas of deep peat. The use of floating tracks in areas where deep peat is located in areas where there are proposed access tracks.	Negligible
Peat	Peat Stability	Moderate	Avoiding construction on steep slopes that have deep peat deposits, avoiding the loading of deep peat, visual inspections during construction and minimising activities in areas of moderate risk during and for a period after heavy rainfall events.	Minor
Peat	Loss and Compaction of Peat and Soils	Minor	Avoiding construction on peat deposits. Minimising the loading of soils. Reuse of peat that is removed from in situ conditions to other areas within the development.	Negligible
Soils	Loss and Compaction of Peat and Soils	Minor	Avoiding loading of soils in wet conditions. Minimising the loading of soils. Reuse of topsoil that is removed from in situ conditions to other areas within the development.	Negligible
Geology	Impact on Solid Geology	Minor	Restoring the borrow pit after use.	Negligible
Peat	Decommissioning	Negligible		Negligible

11.9 Statement of Significance

This Chapter has assessed the likely significance of effects on Geology, Soils and Peat during the construction, operational and decommissioning phase of the Development. The Development has been assessed as having the potential to result in an effect of moderate significance in relation to peat stability and effects of minor or negligible significance for all other potential effects.

Following the implementation of mitigation measures outlined in Sections 11.7 and 11.8, the residual effects relating to peat stability are predicted to be of minor significance, while all other residual effects are predicted to be of negligible significance.

Given that only effects of moderate significance or greater are considered significant in terms of the EIA Regulations, the potential effects on Geology, Soils and Peat are **not significant**.