South Kyle II Wind Farm

Peat Slide Risk Assessment

Vattenfall

31 March 2025 1365043

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Document history

Author	Orrin Bryers, Geo-Survey Engineer	21/08/2024
Checked	Sam Fisher, Senior Geotechnical Engineer	22/08/2024
Approved	Gavin Germaine	22/08/2024

Client Details	
Contact	Simon Lejeune
Client Name	Vattenfall
Address	St Andrew House Haugh Lane Hexham NE46 3QQ

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Local Office:

The Green House
Forrest Estate Dalry
Castle Douglas
DG7 3XS
SCOTLAND
UK
Tel: +44 (0) 1644 430 008

Registered Office:

The Natural Power Consultants Limited
The Green House
Forrest Estate, Dalry
Castle Douglas, Kirkcudbrightshire
DG7 3XS

Reg No: SC177881

VAT No: GB 243 6926 48

Contents

1. Introduction

This report details the Peat Stability Assessment undertaken at the proposed South Kyle II Wind Farm. The Proposed Development comprises x11 wind turbine generators (WTGs) with tip heights to 200m, a sub-station, temporary construction compound and associated infrastructure in the form of external wind turbine transformer housings, meteorological masts, crane hardstand areas, underground electricity cables, associated access tracks, temporary borrow pit, battery storage, green hydrogen storage and water crossings and drainage measures as necessary. The report is accompanied by the following map information:

- Figure A.1 Interpolated Peat Depth
- Figure A.2 Geomorphological Features
- Figure A.3 Slope Angle
- Figure A.4 Factor of Safety
- Figure A.5 Environmental Impact Zonation
- Figure A.6 Peat Stability Risk Zonation
- Figure A.7 Superficial Geology
- Figure A.8 Solid Geology

In addition to this report a Peat Management Plan (Doc No. 1355801) has been produced for the Proposed Development. Additional figures including The Carbon and Peatland Map are included within the wider EIAR.

1.1. Reporting Experience

Report Author: Orrin Bryers is a Geo-Survey Engineer at Natural Power and experienced geoscientist by training (holding a PhD, MSc, and BSc in the Geosciences). Orrin has also gained work experience as a Geoscience Intern (Capricorn Energy) and as a Research Associate working with geospatial data within a university research group. Orrin has conducted field work and reporting of numerous geotechnical studies for onshore wind and solar energy projects of similar terrain and ground conditions to South Kyle II Wind Farm.

Report Checker: Sam Fisher is a Senior Geotechnical Engineer at Natural Power and engineering geologist by training (MSc Engineering Geology) with greater than 7 years of relevant geotechnical experience. Sam has completed multiple peat slide risk assessments for wind energy projects across the UK and Ireland.

1.2. Objectives & Scope

This Peat Slide Risk Assessment (PSRA) comprises a semi-quantitative peat stability risk assessment. The primary objectives of this report are:

- Present a desk study pertinent to the subject of peat stability assessment at the Proposed Development;
- Report on walkover survey and geomorphological mapping exercise to inform the assessment;
- Identify any areas of existing instability or which may pose a risk to the Proposed Development;
- Qualitative and quantitative peat slide risk assessment;
- Provide robust and targeted recommendations for any future construction process and mitigate any potential contributory factors to elevated risk of instability.

This report and survey work has been undertaken in general accordance with the Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Development, second edition, published by the Scottish Government in April 2017.

The Peat Stability Risk Assessment utilises data and visual reconnaissance assessment collected during two main phases of site survey. This data and information are combined with a desk study and review of all salient published materials. The following data sources have been integrated into this assessment: (Table 1.1).

Table 1.1: PSRA Data Sources

Data Source	Location	Date
BGS – Onshore Geological Map Data: (Linear Features, Mass movement deposits, Artificial ground, superficial deposits, hydrogeology, bedrock geology, faulting,1:50,000 scale)	http://mapapps2.bgs.ac.uk/geoindex/home.html	2024
BGS – Engineering Geology Viewer: 1:1M Superficial Engineering Geology; 1:1M Bedrock Engineering Geology	http://mapapps.bgs.ac.uk/engineeringgeology/home.html	2024
Historical Aerial Photograph Data ESRI Satellite World Imagery Google Earth Professional Bing Virtual Earth	https://server.arcgisonline.com/ArcGIS/rest/services/World_Imagery/MapServer/tile/{z}/{y}/{x}	2024
Online news archival search	Various web-based search engines	2024

Source: Natural Power

Assessment of potential instability at the Proposed Development was carried out according to the following work programme:

- Desk Study and review of existing site information carried out in August 2022, including desk-based mapping and site modelling.
- Site reconnaissance survey (August and December 2022). This comprised a walkover survey of the site and identification of potential geo-hazards.
- Desk based aerial image review of open-source available Google Earth and Bing Aerial Images (August 2024).
- Development-wide peat probing survey comprising: An initial site wide peat probe survey within the turbine envelope on a grid resolution of 100m (August 2022), Phase I Survey
- An additional survey at T1, T5 and the Substation building at 10m grid resolution (December 2022) followed by a development-wide 50 m grid resolution survey (June 2023), Phase I Infill Survey.
- Detailed peat probing survey covering areas of peatland and designed infrastructure at higher resolution (10 x 10 m) and proposed access track probing at 50 m spacing with 10 m and 20 m offsets (April 2024), Phase II Survey.
- Further detailed peat probing was conducted in April and August 2024 to cover additional track and hardstand areas, Phase II Infill Survey
- Assessment of peat undrained shear strength through in-situ hand shear vane testing across representative turbine locations within the design envelope (April 2024).

- Development-wide mapping and assessment of salient features such as active, incipient or relic instability within the peat deposits, geomorphological features, peat depth and composition (August and December 2022).
- Quantitative slope stability assessment based on in-situ shear strength data.
- Assessment of the potential risk of peat failure across the turbine envelope.
- Comparison of the potential risk of peat failure with the site hydrological model including proximity to watercourses and sensitivity of those features.
- Recommendations for detailed design/construction control with specific examination the need for measures to mitigate potential peat failure as part of any future wind farm development.

1.3. Detailed Description of Development

The Proposed Development is located to the east of Dalmellington and south-west of New Cumnock. It lies wholly within an area of forestry owned and managed by Forestry and Land Scotland (FLS). The infrastructure is located across multiple hills, such as Benbrack and Clawfin Hill, with the max topographical height of the Proposed Development being 516 m Above Ordnance Datum (AoD) with the Proposed Development Area spanning 21.8 hectares. The north-western edge of the Proposed Development Site is bound by the B741 with the southern extent consisting of other wind farm developments, including the operational South Kyle Wind Farm development.

The Proposed Development is dominated by commercial forestry which is owned and managed by Forestry and Land Scotland (FLS). The forestry is made up of various growth stages with areas of fell, mature trees and recently planted areas. The topography of the site varies due to the multitude of hills and upland watercourses that form the steep-sided valleys.

The Proposed Development is summarised as follows:

- Up to 11 wind turbines up to 200 m to tip height
- Turbine foundations and hardstandings;
- Onsite substation;
- Battery storage facility;
- Hydrogen storage facility
- External transformer housing;
- Crane pads;
- Access tracks;
- Underground electricity cables;
- Permanent anemometry mast;
- 1 Borrow pit;
- Temporary construction and storage compounds and ancillary infrastructure;
- Site signage;
- Temporary construction gatehouse; and
- Drainage and drainage attenuation measures (as required).
- Underground cables linking the turbines to the grid connection

1.4. Location

Regional and local setting is shown below in Figures 1.1 and 1.2. The Proposed Development is located to the east of Dalmellington and south-west of New Cumnock. The infrastructure is located across multiple hills, such as Benbrack and Clawfin Hill, with the max topographical height of the Proposed Development being 537 m with the Proposed Development Area spanning 21.8 hectares. The north-western edge of the Proposed Development Site is bound by the B741 with the southern extent consisting of other wind farm developments, including the South Kyle Wind Farm development.

