ARCUS

WHITELEE WINDFARM EXTENSION SOLAR PV, GREEN HYDROGEN PRODUCTION AND BATTERY STORAGE FACILITIES

PEAT SLIDE RISK ASSESSMENT

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Prepared By:

Arcus Consultancy Services

7th Floor
144 West George Street
Glasgow
G2 2HG

T +44 (0)141 847 0340 l **E** info@arcusconsulting.co.uk
w www.arcusconsulting.co.uk

Registered in England & Wales No. 5644976

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1 INTRODUCTION

1.1 Background

Arcus Consultancy Services were commissioned by ScottishPower Renewables to carry out a Peat Slide Risk Assessment (PSRA) for the proposed Whitelee Solar, Battery and Hydrogen (The Development). The Development will consist of the following key infrastructure:

- PV farm comprising approximately 62,000 solar panels;
- Green Hydrogen Electrolyser Facility
- Battery Energy Storage System (BESS) infrastructure;
- Grid Connection
- Associated Access Tracks

The proposed Site layout is shown on Figure 1 appended with this report in Appendix A.

1.2 Scope and Purpose

This PSRA provides factual information on the peat survey results relating to the proposed development area. The desk-based information and Site surveys have been utilised to assess the potential risk of any peat landslide. The methodology adopted and details on the assessment are outlined in Sections 3, 4 and 5. The assessment has been undertaken in accordance with Scottish Government Guidance in assessing the likelihood and consequence of such an event.

The team responsible for this report comprise engineers with of almost 20 years' experience, 10 of which in the onshore renewable wind sector and civil engineering projects throughout the UK and Ireland. The site walkovers were undertaken May 2021 by experienced Engineers with over 10 years' experience of assessing and surveying peatland environments and renewables site assessment.

The references to EIAR chapters and associated documents relates to the Environmental Impact Assessment Report prepared by Wood Group UK Limited and submitted to the Scottish Government for ScottishPower Renewables in April 2021, associated with the Development 'Whitelee Windfarm Extension Solar PV, Green Hydrogen Production and Battery Storage Facilities'.

2 SITE INFORMATION

2.1 Site Description and Topography

The Site is located approximately 6km south west of Eaglesham within an area of commercial forestry plantation and bogland, and adjacent to Whitelee Wind Farm. The ground elevations within the Southern Section range from approximately 220 metres Above Ordnance Datum (mAOD) at Howeburn Moss (National Grid Reference (NGR) NS 5055 4628) in the north eastern part, to 275mAOD on higher ground at Rough Hill (NS 5443 4539) within the southern part. In the Northern Section, elevations range from 200mAOD in the south western corner, near Drumtee (NS 4965 4639), to 265 mAOD at the high point in the north eastern corner (NS 5148 4807). Further information on Solid Geology is included in Chapter 8 of the EIAR, April 2021.

2.2 Published Geology

2.2.1 Superficial Soils

BGS maps indicate that the superficial deposits beneath the Site comprise predominantly peat deposits, which are present in the centre and the east of the site . Devensian diamicton till is shown to underlie the peat and is predominantly encountered at the surface in the western part of the Northern Section. Peat is also present at isolated locations to the east of the property known as 'Moor' (for example, at NS 5131 4793), and also along Collorybog Burn and Drumtee Water. Alluvium (silt, sand and gravel) occur along the main river valleys within the Study Area, although they are discontinuous in some places. Further information on Superficial Soils is included in Chapter 8 of the EIAR, April 2021.

Figure 2 illustrates the published Superficial Soils.

2.2.2 Solid Geology

The bedrock geology of the Site mainly comprises extrusive igneous rock of carboniferous age, which predominantly consists of microporphyritic basalt of the Clyde Plateau Volcanic (CPV) Formation. This is part of the Strathclyde Group and the rocks comprise lavas, tuffs and volcaniclastic sediments with a wide range of compositions. On BGS geological mapping the CPV Formation is recorded as being present at surface or at shallow depth at a number of locations, for example at NS 5076 4699.

The bedrock is truncated by two sets of faulting with a north east to south west trend and a north west to south east trend. This faulting occurs within the Study Area and also across the wider area, forming boundaries to other Carboniferous volcanic formations to the north and south, in turn forming a corridor of CPV Formation which runs from the north of the Site through to the Whitelee Forest in the south east of the site.

Figure 3 illustrates the published Solid Geology

2.2.3 Geomorphology

Geomorphological mapping can act as a primary instrument in highlighting geological risk factors when considering peat slides. The Scottish Government Guidance provides 5 basic features in which a geomorphological map should convey:

- The position of major slope breaks (e.g. convexities and concavities);
- The position and alignment of major natural drainage features (e.g. peat gullies and streams);
- The location and extent of erosion complexes (e.g. haggs and groughs, large areas of bare peat);
- Outlines of past peat landslides (including source areas and deposits), if visible; and

- The location, extent and orientation of cracks, fissures, ridges and other prefailure indicators.