Source: Natural Power, Google Maps

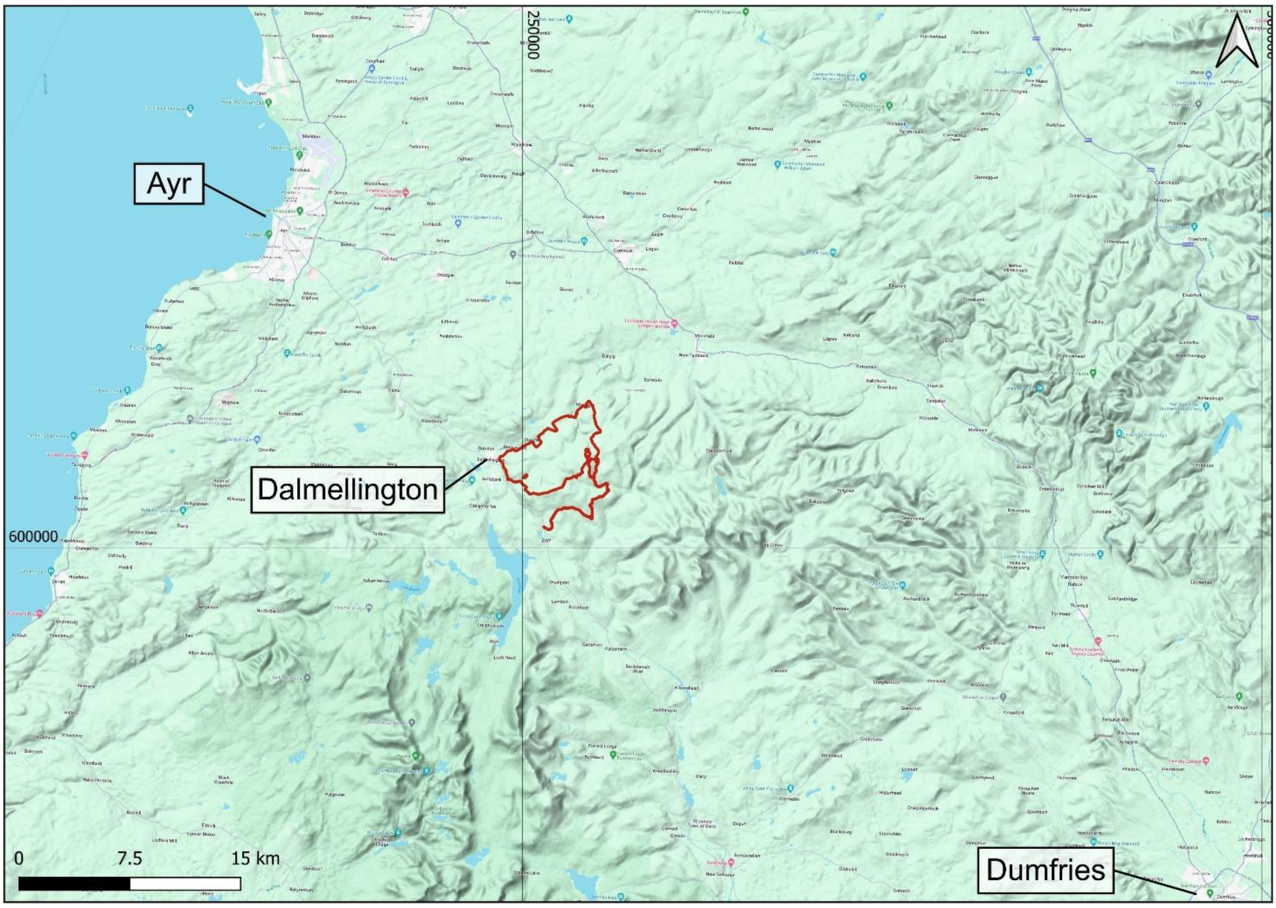


Figure 1.1: Regional Setting (Proposed Development highlighted by red polygon)

Source: Natural Power, Google Sattelite Imagery

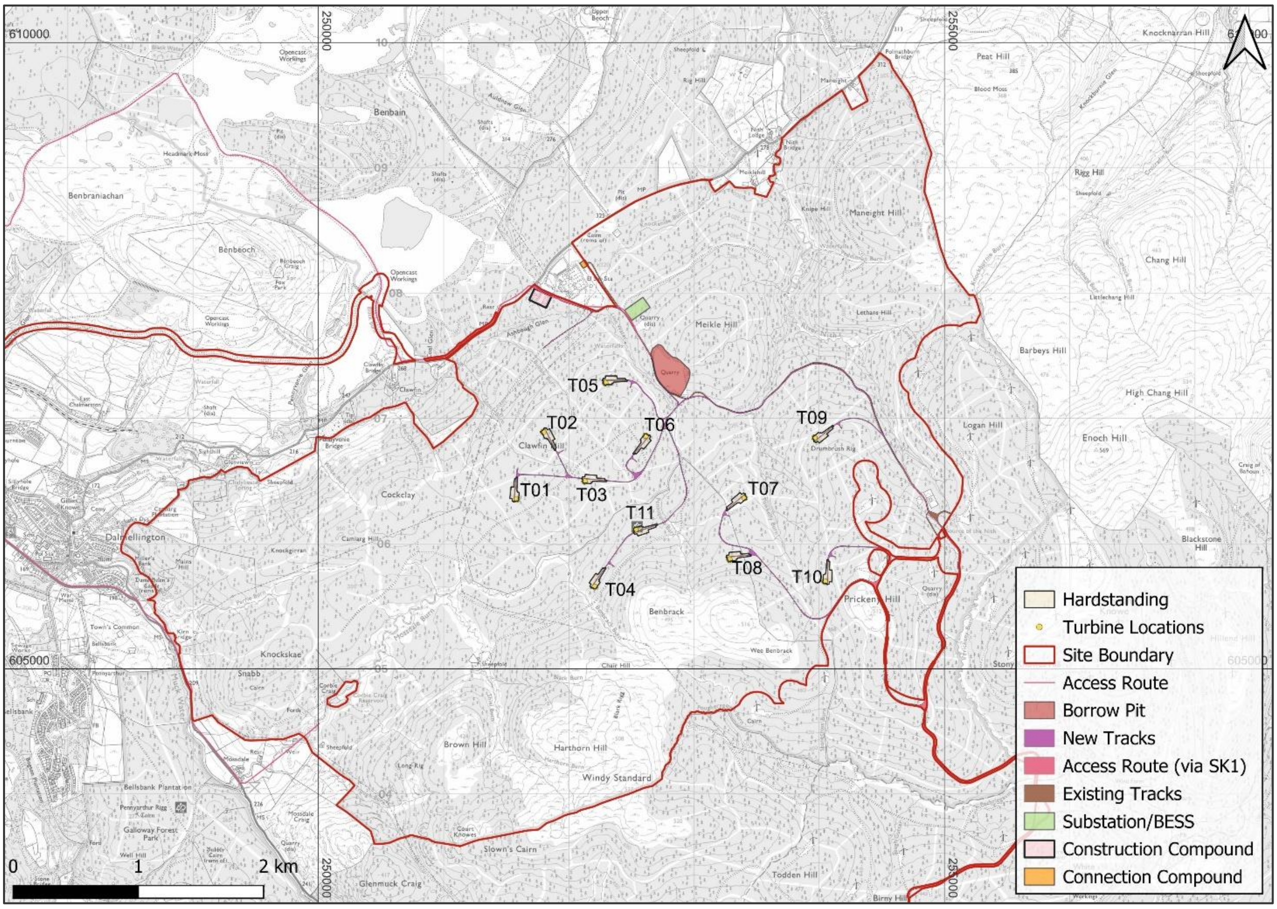


Figure 1.2: Site layout with approximate Turbine Locations and associated infrastructure

1.5. Terrain Description

The Proposed Development infrastructure locations occupy relatively elevated positions of gently to moderately undulating terrain used for commercial forestry which is either mature or clear-felled. The area contains variable deposits of peat that are mostly found on the relatively higher positions and numerous burns with moderate to steep valley sides. Modern and historical Satellite imagery show that several parts of the site are used for extracting rock (quarries to the west of Meikle Hill) but elsewhere there is no sign of land use except for commercial forestry. The Site is bound to the north and northwest by the B741 road whilst the other edges of the site boundary are formed by operational wind farms such as South Kyle Wind Farm.

Peat is present across the majority of the site, with depth varying greatly, from none where bedrock outcrops or is close to the surface, to circa 4 m in the centre of flat boggy areas. The most significant depths of peat within the Proposed Development Area are found in the broad valley floors southeast of Clawfin Hill (southeast of T03), south of Meikle Hill (east of T06) and west of Benbrack (west of T04). Erosive features including occasional peat hags. Due to the presence of commercial forestry across most of the Site, it is difficult to identify other erosional or slope stability features.

The topographic low of the Site is 209m AOD at the western edge to the west of Snabb (249025E, 604895N). Although the topography is variable across the Site, elevation reaches its maximum towards the south at Windy Standard (537m AoD, 252446E, 604042N).

The Proposed Development lies within the watershed of the River Doon, River Nith, and the River Dee.

The largest of these, the River Doon, has two primary watercourses known as the Mossdale Burn and the Linn Water which both have multiple tributaries. Mossdale Burn flows to the southwest and connects to Muck Water. It has multiple tributaries Benbrack Burn which flows to the northwest. Linn Water originates near the top of Benbrack and flows to the southwest and has multiple unnamed tributaries. It eventually flows to the town of Dalmellington to the west of the Site.

The River Nith, situated in the eastern extent of the Proposed Development Area, is sourced from between Drumbrush Rig and Logan Hill and flows to the north. It has multiple tributaries such as the Loup Burn and Powkelly Burn.

The River Dee is found in the southern area of the Proposed Development Area and flows in a south-easterly direction. It has numerous watercourses that lead to it from within the Site Boundary such as Pochiegavin Burn, Black Burn and Murray's Burn.

All proposed turbine locations are situated on the relatively elevated gentle to moderately sloping uplands used for commercial forestry.

The key findings of the site reconnaissance are represented on the Geomorphological Map (Doc No. 1354443, Appendix A.2). A selection of photographs taken during the walkover survey depict the range of site environs, provided below.

Figure 1.3: Peat hags observed in the open moorland on the eastern peripheries of the Site Boundary

Figure 1.4: Mature commercial forestry which shows damaged trees because of wind blow.

Figure 1.5: Heathland alongside young trees and areas of exposed peat located in the ride between sections of mature forestry.

Figure 1.6: Heathland dominated landscape found in the rides between zones of mature commercial forestry.

2. Survey Methodology

2.1. Data Review

In preparation of this report, an initial desk-based assessment has been undertaken to allow subsequent surveys to be targeted. Table 1.1 highlights the key sources of information for this report.

Readily accessible aerial imagery records dating to 2006 do not show any major changes occurring through to the present day within the Proposed Development Area. Historical mapping available from the National Library of Scotland shows that there were several key historical changes to the land use within the Proposed Development up to present day. Firstly, large areas of undeveloped land mapped as open moorland were developed into commercial forestry plantations in the 1960's-1970's. This industry has remained dominant within the Proposed Development to modern day. More recently, the South Kyle Wind Farm has been developed in the west – southwest area of the Site (operational since 2023). Beyond the Site Boundary, further commercial forestry developed in areas of previously open moorland and in the 19th to 20th century mining activities (predominantly iron and coal mining) brought the development of infrastructure like railways and workers housings (for example in Dalmellington to the northwest of the Site Boundary).

Natural Power's project directory and online sources were searched for reports of peat slide incidents on adjacent wind farm developments. These searches did not provide any pertinent information.

2.2. Geomorphology

Reconnaissance and geomorphological mapping were carried out during August 2022. This exercise provided opportunity for geotechnical engineers to visualise the terrain, access geological and soil exposures, examine slope systems, vegetation cover and record any hydrological features impacting peat stability.

No historical peat slides were identified during the site walkover or from aerial photographs.

No evidence of cracking, compression features of peat creep was identified during the site walkover. As described and illustrated in Section 1.5 and 1.6, evidence of damaged peat in the form of peat hag collapse were identified on the Proposed Development. Although these features are not typically associated with major peat instability, they can increase weathering rates and influence water flow pathways.

From the aerial photography and site visit there was no evidence of slope instability at the Proposed Development. Assessment of soil and rock slope stability will be important during future ground investigations including storage locations of overburden material. The BGS does not record any further evidence of slope stability within the site boundary.

The culmination of this survey and desk-based review of aerial photographs was the production of a geomorphology map, (Doc No. 1354443, Appendix A.2). This map was used in the qualitative stability risk assessment and maps the major features across the development pertinent to the risk model.

2.3. Peat Survey

The soil probing coverage has allowed for:

- Development-wide peat probing survey comprising: An initial site wide peat probe survey within the turbine envelope on a grid resolution of 100m (August 2022), Phase I Survey
- An additional survey at T1, T5 and the Substation building at 10m grid resolution (December 2022) followed by a development-wide 50 m grid resolution survey (June 2023), Phase I Infill Survey.
- Detailed peat probing survey covering areas of peatland and designed infrastructure at higher resolution (10 x 10 m) and proposed access track probing at 50 m spacing with 10 m and 20 m offsets (April 2024), Phase II Survey.
- Further detailed peat probing was conducted in April and August 2024 to cover additional track and hardstand areas, Phase II Infill Survey.

Peat depths were recorded using probes inserted into the peat and measuring the depth to refusal. This provides a wide-ranging dataset but carries the following limitations.

- Peat probes may record depth to obstructions (e.g., tree roots, rock clasts) and not the true depth of the peat;
- Peat probes may over-estimate peat depth where the underlying soil strata is very soft;
- Peat probes can underestimate peat depth in very dry peat deposits due to early refusal of the probe;
- Peat probes do not differentiate between peat and mineral sub-soils.

In-situ hand shear vane tests were conducted to provide an estimate of undrained shear strength within the peat at a chosen selection of deeper peat across the site and at relevant turbine locations where peat was encountered deeper than 0.50m. Supplementary to this, peat cores have been taken at select locations to provide confirmation of probe depth correlation, material classification and morphology.

Peat depth mapping is shown in Appendix A.1 (IFS Doc no. 1290311). To prepare the interpolated peat depth mapping; a spatial interpolation method termed ‘Ordinary Kriging’ was applied.

This is a statistical interpolation function that examines point data (and weights the surrounding measured values) to derive a prediction for unmeasured locations. Ordinary Kriging is considered generally acceptable for geological / soil science applications. Limitations of the Kriging method are widely accepted to be:

- Confidence in the output related to number and density of points within the input dataset.
- Search window needs to be set to limit influence of distant data points.

The interpolation parameters and peat depth data set are deemed suitable for informing the peat slide risk assessment. Figure A.1 appended to this report, indicates interpolated peat depth across site, a total of 4,966 peat probe data points were acquired during the phase one and two surveys.