Figure 4 'Geomorphological Map' has been prepared to inform a baseline information of the Site with consideration given to existing site conditions through site visit and aerial photography, slope angle and geomorphological data.

The reservoir 'Craigendunton Reservoir' is located just north of the site boundary where various burns issue. Several tributaries and run-off's are also located across the site including Collorybog Burn, Drumtree Water, Dunton Water, Howe Burn and Birk Burn.

Across the Site as a whole, there is little evidence of past peat failure and during the site walkover, there was no existing slippages with exception to some very localised river bank erosion. BGS mapping on landslides recorded none within the site or immediate vicinity.

The developable Site area varying slopes, although large expansions of the area were generally flat. Localised steeper slopes were present in the vicinity of the watercourses, and within the north of the site, the gradients sloped gently downward to the north-west. The majority of the developable Site area is between 0^{o} – 15^{o} slopes.

2.3 Hydrology and Hydrogeology

An overview of the hydrology is provided below, however the detailed Hydrology and Hydrogeology assessment is included in Chapter 8 of the EIAR, April 2021.

2.3.1 Hydrology

Dunton Water issues from Craigendunton reservoir located in the northern site area and drains south west before merging with Calf Fauld Burn and flowing into Craufurland Water approximately 1.5 km south west of site.

In the south east of site Slough Burn drains south west before converging with Gawkshaw Burn and several other tributaries before flowing into Hareshawmuir Water. Collorybog Burn converges with Drumtee Water in the north of site before flowing south west. Howe Burn drains west, just south of Drumtee Water, before converging with Drumtee Water.

Birk burn in the north east of site drains west to Craigendunton reservoir. Dunton Water has a SEPA overall status of "Good".

2.3.2 Hydrogeology

BGS 1:50,000 digital mapping and the BGS GeoIndex shows the Carboniferous Strathclyde Group bedrock beneath the Site is a Class 2C low productivity aquifer in which highly indurated greywackes have limited groundwater in the near-surface weathered zone and secondary fractures. As a result, the bedrock can locally yield only small amounts of groundwater with short and localised flow paths in near-surface weathered zone and secondary fractures.

2.4 Sources of Information

The following sources of information were used as part of the desk study investigations:

- British Geological Survey - Online GeoIndex;
- Ordnance Survey (OS) topographical information;
- Aerial and Satellite photography via Ordnance Survey and Google Earth.
- Soil Survey of Scotland - 'MacAulay Institute for Soil Research' 1984;
- Soil Survey of Scotland - 'Scottish Peat Surveys' 1964;
- Scottish Government (SG) - 'Peat Landslide Hazard and Risk Assessments' December 2017;

- Scottish Government, Scottish Natural Heritage, SEPA (2017) Peatland Survey, Guidance on Developments on Peatland;
- The Scottish Government - Scotland's Third National Planning Framework, 2014;
- The Scottish Government - Scottish Planning Policy, 2014;
- Assessments by other EIA specialists (specifically hydrology and ecology for data on sensitive receptors);
- Scotland's Environment Interactive Map

3 GUIDANCE AND METHODOLOGY

3.1 General Guidance on Peat Failure

The SG guidance divides peat instability into two categories[1], 'peat slides' and 'bog bursts'. The guidance states that peat slides have a greater risk of occurrence in areas where:

- Peat is encountered at or near to ground surface level;
- The thicknesses are recorded in the region of 2.0 m (above which, in general terms, peat instability would increase with peat thickness); and
- The slope gradients are steep (between 5° and 15°).

Figure 5 illustrates the 'Slope Gradients' at the site.

Bog bursts are considered to have a greater risk of occurrence in areas where:

- Peat depth is greater than 1.5 m; and
- Slope gradients are shallow (between 2° and 10°).

It should be noted however that peat instability events, although uncommon, can occur out with these limits and reports of bog bursts are generally restricted to the Republic and Northern Ireland.

Preparatory factors which effect the stability of peat slopes in the short to medium-term include:

- Loss of surface vegetation (deforestation);
- Changes in sub-surface hydrology;
- Increase in the mass of peat through accumulation, increase in water content and growth of tree planting; or
- Reduction in shear strength of peat or substrate due to chemical or physical weathering, progressive creep and tension cracking.

Triggering factors which can have immediate effect on peat stability and act on susceptible slopes include:

- Intensive rainfall or snow melt causing pressures along existing or potential peat/substrate interfaces;
- Snow melt;
- Alterations to drainage patterns, both surface and sub-surface;
- Peat extraction at the toe of the slope reducing the support of the upslope material;
- Peat loading (commonly due to stockpiling) causing an increase in shear stress; and
- Earthquakes or rapid ground accelerations such as blasting or mechanical movement.

Consideration of peat stability should form an integral part of the design of a windfarm development. While peat does not wholly provide a development constraint, areas of deep peat or peat deposits on steep slope should be either avoided through design and micro-siting or mitigation measures should be designed to avoid potential instability and movement.

3.2 Assessment Approach

This PSRA has been carried out in accordance Scottish Government (SG) guidance of 2017 titled 'Peat Landslide Hazard and Risk Assessments - Best Practice Guide for Proposed Electricity Generation Developments', Scottish Government.