2.4. Slope Mapping

The Slope Angle Map (Appendix A.3, IFS Doc No. 1354466) is comprised from digital elevation model data, carrying a grid resolution of 5m. The risk assessment considers slope angle in two aspects. Firstly, the slope angle is used to screen the site for instability within the slope stability analysis numerical calculation. This is adjoined to qualitative assessment of the slope in terms of a contributory factor to failure. This combined approach ensures a robust assessment of the risk.

3. Geology & Environment

3.1. Superficial Deposits

The BGS onshore GeoIndex indicates areas of Proposed Development to be covered with Peat and Till (Diamicton), localised deposits of Alluvium (Silt, Sand and Gravel) found along the modern watercourses mainly in the southwestern parts of the Site, and highly localised Glaciofluvial Deposits (Gravel, Sand and Silt) found adjacent to T11. A Superficial Geology Map utilising the BGS 1:50,000 Superficial Deposits map can be found in Appendix A.7 of this report.

Peat – partially decomposed mass of semi-carbonized vegetation which has grown under waterlogged, anaerobic conditions, usually in bogs or swamps.

Alluvium – described as a general term for clay, silt, sand and gravel. It is the unconsolidated detrital material deposited by a river, stream or other body of running water as a sorted or semi-sorted sediment in the bed of the stream or on its floodplain or delta, or as a cone or fan at the base of a mountain slope. Synonym: alluvial deposits. Normally soft to firm consolidated, compressible silty clay, but can contain layers of silt, sand, peat and basal gravel. A stronger, desiccated surface zone may be present.

Till –Till is unsorted and unstratified drift, generally overconsolidated, deposited directly by and underneath a glacier without subsequent reworking by water from the glacier. It consists of a heterogenous mixture of clay, sand, gravel, and boulders varying widely in size and shape (diamicton).

Glaciofluvial Deposits - deposited by meltwater streams. Includes mostly coarse-grained sediments (i.e. sand and gravel) with some finer-grained layers (i.e. clay and silt). Sand and gravel, locally with lenses of silt, clay or organic material.

The 1:1M Superficial Engineering Geology Map by the BGS shows Fine Till, Organic Soil and Fine Soil on the site. The GSNI provides the following engineering geology information on these:

Fine Till

Description: Firm to very stiff or hard slightly gravelly sandy CLAY with interbeds of laminated clay/silt and beds/lenses of sand and gravel. Often fissured, particularly in the upper few metres. Low to high permeability flow dominantly through lenses/interbeds of sand and gravel.

Foundations: Variable but generally good foundation conditions dependant on shear strength, consolidation characteristics and presence of water-bearing sand and silt layers/lenses. Differential settlement possible where foundations overlap fine and coarse soils.

Excavation: Easy digging. Excavations likely to require immediate support due to water-bearing layers/lenses of silt, sand and gravel.

Engineered Fill: Suitable as general cohesive fill depending on plasticity and water content. Generally, should be placed as soon as possible after excavation and subject to minimum construction traffic when wet.

Site Investigation: Important to determine deposit thickness and lithological variation, including the presence of laminated silts and clays and water-bearing sand and gravel layers.

The glacial till will most likely form a substrate and sub-soil to the peat deposits. The heterogenous nature of this material will give rise to a wide range of geotechnical behaviours. Where soft cohesive clays are present this may create conditions for sliding and mass movement.

In this assessment, peat slide has been assessed based on sliding within or at the base of the peat layer; and not within the underlying soil substrate. Loose poorly consolidated granular soil deposits can also create marginally stable terrain. These issues would be investigated in detail by a future phase of intrusive geotechnical investigation.

Organic Soil

Description: Very soft to firm fibrous to amorphous PEAT. Deposits may be selectively worked to shallow depth in some areas. Very low to moderate permeability flow dominantly through matrix.

Foundations: Very poor foundation conditions. Very weak and highly compressible deposits acidic groundwater may pose a risk to buried steel and concrete. Specialist very low load or 'floating' foundations may be suitable in some cases but, where possible, deposits at surface should be removed or pile foundations to stronger deposits employed.

Excavation: Easy digging but poor trafficability may require specialist machinery. Requires immediate support and dewatering. Dewatering will lead to surface lowering and oxidation of peat.

Engineered Fill: Unsuitable for use as fill. May be suitable for reuse as topsoil if mixed with other material.

Site Investigation: Important to determine extent and depth of peat deposits. Groundwater acidity should be determined prior to selection of buried concrete.

Fine Soil

Description: Very soft to very stiff sometimes sandy CLAY or SILT. Desiccation of top few metres may result in firm to stiff material overlying soft to very soft deposits at depth. Generally very low to moderate permeability flow dominantly through fissures. Includes lacustrine deposits, glaciolacustrine deposits, fine marine deposits, estuarine alluvium and lowland river alluvium (any of which may contain peat beds or lenses) and loess/loessic soils.

Foundations: Variable foundation conditions, dependant on shear strength and consolidation characteristics. Settlement rates usually slow but with potentially high total settlements. Possible foundation design considerations may include the potential risk of severe differential settlements in soft, highly compressible zones the potential for sudden collapse of loessic deposits when saturated under engineering loads potentially high sulphide contents of some estuarine alluvium and frost-susceptibility of near surface silty and fine sandy lithologies.

Excavation: Easy digging. Excavations usually require immediate support but stiff clays may be stable in short-term where groundwater ingress is controlled or absent. Running conditions may occur in silts and sands below the water table presence of water-bearing sand/silt layers will require groundwater control measures.

Engineered Fill: May be suitable as selected cohesive fill depending on grading, plasticity, water content and sulphate/sulphide contents where buried concrete and steel are likely to be used otherwise suitable as general cohesive fill. Generally, should be placed as soon as possible after excavation and subject to minimum construction traffic when wet. Material containing a significant proportion of organics, such as some alluvium, are unsuitable as fill.

Site Investigation: Important to determine lithological variability and the presence, depth and extent of any soft compressible zones (and depth to sound strata). Assessment of shrink-swell potential and sulphate/sulphide contents in clay deposits and the potential for rapid collapse settlement in loessic deposits is advisable. In situ loading tests advisable to assess bearing strength at selected sites.

Peat Coverage

Determined by the Natural Power Phase I and 2 surveys and is shown in the Interpolated Peat Depth map in Figure A.1 appended to this report

Peat Details

11 peat cores were carried out across the site using a shear gouge. Peat cores were undertaken at turbine centres for T01, T03, T06, T07, T08, T09 and T10 and at x4 new proposed track positions (Track 1 – 4).

Each core is photographed, given a general description, water content estimate (B) and Von Post rating (H) (Table 3.2). Peat deposit characteristics vary across the site. The core generally refused at the base of the peat. All Peat Cores and photographs are displayed in Appendix B.2 of this report. Examples of peat core are shown below in Figure 3.1.

Source: Natural Power, Phase 2 Site Survey.

Figure 3.1: Photo of peat core undertaken at T01 m depth 0-0.60m)

Hand shear vanes were undertaken at all peat core locations where there was sufficient peat for a reading. (Generally, peat depths >0.50m). Shear values are generally moderate strength across the locations.

None of the deposits are considered dry (B2 to B6 Wetness) and have humification levels between H2 and H9. Samples were collected and laboratory chemical testing was carried out on cored samples from positions T01 (0-1.0m), T03 (0-0.90m), T07 (0-1.0m), T08 (0-1.10m) and T09 (0-0.80m).

Table 3.1: Peat Core Descriptions

Location ID	Top depth	Bottom depth	Log
T03	0.00	0.30	Soft dark brown plastic fibrous PEAT (H6/B5)
	0.30	0.50	Firm dark brown spongey fibrous PEAT (H6/B5)
	0.50	0.90	Soft brown plastic pseudo-fibrous PEAT (H7/B6)
T09	0.00	0.30	Soft dark brown spongey fibrous PEAT (H4/B3)
	0.30	0.80	Firm brown plastic pseudo-fibrous PEAT (H7/B2)
T01	0.00	0.40	Soft brown sponge fibrous PEAT (H6/B5)
	0.40	0.65	Firm dark brown plastic pseudo-fibrous PEAT (H7/B4)
T08	0.00	0.40	Soft dark brown plastic pseudo-fibrous PEAT (H6/B2)
	0.40	1.10	Soft brown plastic pseudo-fibrous PEAT (H7/B6)
T07	0.00	0.30	Soft brown plastic pseudo-fibrous PEAT (H5/B2)
	0.30	0.80	Soft brown plastic pseudo-fibrous PEAT (H7/B6)
	0.80	1.00	Very soft dark brown plastic amorphous PEAT (H9/B2)
T06	0.00	0.20	Soft brown spongey fibrous PEAT (H3/B2)
	0.20	0.50	Soft brown plastic pseudo-fibrous PEAT (H7/B3)

T10	0.00	0.20	Soft brown spongey fibrous PEAT (H5/B5)
	0.20	0.70	Firm brown plastic pseudo-fibrous PEAT (H7/B3)
Track 1 (PP-1044)	0	0.10	Firm brown spongey fibrous PEAT (H2/B6)
	0.10	0.80	Firm brown spongey fibrous PEAT (H5/B5)
	0.80	1.20	Soft brown plastic pseudo-fibrous PEAT (H6/B4)
	1.20	1.80	Soft black plastic pseudo-fibrous PEAT (H7/B3)
Track 2 (PP-1064)	0	0.80	Soft brown spongey fibrous PEAT (H6/B5)
Track 3 (PP-1434)	0	0.80	Soft brown spongey fibrous PEAT (H6/B5)
	0.80	1.60	Soft brown plastic pseudo-fibrous PEAT (H6/B4)
	1.60	1.80	Firm black plastic amorphic PEAT (H9/B2)
Track 4 (PP-1134)	0	0.30	Soft brown spongey fibrous PEAT (H6/B4)
	0.30	0.80	Soft brown plastic pseudo-fibrous PEAT (H7/B4)

The results from the laboratory chemical testing showed that Total Organic Carbon ranged from 32% (T01) to 43% (T09). These results are available in Appendix B.4 of this report.

3.2. Peat Depth Analysis

Natural Power carried out at total of 4,883* peat probes across the site during the Phase I and Phase II peat surveys. Table 3.3 below presents the combined data collected across both surveys.

Table 3.2: Peat Probe Data

Peat Depth	Number of probes	% (Of total)
<0.50m	2105	43.1
0.5m < x ≤ 1.0m	1721	35.2
1.0m < x ≤2.0m	815	16.7
2.0m < x ≤ 3.0m	229	4.7
>3.0m	13	0.3

*Source: Natural Power peat probing survey data. *Total number of depth points collected was 5,049 as 98/5,147 probe points were inaccessible).*

The collected peat probe depths suggest that the majority of the site is covered by significant amounts of peat, with a peat depth average of 0.79m. There are several deep pockets of peat in excess of 3.0m, with a maximum depth of 3.8m. The most extensive areas of deep peat within the Proposed Development Area are found in the broad valley floors southeast of Clawfin Hill (southeast of T03), south of Meikle Hill (east of T06) and west of Benbrack (west of T04). In general, the proposed infrastructure avoids the deepest peat deposits across the site.

Turbines with probing depths less than 0.50m are considered to not be peat and rather peaty soil or topsoils. In this case there is not considered to be any peat slide risk where the average peat depth across the turbine is less than 0.50m. The peat depth interpolation map is appended to this report (Figure A.1).

Peat Depth at Infrastructure Locations

Table 3.3 summarises the peat depths recorded across the proposed wind turbine location, borrow pits, construction compound and substation.

Table 3.3: Overview of Peat Depth at Turbines and Ancillary Infrastructure

Depth Range	0 – 1.0m	1.0 – 2.0m	2.0m – 3.0m	>3.0m
Location	**Peat Depth Turbine Centre (m)**	**Peat Depth (m) Hardstanding**	**Slope Geometry (Degrees)**	**Comments**
T01	0.67	0.78	6	
T02	0.52	0.59	2	
T03	1.40	1.81	4	
T04	0.41	1.12	10	
T05	0.68	0.54	5	
T06	0.36	0.71	5	
T07	0.90	0.72	7	
T08	0.98	1.03	4	
T09	0.48	0.54	6	
T10	0.62	0.61	8	
T11	0.52	0.58	6	
Substation Building/Battery Storage Facility	0.38		7	
Temporary Construction Compound*	1.00		2.5	*Located on existing hardstanding associated with South Kyle I Wind Farm to be expanded during construction and fully reinstated following completion of works

Source: Natural Power

Peat Depth on Access Tracks

The peat depths across the proposed new access tracks are generally quite high, with a site wide average of 0.65m over all proposed new tracks. Deeper areas are confined to localised pockets. Table 3.4 summarises the mean peat depth along discrete sections of the proposed new wind farm access tracks where the mean peat depths are greater than 0.50m.

Table 3.4: Overview of Peat Depths at tracks crossing Peat over 0.50m

Depth Range	0 – 1.0m	1.0 – 2.0m	2.0m – 3.0m	>3.0m
Location	**Average Peat Depth (m)**			**Comments**
Track Section 1: New track southwest of Prickeny Hill (253956E, 605397N) to T08 hardstanding (253454E, 605909N)	0.66			2x water crossings on track section (unnamed tributaries of the Powkelly Burn)
Track Section 2: New track from north of Prickeny Hill (254471E, 605971N) to T10 hardstanding (254072E,605870 N)	0.70			
Track Section 3: New track between T08 and T07 hardstanding (from 253447E, 605929N to 253254E, 606261N)	0.67			
Track Section 4: New track to T9 hardstanding at Drumbrush Rig (from 254515E, 606854N to 254112E, 606939N)	0.56			
Track Section 5: New track to T11 hardstanding (from 252914E, 606325N to 252707E, 606150N)	0.63			1x watercrossing (Penniquite Burn)
Track Section 6: New track to T06 hardstanding (from 252540E,	0.92			

Depth Range	0 – 1.0m	1.0 – 2.0m	2.0m – 3.0m	>3.0m
606542N to 252520E, 606715N)				
Track Section 7: New track heading west toward T03 hardstanding (from 252539E,606536N to 252303E, 606502N)	0.80			
Track Section 8: New track heading west from T03 to T01 hardstanding (from 252103E, 606520N to 251585E, 606521N)	0.81			
Track Section 9: New track from existing track to T02 hardstanding (from 252002E, 606534N to 251897E, 606743N)	0.87			1x watercrossing (Stony Burn)

Source: Natural Power

Estimation of Peat Shear Strength

20 Hand shear tests were carried out at core locations where peat depths allowed. Each test was carried out using a Geonor H-60 Hand Shear Vane Tester using a 33mm steel vane. The corrected HSV results are presented within Appendix B.3.

Figure 3.1 depicts the peak undrained shear strength data against depth.