[1] Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (2017): file://arcus01/Technical%20Information/Engineering/Geotechnical%20and%20Environmental%20Reference%20Documents/Peat/ScotGov-PeatLandslideHazardandRisk-2017.pdf (Accessed 13/01/2020)

In June 2014, the new 'Scottish Planning Policy' (SPP)[2] and 'National Planning Framework (NPF3)[3] were published. In relation to peat and the assessment of effects on resource, NPF3 references Scottish Natural Heritage 'Scotland's National Peatland Plan'. These policy, framework and guidance documents are therefore also considered in this PSRA. The PSRA undertaken is based on;

- Desk based assessment;
- Site visits;
- Historic peat probing data;
- Further peat probing including infrastructure specific probing; and
- A hazard and risk ranking assessment.

The area of the Development subject to assessment was determined by the Proposed Site Layout as provided by the client and included in the EIAR report in April 2021, which considered initial findings from desk studies and anticipated peat deposits as well as other physical and environmental constraints.

3.3 Peat Probing Methodology

Peat probing was undertaken by Arcus to inform the Peat Slide Risk Assessment and to supplement existing peat information, and primarily to cover the areas of infrastructure which had no peat depth data. This included capturing the remainder of the solar array areas with no data on a 50m x 50m grid basis. In addition to this, detailed probing data was collected along the grid connection route, at 50m centres and then adjacent either side in accordance with SG guidance.

Peat Cores were also obtained from the area of the green hydrogen electrolyser facility.

3.3.1 Development of Hazard Rank

The early stages of the PSRA includes a desk study of existing data, mapping and site visit. Following identification of peat depths within the Site, the assessment was carried out to determine the potential effects on the peat resource from construction activities which would include:

- Construction of tracks;
- Foundation construction;
- Grid Route excavations
- Construction of hardstanding/laydown; and
- Temporary Storage of Peat

An assessment of the peat probing data and a review of any available Site information would be undertaken and a hazard rank calculated zonally across the Development reflecting risk of peat instability/constraint to construction.

Where practical, the Development layout would be designed to avoid areas of a risk score above 'low'. Where this has not been achieved, areas affected have been discussed in both the EIA as having significant effect, with relative mitigation measures proposed to reduce this, and if required can be offered for the risk register which sets out specific mitigation measures which are considered necessary to reduce the risk of inducing instability.

[2] Scottish Government Scottish Planning Policy (2014): https://www.gov.scot/publications/scottish-planning-policy/ (Accessed 13/11/2019)

[3] Scottish Government National Planning Framework 3: https://www2.gov.scot/About/Performance/scotPerforms (Accessed 13/11/2019)

4 SITE SURVEYS

4.1 Introduction

The existing peat depths across the Site have been determined through a phased survey approach. The survey was initiated to inform the EIAR to inform the design of the development. Further probing then took place post submission in response to request for PSRA and therefore gathering further data to inform the PSRA.

Initial peat depth surveys were undertaken by McArthur Green throughout 2020 comprising 50 m grid coverage across the northern part of the Development area, primarily the solar area. This methodology was applied to the remainder of the solar area in May 2021 by Arcus. This method was in accordance with Scottish Government guidance for investigating peat.

Peat depths were measured along the proposed grid connection at 50 m centres with offsets of 25 m on either side of the centre line.

4.2 Peat Depth

Throughout the peat surveys to date across the Development, a total of 516 probes were sunk. Over 21% of these recorded no peat or peat less than 0.5 m, while over 17% recorded peat between 0.5 m and 1.0 m. Thick peat (where the depth was greater than 1.0 m) was recorded at almost 62% of locations.

Peat depths ranged from 0 m to 5.3 m depth across the study area and the average peat depth was 1.70m. The deepest peat at the site was recorded in the central area where the grid connection passed through the Mosses and Bog and there were localised deep pockets recorded in the north-eastern area of the electrolyser and in the topographic flat/low lying areas in and around the proposed solar areas in the north western site area.

Figure 7 'Interpolated Peat Depths' included in Appendix A illustrates the peat depths across the site area. The distribution of peat deposits along the proposed tracks and infrastructure are shown on Figure 6 'Recorded Peat Depths' is included in Appendix A.

Peat depths 1 are summarised in Table 1 while some key Site survey locations are illustrated in photographs 1 to 4. Additional photographs are included in Appendix C

Photograph 1 – Electrolyser Area Facing West

Photograph 2 – Southern Solar Area Facing West.

Photograph 3 – BESS Area Facing North

Photograph 4 – Grid Connection route Howeburn Moss Facing East

The peat slide risk assessment was undertaken on the Proposed Site layout as provided by client and submitted as part of the EIAR, April 2021. Table 1 summarises the peat depths recorded across the Site.