Source: Natural Power, Hand Shear Vane Results

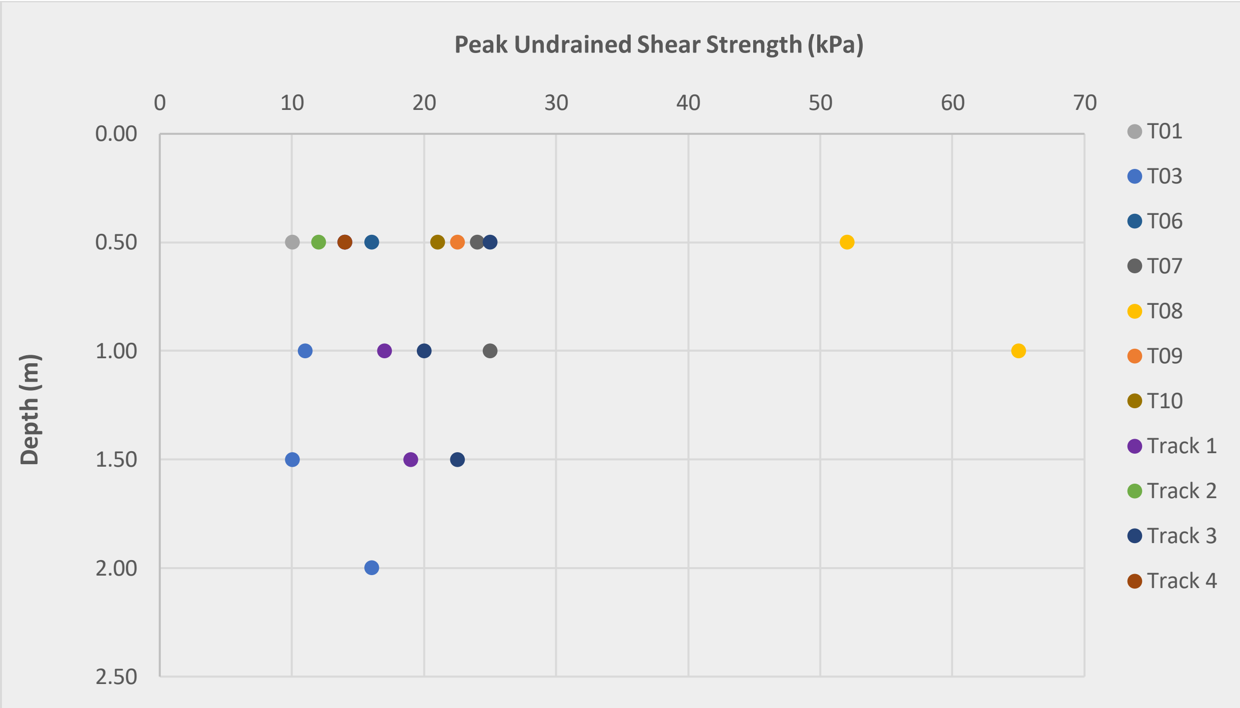


Figure 3.2: Peak Undrained Shear Strength (kPa) against Depth (mbgl) across the areas of key infrastructure at the Proposed Development.

The peak undrained shear strength is seen to be generally medium to high across the test points, from 10 to 65 kPa within the peat deposits with a slight trend showing increasing shear strength with depth. The site wide average is 21.5 kPa (strength), so a conservative value of 10 kPa is considered appropriate for the site wide slope analysis.

Residual undrained shear strength ranged from 6 to 42 kPa and showed a site wide average of 18 kPa.

Humification of Peat

The peat cores undertaken on site are presented in Appendix B.1. The peat has been characterised according to the von post classification (Von Post & Granland, 1926), Table 3.5 sets out the Von Post classification.

Table 3.5: Von Post Classification

Degree of Humification	Peat Description
H1	Completely unconverted and mud-free peat which when pressed in the hand only gives off clear water. Plant remains are easily identified.
H2	Practically unconverted and mud free peat which when pressed in the hand gives off almost clear colourless water. Plant remains are still easily identifiable.
H3	Very slightly decomposed or very slightly muddy peat which when pressed in the hand gives off marked muddy water, but no peat substance passes through the fingers. The pressed residue is thickish. Plant remains have lost some of their identifiable features.

Degree of Humification	Peat Description
H4	Slightly decomposed or slightly muddy peat which when presses in the hand gives off marked muddy water. The pressed residue is thick. Plant remains have lost more of their identifiable features.
H5	Moderately decomposed or muddy peat. Growths structure evident but slightly obliterated. Some amorphous peat substance passes through the fingers when pressed but, mostly muddy water. The pressed residue is very thick.
H6	Moderately decomposed or very muddy peat with indistinct growth structure. When pressed approximately 1/3 of the peat substance passes through the fingers. The remainder extremely thick but with more obvious growth structure than in the case of unpressed peat
H7	Fairly well decomposed or markedly muddy peat but the growth structure can just be seen. When pressed about half the peat substance passes through the fingers. If water is also released this is dark and peaty.
H8	Well decomposed or very muddy peat with very indistinct growth structure. When pressed about 2/3 of the peat substance passes through the fingers and at times a thick liquid. The remainder consists mainly of more resistant fibres and roots.
H9	Practically completely decomposed or mud-like peat in which almost no growth structure is evident. Almost all the peat substance passes through the fingers as a uniform paste when pressed.
H10	Completely decomposed or mud peat where no growth structure can be seen. The entire peat substance passes through the fingers when pressed.

Source: Von Post & Granland, 1926

The peat encountered on site is variable with Von Post classifications between H2 and H9 generally becoming increasingly decomposed within the deeper peat deposits.

3.3. Solid Geology

The BGS 1:50,000 Solid Geology map layer on the Onshore Geoindex shows that the bedrock underlying the Proposed Development Area is predominantly the Carrick Volcanic Formation (Basalt and Basaltic Andesite) in the northern parts of the site (underlying T01, T02, T03, T05, T06) and the Marchburn Formation (Wacke) in the southern areas (T07, T08, T09, T10). The northern edge of the Carrick Volcanic Formation at the Site Boundary is fault-bound by the Scottish Lower and Middle Coal Measures Formation (Sedimentary Rock Cycles, Coal Measure Type). The southern edge of the Site Boundary shows a faulted boundary between the Marchburn Formation and the Kirkcolm Formation (Wacke). The northern area also shows units of the Lanark Group (Conglomerate) trending southwest northeast. The southern area of the Proposed Development Area is also mapped with lenses of the Marchburn Formation (Conglomerate), mapped beside T04 trending northeast southwest. The Site contains several igneous units on the BGS map, the Western Midland Valley Westphalian to Early Permian Sills (Analcime-Gabbro and Quartzs-Microgabbro) are mapped in the north of the site, the Southern Midland Valley Felsite Sills (Felsite) and the North Britain Siluro-Devonian Calc-Alkaline Dyke Suite (Andesite) are mapped in the west of the site.

Faults are shown within the Proposed Development Area trending southwest northeast. A fault is inferred to run directly through the Proposed Development Area in a southwest northeast orientation between the Carrick Volcanic Formation and Marchburn Formation (Wacke). The proposed T11 position lies directly on this inferred fault. Additionally, both the proposed substation and temporary construction compound are intersected by northwest southeast trending inferred faults on the BGS map. The fault bounding the Marchburn Formation (Wacke) and Kirkcolm Formation (Wacke) is mapped as a Reverse / Thrust fault.

Figure A.8 appended to this report depicts the Solid Geology map over the Proposed Development Area.

3.4. Hydrogeology

According to the BGS Hydrogeology 1:625,000 map, the bedrock units underlying the Proposed Development are of the Unnamed Igneous Intrusion (Late Silurian to Early Devonian) or the Lanark Group. The Unnamed Igneous Intrusion is characterised as being a low productivity aquifer producing small amounts of groundwater in near surface weathered zones and secondary fractures from rare springs. The Lanark Group is characterised as a regional-scale moderately productive aquifer of sandstones, in places flaggy, with siltstones, mudstones and conglomerates and interbedded lavas with local yields up to 12 l/s.

3.5. Hydrology Flooding and Draining

Hydrologically, the Proposed Development lies within the watershed of the River Doon, River Nith, and the River Dee. Figure 8.1, Volume 2a of the EIAR Chapter shows a hydrological overview of the Proposed Development that highlights the watercourses draining the Proposed Development Area and the associated main catchments.

According to the SEPA Flood Maps[1], there is no risk of flooding from rivers or surface water within the site boundary.

3.6. Designated Sites and Receptors

There are five designated conservation sites within 3 km of the Proposed Development. Their locations in relation to the Proposed Development are presented in Figure 8.1, Volume 2a and the details of each site, including their qualifying interests are presented in Table 3.6

Benbeoch, Dalmellington Moss, Bogton Loch, Ness Glen and Loch Doon are designated as Sites of Special Scientific Interest (SSSI). Additionally, Benbeoch is classed a Geological Conservation Review (GCR) Site.

The most immediate environmental receptors are the watercourses of the River Doon, River Nith, and the River Dee which the numerous minor watercourses found on the Proposed Development flow into.

The scheme has been designed to minimise impact to the environment and in particular remove impact to Private Water Supplies (PWS) and GWDTE’s. The Hydrology Section of the EIAR and AI should be referred to for more information. However, in terms of peat slide risk assessment, these receptors are encapsulated by the environment impact scoring within the current assessment.

A summary of designated areas is presented below in Table 3.6.

Table 3.6: Designated Sites

Site	Designation	Distance from Site	Type	NGR
Benbeoch	SSSI / GCR	1.3 km	Geological: Igneous Petrology: Carboniferous-Permian Igneous.	NS 49348 08298

[1] https://map.sepa.org.uk/floodmaps

Site	Designation	Distance from Site	Type	NGR
Dalmellington Moss	SSSI	1.4 km	Raised bog.	NS 46450 06429
Bogton Loch	SSSI	1.4 km	Breeding bird assemblage. Open water transition fen.	NS 46871 05381
Loch Doon	SSSI	2.1 km	Arctic charr.	NX 49883 99366
Ness Glen	SSSI	2.7 km	Atlantic woodland bryophyte assemblage. Upland mixed ash woodland.	NS 47713 02054

4. Peat Slide Hazard – Risk Assessment Methodology

4.1. Processes Contributing to Peat Instability

The key principals of the peat slide risk assessment are presented below. Discussions of the factors which contribute to peat failure have been presented in Table 4.1.

Table 4.1: Contributary Factors to Peat Instability

Factor	Discussion
Groundwater Infiltration	There are two processes which may facilitate groundwater infiltration: Periods of drying, resulting in cracking of the peat surface; and Slope creep resulting in additional tension cracks. Drying out of the upper peat, particularly in areas of thinner peat, is likely to result in the development of near-surface cracks which could facilitate ingress of water into the peat.
Surface Loading	Any mechanisms which increase the surface load on a peat deposit can increase the likelihood of failure. This can include surface water ponding and surcharge loading, for example; construction works, stockpiling and forestry operations.
Vegetation Loss	Loss of vegetation can have a negative impact, making the peat susceptible to weathering, increasing rates of infiltration and a loss of strength.
Soil Weathering/Erosion	Weathering can weaken in-situ peat materials and destabilise a slope system. This may be in the form of weathering of peat or underlying mineral soils which could reduce shear strength at the peat/ mineral soil interface. Vertical cracking and slope creep may slowly break down peat structure over long periods of time. This can develop into peat 'hagging', which is a strong indication that natural weathering processes are ongoing. Peat hags expose the peat to increased weathering rates and may provide preferential surface water flow pathways. Several areas within the Site Boundary show peat hags, none were identified at proposed infrastructure positions.
Precipitation	The likely failure mechanism following a period of heavy rainfall is linked to the infiltration of surface water. There is a resulting build-up of pore water pressures within the soils and therefore reduced effective shear strength. This may be focussed within the peat deposit or at the interface between the peat and underlying mineral soil. Secondary effects may include swelling of the peat deposit and increased loading due to surface water ponding. Snow and subsequent melt can have a similar effect.
Slope Morphology	There are three main effects arising from slope morphology: Firstly, the concentration of tensile stress at the apex of a convex slope predisposes the slope for failure initiation at that point. In a convex slope the material lower down supports the material above which is held in compression. A concave slope has the opposite characteristics as material at the base maintains the apex in tension. Secondly, at the point of maximum slope convexity, because of favourable down-slope drainage conditions, a body of relatively well-drained and relatively strong peat material develops. This body of peat acts as a barrier providing containment for growth of peat upslope. This relatively well drained body of peat can subsequently fail due to a build-up of lateral pressure on the upslope face. In this scenario the slope is not supported from below so eventually the lateral pressures

Factor	Discussion
	exceed the forces resisting sliding. The apex or point of convexity is also a likely initiation point for slope failure due to the slope tension being concentrated at this point. Thirdly a failure mechanism, analogous to a piping failure underneath a dam, is postulated where springs are present in locations immediately down-slope of the relatively well drained peat body. Under these circumstances high pore pressure gradients within the peat can lead to hydraulic failure and undermining of the relatively well drained peat body resulting in a breach and loss of lateral support to peat upslope. Evolving slope morphology can be significant; for example, in the case of slope undercutting by water erosion. Any mechanism by which mass is removed from a slope toe or deposited on a slope crest will contribute to instability.
Peat Depth & Slope Angle	Peat slides correspond in appearance and mechanism to translational landslides and tend to occur in shallow peat (up to 2.0m) on slopes between (5° – 15°). A great majority of recorded peat landslides in Scotland, England & Wales are of the peat slide type. MacCulloch, (2005) highlights that a slope angle of 20° appears to be the limiting gradient for the formation of deep peat. Therefore, the risk assessment has assigned slope angles >20° to be an unlikely contributory factor to failure. Slope angle indicators and corresponding probability factors have been similarly adapted from MacCulloch, (2005). Boylan et al, (2008) indicates that most peat failures occur on slope angles between 4° and 8°. It is postulated that this may correspond to the slope angles that allow a significant amount of peat to develop that over time becomes potentially unstable. Thus, for this assessment <3degrees has been assigned a low risk.
Hydrology	Natural watercourses and artificial drainage measures have often been identified as a contributory factor of peat failure. Preferential drainage paths may allow the migration of water to a failure plane therefore triggering failure when groundwater pressures become elevated. Within a peat mass, sub surface peat pipes can enable flow into a failure plane and facilitate internal erosion of slopes. It is also noted that in some instances, agricultural works can lead to the disturbance of existing drainage networks and cause failures.
Existing / Relict Failures	The presence of relict failures and any indication of previous instability are often important, indicating that site conditions exist that are conducive to peat failure. Relict peat slides may be dormant over long periods and be re-activated by any number of the contributory factors discussed in this table.
Anthropogenic Effects	Human impact on peat environments can include a range of affects associated with wind farm construction. Activities such as drainage, access tracks across peat, peat cutting, and slope loading are all examples. Rapid ground acceleration is one such example where shear stress may be increased by trafficking or mechanical vibrations. The Site is actively managed for commercial forestry, so has been modified for related activities such as constructing drainage ditches and access tracks.

Source: Natural Power

4.2. Peat Failure Modes

Peat failure in this assessment refers to the mass movement of a body of peat that would have a significant adverse impact on the surrounding environment or infrastructure. This definition excludes localised movement of peat, for example movement that may occur below an access track, creep movement or erosion events and failures in underlying mineral soils.

The potential for peat failure across the development is examined with respect to the activities envisaged during construction and operation of the wind farm. There are several classification systems for the mass movement of peat that were drawn together by PLHRAG, (2017).

Hutchinson (1988) defines the two dominant failure mechanisms namely peat flows and peat slides.