Table 1 – Peat Depth Summary

Peat Depth Range (m)	No of peat probes	Percentage of Total (%)
0.00 - 0.50	158	30.6
0.51 - 1.00	78	15.1
1.01 - 1.50	55	10.6
1.51 - 2.00	54	10.5
2.01 - 2.50	40	7.7
2.51 - 3.00	45	8.7
3.01 - 3.50	24	4.7
3.51 - 4.00	19	3.7
4.01 - 4.50	7	1.4
4.51 - 5.00	10	1.9
5.01 - 5.50	26	5.1

4.3 Substrate

To assist with the peat slide risk assessment, an estimation of the underlying substrate was obtained during the visit, comprising a resistance-based approach at base of probe.

- Gradual refusal – Clay;
- Crunching/Gritty – Weathered Rock/Gravel; or
- Abrupt Refusal/Hard – Rock

The substrate parameters are included in the Hazard and Exposure Assessment in Section 5 of this report.

4.4 Peat Cores

Two peat cores were obtained from the proposed Hydrogen Electrolyser within the greatest depths during the peat probing assessment, in order to further characterise the peatland. The methodology in which the peat coring was undertaken was guided by the Peatland Survey (2017) *Guidance on Developments on Peatland*[4], commissioned by the Scottish Government, Scottish National Heritage and SEPA. An outline of the methodology along with photographs and characterisation of the peat cores are presented in the Peat Coring Records in Annex B.

The cores samples were obtained between 0.9m and 2.3m from the west and east respectively. Beyond these depths the cores were either restricted by the underlying substrate or the peat was unrecoverable due to the near structureless nature of the material

Humification of peat is determined using the Von Post scale which indicates the degree to which peat has undergone humification or, more correctly, a type of decomposition which includes breakdown under anaerobic conditions. The Von Post Scale (H) ranges from 1 to 10, the higher the number the higher the degree of humification.

Humification values from the cores varied between 3 (0-0.50m) and 9 (from 2.0-2.30m) was recorded within the western core whilst humification values for the eastern core was 2 and 4 between 0 and 0.9m respectively.

The definitions of the Von Post values are presented in the Peat Coring Records in Appendix D.

[4] Scottish Government, Scottish Natural Heritage, SEPA (2017) Peatland Survey. *Guidance on Developments on Peatland*,

5 HAZARD AND EXPOSURE ASSESSMENT

5.1 Background

A 'Hazard Ranking' system has been applied across the Site based on the analysis of risk of peat landslide as outlined in the Scottish Government guidance. This is applied on the principle:

Hazard Ranking = Hazard x Exposure

Where 'Hazard' represents the likelihood of any peat slide event occurring and 'Exposure' being the impact or consequences that a peat slide may have on sensitive receptors that exist on and around the study area.

5.2 Methodology

The determination of Hazard and Exposure values is based on a number of variables which impact the likelihood of a peat slide (the Hazard), and the relative importance of these variables specific to the Site.

Similarly, the consequences or Exposure to receptors is dependent on variables including the particular scale of a peat slide, the distance it will travel and the sensitivity of the receptor.

In the absence of a predefined system, the approach to determining and categorising Hazard and Exposure is determined on a Site by Site basis. The particular system adopted for the Development PSRA assessment is outlined in the following sub sections.

5.3 Hazard Assessment

The potential for a peat slide to occur during the construction of a windfarm depends on several factors, the importance of which can vary from Site to Site. The principal factors considered in determining the hazard rank are:

- Peat depth;
- Slope gradient;
- Substrate material;

Further consideration is given to the conditions which surround each probe locations, therefore the assessment draws on the presence of the following to support the principal factors:

- Evidence of instability or potential instability (is there existing peat hags, cracks or other surface instabilities);
- Vegetation cover(is the vegetation intact or was there areas of bare peat); and
- Hydrology (the presence of surface watercourses/ditches etc).

Without a sufficient peat depth and a prevailing slope, peat slide hazard would be negligible for the Development, however the substrate material is also considered a relevant factor in relation to the mechanics of slide.

5.4 Hazard Rating

When several factors may impact on the Hazard potential, a relative ranking process is applied attributing different weighting to each factor as shown below.

Table 3: Coefficients for Slope Gradients

Slope Angle (degrees)	Slope Angle Coefficients
Slope < 2°	1
2° < Slope < 4°	2
4° < Slope < 8°	4
8° < Slope < 15°	6
Slope >15°	8

Table 4: Coefficients for Peat Thickness and Ground Conditions

Peat Thickness	Ground Conditions Coefficients
Peaty or organic soil (<0.5m)	1
Thin Peat (0.5 – 1.0m)	2
Deep Peat (>1.0m)	3*
Very Deep Peat (>3.0)	8

* - Note that thicker peat generally occurs in areas of shallow gradient and records indicate that thick peat does not generally occur on the steeper gradients.

Table 5: Coefficients for Substrate

Substrate Material	Substrate Coefficients
Gravel (G)	1
Rock (R)	1.5
Clay (C)	2
Not proven	2
Slip material (Existing materials)	5

The Hazard Rating Coefficient for a particular location is calculated using the following equation:

Hazard Rating Coefficient = Slope Gradient x Peat Thickness x Substrate

From the Hazard Rating Coefficient, the risk to stability can be ranked as set out in Table 6.

Table 6: Hazard Rating

Hazard Rating Co-efficient	Potential Stability Risk (Pre-Mitigation)
<5	Negligible
5 to 15	Low
16 to 30	Medium
31 to 50	High
> 50	Very High

5.5 Peat Stability Assessment

The likelihood of a particular slope or hillside failing can be expressed as a Factor of Safety. For any potential failure surface, there is a balance between the weight of the potential landslide (driving force or shear force) and the inherent strength of the soil or rock within the hillside (shear resistance).

The stability of a slope can be assessed by calculating the factor of safety F, which is the ratio of the sum of resisting forces (shear strength) and the sum of the destabilising forces (shear stress):

$$F = \frac{c' + (\gamma - m\gamma_w)z\cos^2\beta\tan\phi'}{\gamma z \sin\beta\cos\beta}$$

where c' is the effective cohesion, γ is the bulk unit weight of saturated peat, γ_w is the unit weight of water, m is the height of the water table as a fraction of the peat depth, z is the peat depth in the direction of normal stress, β is the angle of the slope to the horizontal and ϕ' is the effective angle of internal friction. Values of F < 1 indicate a slope would have undergone failure under the conditions modelled; values of F > 1 suggest conditions of stability.

Assumed geotechnical parameters have been sought from various literature values and for the purposes of the assessment in this report have the following average values have been utilised in the formula to inform the stability assessment;

C' – effective cohesion (kPa), typically ranging from 2.5 to 8.5 therefore **5.0** has been adopted for the purposes of the assessment.

ϕ – effective angle of friction (°), typically ranging from 21.6 to 43.5 therefore **29.6** has been adopted for the purposes of the assessment.

Υ – unit weight (kN/m2), typically ranging from 9.61 to 10, therefore **10** has been adopted for the purposes of the assessment.

In accordance with the best practice method, F values of <1.0 indicate slopes that would experience failure under the modelled conditions and as such are considered areas of high risk. However, Boylan et al (2008) indicate that a relatively high value of F=1.4 should be used to identify slopes with the potential for instability. Adopting a similar and more onerous approach, high risk areas are indicated where F is <1.0, medium risk areas are indicated between 1.01 to 1.50, low risk between 1.51 and 2.00 and very low/negligible values > 2.0.

Using digital terrain modelling and GPS co-ordinates of each peat probe, a factor of Safety, F has been calculated for each probe location which has been created through ArcGIS Spatial Analyst tools. The 'Factor of Safety Plan' is shown on Figure 8.

5.6 Exposure Assessment

The main Exposure receptors identified within the Site and surrounding area which could potentially be affected in the event of a peat slide were existing windfarm infrastructure, existing tracks, dwellings, watercourses and associated tributaries and sensitive habitats. The proposed infrastructure was also considered a receptor.

The impact of a peat slide on receptors can be assessed on a relative scale based on the potential for loss of habitat, a historical feature or disruption/danger to the public. To effectively assess the impact, the assessment of Exposure effect must also consider the distance between the hazard and the receptor, and the relative elevation between the two.

5.7 Exposure Rating

Similar to the Hazard Rating, the Exposure Ratings were determined using relative ranking process by attributing the different weighting systems to each factor as shown below:

Table 6: Coefficients for Receptor Type

Receptor	Receptor Coefficients
Electrolyser Laydown Area	2
PV Layout	3
Existing/Proposed Tracks/Temporary Compound	3
Minor watercourses and tributaries.	6
Electrolyser, New Cables/Grid Connection, BESS Compound	6
Residential Properties/Community, Watercourses/Lochs, Blanket Bog	8

Table 7: Coefficients for Distance from Receptor

Distance from Receptor	Distance Coefficients
> 1 km	1
100 m to 1 km	2
10 m to 100 m	3
<10 m	4

Table 8: Coefficients for Receptor Elevation

Receptor Elevation	Elevation Coefficients
< 10 m	1
10 m to 50 m	2
50 m to 100 m	3
> 100 m	4

The Exposure Rating Coefficient for a particular location is calculated using the following equation:

Exposure Rating Coefficient = Receptor x Distance x Elevation

From the Hazard Rating Coefficient, the risk to stability can be ranked as set out in Table 9.

Table 9: Exposure Rating

Exposure Rating Co-efficient	Potential Stability Risk (Pre-Mitigation)
<6	Very Low
7 to12	Low
13 to 24	High
25 to 30	Very High
>30	Extremely High

5.8 Rating Normalisation

In order to achieve an overall Hazard Ranking in accordance with the Scottish Government Guidance, the Hazard and Exposure Rating Coefficient derived from the coefficient tables are normalised as shown in Table 10.

Table 10: Rating Normalisation

Hazard Rating		**Exposure Rating**	
Current Scale	**Normalised Scale**	**Current Scale**	**Normalised Scale**
< 6 Negligible	1	<5 Very Low	1
7 to 12 Low	2	5 to 15 Low	2
13 to 24 Medium	3	16 to 30 High	3
25 to 30 High	4	31 to 50 Very High	4
>30 Very high	5	>50 Extremely High	5

The record of the Hazard Rank Assessment is included in Appendix B of this report.

6 HAZARD RANKING

Having identified the rating coefficients as defined in Section 5 of this report, it is possible to categorise areas of the Site with a Hazard Ranking by multiplying the Hazard and Exposure Rating. Hazard Ranking and associated suggested actions matrix are shown in Tables 11 and 12 below:

Table 11 - Hazard Ranking and Suggested Actions

Hazard Ranking		**Action Suggested in the Scottish Executive Guidance**
17-25	High	Avoid project development at these locations.
11-16	Medium	Project should not proceed unless hazard can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce hazard ranking to low or less
5-10	Low	Project may proceed pending further investigation to refine assessment. Mitigation of hazards maybe required through micro-siting or re-design at these locations.
1-4	Negligible	Project should proceed with monitoring and mitigation of peat landslide hazards at these locations as appropriate.

Table 12- Hazard Ranking Matrix

Hazard Rating	5	Low	Low	Medium	High	High
	4	Negligible	Low	Medium	Medium	High
	3	Negligible	Low	Low	Medium	Medium
	2	Negligible	Negligible	Low	Low	Low
	1	Negligible	Negligible	Negligible	Negligible	Low
		1	2	3	4	5
		Exposure Rating				

Receptor exposure was assessed for each of the twelve hazard zones using the approach in Section 5. A summary of the Hazard Ranking result for each identified area is summarised in Table 13 and is presented in Figure 9 'Hazard Ranking Zonation Plan'.

7 SLIDE RISK AND MITIGATION

7.1 General

This PSRA has shown the Site to be generally of negligible or low hazard ranking. There were isolated areas recorded as medium risk which were recorded in the solar area or along the grid connection. The location if these points lay within a generally wider zone dominated by low risk points and presented as a low risk.

Where the hazard ranking has been lowered through mitigation measures, the original ranking will remain in the overall hazard zoning plan and it should be acknowledged that the hazard zonation plan is based on the pre-mitigation status

While the specific recommended mitigation in low ranked areas are proposed other mitigation is embedded in the design at EIA stage, it is also necessary for detailed design and construction of the Development infrastructure to be undertaken in a competent and controlled manner.

The embedded mitigation and good practice measures are set out in Section 7.2. It should be noted that the mitigation measures defined are not exclusive and other forms of mitigation may well be required and should be developed by designers and implemented during construction of the scheme.

Table 13 – Hazard Rank

Hazard Area and Infrastructure		**Unmitigated Hazard**		**Mitigated Hazard**	
Hazard Area	**Infrastructure Affected**	**Ranking**	**Key Aspects**	**Potential Mitigation**	**Ranking**
H1	Existing Track, Proposed Track, Construction Compound,	Negligible	Location and topography: North-west of the site, south of Kingswell. Generally flat with some gentle slopes. Peat Depth: (min) 0.0m - (max) 1.0m. Slope Gradient: 0° to 8° Exposure: Existing Track, Proposed Track, Construction Compound	Best practice measures in relation to drainage prior to and during construction will be implemented and should be detailed in a Construction Environmental Management Plan. Management of excavated peat and peaty soils should be undertaken with care and in line with bet practices, and in accordance with a site specific Peat Management Plan. Micro-siting out with areas of deep peat where possible. Adoption of floating tracks in	Negligible

				areas of peat greater than 1.0m. Maintain a Geotechnical Risk Register throughout the works; Presence of geotechnical specialist on-site during the construction phase to undertake to provide monitoring and advice when required;	
H2	Proposed Tracks, Solar Panels	Low	Location and topography: North western site area, – Generally flat in the west with more gentle slopes and localised steep slopes to the east. Peat Depth: (min) 0.0m - (max) 3.500m. Slope Gradient: 0° to 15° Exposure: Proposed Tracks, Solar Panels, Minor Watercourse	Best practice measures in relation to drainage prior to and during construction will be implemented and should be detailed in a Construction Environmental Management Plan. Management of excavated peat and peaty soils should be undertaken with care and in line with bet practices, and in accordance with a site specific Peat Management Plan. Micro-siting out with areas of deep peat where possible. Adoption of floating tracks in areas of peat greater than 1.0m. Maintain a Geotechnical Risk Register throughout the works; Presence of geotechnical	Low

				specialist on-site during the construction phase to undertake to provide monitoring and advice when required;	
H3	Proposed Tracks, Solar Panels	Negligible	Location and topography: North-central solar site area, gently sloping in the north with steeper slopes in the southern zones. Peat Depth: (min) 0.1m - (max) 3.00m Slope Gradient: 0° to 15° Exposure: Proposed Tracks, Solar Panels, Minor Watercourse	Best practice measures in relation to drainage prior to and during construction will be implemented and should be detailed in a Construction Environmental Management Plan. Management of excavated peat and peaty soils should be undertaken with care and in line with bet practices, and in accordance with a site specific Peat Management Plan. Micro-siting out with areas of deep peat where possible. Adoption of floating tracks in areas of peat greater than 1.0m. Maintain a Geotechnical Risk Register throughout the works; Presence of geotechnical specialist on-site during the construction phase to undertake to provide monitoring and advice when required;	Negligible

H4	Solar Panels	Low	Location and topography: Gently sloping Peat Depth: (min) 0.1m (max) 1.0m. Slope Gradient: 2º to 15º Exposure: Solar Panels, Minor Watercourse	Best practice measures in relation to drainage prior to and during construction will be implemented and should be detailed in a Construction Environmental Management Plan. Management of excavated peat and peaty soils should be undertaken with care and in line with bet practices, and in accordance with a site specific Peat Management Plan. Micro-siting out with areas of deep peat where possible. Adoption of floating tracks in areas of peat greater than 1.0m. Maintain a Geotechnical Risk Register throughout the works; Presence of geotechnical specialist on-site during the construction phase to undertake to provide monitoring and advice when required;	Low
H5	Solar Panels and grid connection	Negligible	Location and topography: most southerly areas of solar development, just north of the Bught Burn, sloping south towards the burn.	Best practice measures in relation to drainage prior to and during construction will be implemented and should be detailed in a Construction	Negligible

			Peat Depth: (min) 0.0m - (max) 1.50m. Slope Gradient:2° to 15° Exposure: Solar Panels, Grid Connection, Minor Watercourse	Environmental Management Plan. Management of excavated peat and peaty soils should be undertaken with care and in line with bet practices, and in accordance with a site specific Peat Management Plan. Micro-siting out with areas of deep peat where possible. Adoption of floating tracks in areas of peat greater than 1.0m. Maintain a Geotechnical Risk Register throughout the works; Presence of geotechnical specialist on-site during the construction phase to undertake to provide monitoring and advice when required;	
H6	Solar Panels, Hydrogen Electrolyser and grid connection	Low	Location and topography: most south-easterly area of solar development, just north of the Bught Burn, sloping south towards the burn. Peat Depth: (min) 0.0m - (max) 4.0m. Slope Gradient:2° to 15° Exposure: Solar Panels, Grid	Best practice measures in relation to drainage prior to and during construction will be implemented and should be detailed in a Construction Environmental Management Plan. Management of excavated peat and peaty soils should be undertaken with care and in line with bet	Low

			Connection, Minor Watercourse	practices, and in accordance with a site specific Peat Management Plan. Micro-siting out with areas of deep peat where possible. Adoption of floating tracks in areas of peat greater than 1.0m. Maintain a Geotechnical Risk Register throughout the works; Presence of geotechnical specialist on-site during the construction phase to undertake to provide monitoring and advice when required;	
H7	Grid Connection	Negligible	Location and topography: South of Bught Burn, generally flatlying, blanket bog conditions. Peat Depth: (min) 0.0m - (max) 4.5m. Slope Gradient: 0° to 8° Exposure: Proposed Grid Connection, Minor Watercourses, Sensitive Habitats (Blanket Bog)	Best practice measures in relation to drainage prior to and during construction will be implemented and should be detailed in a Construction Environmental Management Plan. Management of excavated peat and peaty soils should be undertaken with care and in line with bet practices, and in accordance with a site specific Peat Management Plan. Micro-siting out with areas of deep peat where possible.	Negligible

				Adoption of floating tracks in areas of peat greater than 1.0m. Maintain a Geotechnical Risk Register throughout the works; Presence of geotechnical specialist on-site during the construction phase to undertake to provide monitoring and advice when required;	
H8	Grid Connection	Low	Location and topography: Howeburn Moss, Flow Moss, generally flatlying, blanket bog conditions located either side of Howe Burn. Peat Depth: (min) 0.0m - (max) 4.5m. Slope Gradient: 0° to 4° Exposure: Proposed Grid Connection, Minor Watercourses, Sensitive Habitats (Blanket Bog)	Best practice measures in relation to drainage prior to and during construction will be implemented and should be detailed in a Construction Environmental Management Plan. Management of excavated peat and peaty soils should be undertaken with care and in line with bet practices, and in accordance with a site specific Peat Management Plan. Micro-siting outw with areas of deep peat where possible. Adoption of floating tracks in areas of peat greater than 1.0m. Maintain a Geotechnical Risk Register	Low

				throughout the works; Presence of geotechnical specialist on-site during the construction phase to undertake to provide monitoring and advice when required;	
H9	Grid Connection	Negligible	Location and Topography: West of Craigendunton Reservoir, generally flatlying area within the eastern side of Flow Moss, blanket bog conditions Peat Depth: (min) 0.0m - (max) 4.5m. Slope Gradient: 0° to 4° Exposure: Proposed Grid Connection, Minor Watercourses, Sensitive Habitats (Blanket Bog)	Best practice measures in relation to drainage prior to and during construction will be implemented and should be detailed in a Construction Environmental Management Plan. Management of excavated peat and peaty soils should be undertaken with care and in line with bet practices, and in accordance with a site specific Peat Management Plan. Micro-siting out with areas of deep peat where possible. Adoption of floating tracks in areas of peat greater than 1.0m. Maintain a Geotechnical Risk Register throughout the works; Presence of geotechnical specialist on-site during the	Negligible

				construction phase to undertake to provide monitoring and advice when required;	
H10	Grid Connection	Low	Location and Topography: South of Craigendunton Reservoir and north of Rough Hill, generally flatlying area. Peat Depth: (min) 0.0m - (max) 4.5m. Slope Gradient: 2° to 8° Exposure: Proposed Grid Connection, Minor Watercourses, Sensitive Habitats (Blanket Bog)	Best practice measures in relation to drainage prior to and during construction will be implemented and should be detailed in a Construction Environmental Management Plan. Management of excavated peat and peaty soils should be undertaken with care and in line with bet practices, and in accordance with a site specific Peat Management Plan. Micro-siting out with areas of deep peat where possible. Adoption of floating tracks in areas of peat greater than 1.0m. Maintain a Geotechnical Risk Register throughout the works; Presence of geotechnical specialist on-site during the	Low

				construction phase to undertake to provide monitoring and advice when required;	
H11	Grid Connection, BESS Area	Negligible	Location and topography: Situated adjacent to existing windfarm tracks, north of Rough Hill Burn, generally flatlying area. Peat Depth: (min) 0.0m - (max) 1.0m. Slope Gradient: 0° to 4° Exposure: Proposed Grid Connection, BESS, Minor Watercourses.	Best practice measures in relation to drainage prior to and during construction will be implemented and should be detailed in a Construction Environmental Management Plan. Management of excavated peat and peaty soils should be undertaken with care and in line with bet practices, and in accordance with a site specific Peat Management Plan. Micro-siting out with areas of deep peat where possible. Adoption of floating tracks in areas of peat greater than 1.0m. Maintain a Geotechnical Risk Register throughout the works; Presence of geotechnical specialist on-site during the construction	Negligible

				phase to undertake to provide monitoring and advice when required;	
H12	Grid Connection	Low	Location and topography: Situated adjacent to existing windfarm tracks, north of Rough Hill Burn, generally flatlying area. Peat Depth: (min) 0.0m - (max) 2.5m. Slope Gradient: 0° to 8° Exposure: Proposed Grid Connection, Minor Watercourses.	Best practice measures in relation to drainage prior to and during construction will be implemented and should be detailed in a Construction Environmental Management Plan. Management of excavated peat and peaty soils should be undertaken with care and in line with bet practices, and in accordance with a site specific Peat Management Plan. Micro-siting out with areas of deep peat where possible. Adoption of floating tracks in areas of peat greater than 1.0m. Maintain a Geotechnical Risk Register throughout the works; Presence of geotechnical specialist on-site during the	Low

				construction phase to undertake to provide monitoring and advice when required;	

7.2 Embedded Mitigation

Embedded mitigation includes measures taken during design of the Development to reduce the potential for peat slide risk. In summary the principal measures that have been taken are:

- Locating infrastructure on shallower slopes, where possible; and
- Locating infrastructure on areas of shallow peat (or no peat) where possible.

7.3 Peat Slide Mitigation Recommendations

Mitigation measures are outlined in Table 13 above outlining general best practice mitigation that should be adopted, however this is not extensive and at a post consent stage could be supplemented by:

- Ground investigations prior to detailed design;
- Identification of areas sensitive to changes in drainage regime prior to detailed design;
- Update the PSRA as necessary following detailed ground investigations;
- Development of a drainage strategy that will not create areas of concentrated flow and will not affect the current peatland hydrology;
- Design of a Development drainage system for tracks and hardstanding that will require minimal ongoing maintenance during the operation of the windfarm;
- Inspection and maintenance of the drainage systems during construction and operation;
- Identification of suitable areas for stockpiling material during construction prior to commencement of works; and
- Consideration of specific construction methods appropriate for infrastructure in peat land (i.e. geogrids) as part of design Development.

8 PSRA CONCLUSIONS

This PSRA has been undertaken for the proposed Whitelee Solar, Battery and Hydrogen in accordance with the SG guidance. The early stages of the assessment included a desk study, historic peat probing across the Site, followed by further intensive probing exercise on the finalised Site layout design. The information gathered during this investigation was used to develop a Hazard Ranking across the Development Site.

The findings of the probing indicates varying depths of peat across the site, although generally shallower in northerly slopes where the solar panels are proposed, deepening locally with topography, particularly at the Hydrogen Electrolyser and thereafter relatively deep throughout the grid connection route.

Based on the peat depths recorded and resulting assessment and analysis, the PSRA has indicated that the majority of the Site is generally of 'Low' or 'Negligible' hazard rank mainly in areas where no infrastructure is proposed.

Notwithstanding this, infrastructure locations and existing site conditions should be checked on Site at the time of construction and micro-siting adopted if required in order to maintain the design objective of avoiding any potential peat slide risk.