- Peat Flows & Bog Bursts: are debris flows involving large quantities of water and peat debris. These flow down slope using pre-existing channels and are usually associated with raised bog conditions.
- Peat Slides: comprise intact masses of peat moving bodily down slope over comparatively short distances. A slide which intersects an existing surface water channel may evolve into a debris flow and therefore travel further down-slope. Slides are historically more common within blanket bog settings.

Due to the discrete areas of peat recorded across the development widespread instability comprising peat flows and bog bursts are considered unlikely at this stage. Smaller scale peat slides and debris flows are therefore the focus of the study and characterised by the definition above.

4.3. Geotechnical Principles

The main geotechnical parameters that influence peat stability are:

- Shear strength of peat;
- Peat depth;
- Pore water pressure (PWP);
- Loading conditions.

The stability of any slope is defined by the relationship between resisting and destabilising forces. In the case of a simplified infinite slope model with a translational failure mode, sliding is resisted by the shear strength of the basal failure plane and the element of self-weight acting normal to the failure plane. The stability assessments within this report considers an undrained 'total stress' scenario when the internal angle of friction (φ') = zero.

An undrained peat deposit may be destabilised by; mass acting down the slope, angle of the basal failure plane and any additional loading events. The ratio between these forces is the Factor of Safety (FoS). When the FoS is equal to unity (1) the slope is in a state of 'limiting equilibrium' and is sensitive to small changes in the contributory factors leading to peat failure.

The infinite slope model as defined in Skempton et al. (1957) has been adapted to determine the FoS of a peat slope. A modified approach has been used; assuming a minimum FoS (Typically 1.3 after, BS6031: 2009).

The infinite slope analysis is based on a translational slide. This analysis adopts total stress (undrained) conditions in the peat. This state applies to short-term conditions that occur during construction and for a time following construction until construction induced pore water pressures (PWP) dissipate. (PWP requires time to dissipate as the hydraulic conductivity can be low in peat deposits). The following assumptions were used in the analysis of peat deposits across the Site:

- The groundwater is resting at ground level;
- Minimum acceptable factor of safety required is 1.3;
- Failure plane assumed at the basal contact of the peat layer;
- Slope angle on base of sliding assumed to be parallel to ground surface and that the depth of the failure plane is small with respect to the length of the slope;
- Thus, the slope is considered as being of infinite length with any end effect ignored;
- The peat is homogeneous.

The analysis method for a planar translational peat slide along an infinite slope was for calculated using the following equation in total stress terms highlighted by MacCulloch, (2005) and originally reported by Barnes, (2000):

$$\mathbf{F = Cu / (\gamma * z * \sin\beta * \cos\beta)}$$

Where:

- F = Factor of Safety (FoS)
- Cu = Undrained shear strength of the peat (kPa)
- γ = Bulk unit weight of saturated peat (kN/m^3)
- z = Peat depth in the direction of normal stress
- β = Slope angle to the horizontal and hence assumed angle of sliding plane (degrees)

Undrained shear strength values (Cu) are used throughout this assessment. Effective strength values are not applicable for the case of rapid loading of the peat during short term construction phase of works hence the formula cited above, has been adopted. Drawing Doc no. 1355047, Appendix A.4 maps out the calculated FoS for the Proposed Development when applying a conservative 10 kPa as the undrained shear strength for peat soils. This mapping includes the predicted FoS where a 20 kPa surcharge is applied to the surface. The factor of safety map shows no part of the proposed development infrastructure to fall below a factor of safety of 1.3.

4.4. Risk Assessment Method

Natural Power has undertaken this assessment following the principles of the Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Scottish Executive 2017). Updated as a second edition in April 2017, this guide provides best practice methods which should be applied to identify, mitigate and manage peat slide hazard and associated risks in respect of consent application for electricity generation projects in the UK.

This guidance clearly acknowledges risk assessment as an iterative process and as such this assessment should be updated throughout the development and as more information becomes available particularly as pre-construction phases are reached.

A semi quantitative risk assessment has been used to determine the risk of peat failure. The methodology is defined in PLHRAG, (2017) and has been augmented with methods set out by Clayton (2001) & MacCulloch, (2005) Risk factors are summarised on Table 4.3.

The assessment uses the numerical stability analysis and presents results for Factor of Safety (FoS) across the Proposed Development. The calculated FoS, is complimented with an assessment of the slope angle, peat depth and key geomorphological features. A Peat Stability Risk Zonation map has been produced using GIS computation of these factors. (Doc no. 1355033, Appendix A.6). The risk map is used for screening wide areas of the study area, additional engineering judgement has been applied according to discrete conditions within Table 6.1 of this report.

Table 4.2: Contributary factors to peat instability

Contributory Factor	Comment	Criteria	Probability	Scale
Peat Depth* (A)	Peat slides tend to occur in shallow peat (up to 2.0m) on A great majority of recorded peat landslides in Scotland, England & Wales are of the peat slide type.	0 – 0.5 m	Negligible	1
		>3.0 m	Unlikely	2
		0.5 – 1.0 m	Likely	3
		2.0 – 3.0 m	Probable	4
		1.0 – 2.0 m	Almost certain	5
Slope Angle* (B)	It has been acknowledged that peat slide tends to occur in shallow peat (up to 2.0m) on slopes between 5o and 15o. Slopes above 20^{o} tend to be devoid of peat or only host a thin veneer deposit.	0° – 3°	Negligible	1
		>20°	Unlikely	2
		4° – 9°	Likely	3
		16° – 20°	Probable	4
		10° – 15°	Almost certain	5
FoS* (C)	Values are from Infinite slope model using Cu characteristic value of 10 kPa derived from hand shear vane in-situ testing. Slope angle and peat depth also input to this factor.	≥ 1.3	Negligible	1
		1.29-1.20	Unlikely	2
		1.10-1.19	Likely	3
		1.00-1.09	Probable	4
		<1.0	Almost certain	5
Cracking (D)	Visual assessment undertaken in the field during detailed probing survey and covers the same extends of this survey. Field workers examined for evidence of any major crack networks which may allow surface water to penetrate the peat mass. Reticulate cracking was not investigated as this normally requires intrusive ground investigation to remove the surface fibrous layer.	None	Negligible	1
		Few	Unlikely	2
		Frequent	Likely	3
		Many	Probable	4
		Continuous	Almost certain	5
Groundwater (E)	Challenging to evaluate without very detailed mapping and/or intrusive data. Look for entry / exit points. Evidence of surface hollows, collapse features at surface reflecting evidence of sub-surface peat pipe network, audible indicators including the sound of sub-surface running ground water surrounding proposed infrastructure locations	None	Negligible	1
		Few	Unlikely	2
		Frequent	Likely	3
		Many	Probable	4
		Continuous	Almost certain	5
Surface *Hydrology (F)	Ranging from wet flushes to running burns to hags. Must be evaluated in conjunction with the season and weather preceding the site visit.	None	Negligible	1
		Few	Unlikely	2
		Frequent	Likely	3
		Many	Probable	4
		Continuous	Almost certain	5
Previous Instability (G)	Visual survey, scale and age are important as small to medium relict failures may be easy to detect but very large ones may require remote imaging. Recent failures should be obvious due to the scar left.	None	Negligible	1
		Few	Unlikely	2
		Frequent	Likely	3
		Many	Probable	4
		Continuous	Almost certain	5
Land Management	Anthropogenic influences: forestry operations and removal of vegetation can be associated with de-stabilising peat deposits.	None	Negligible	1
		Few	Unlikely	2

Contributory Factor	Comment	Criteria	Probability	Scale
(H)	This can occur as a result to surface disturbance and remoulding of peat through excavation, vehicle movements and loading. Changes in land use activities may also be associated with changes in drainage conditions. Criteria based on evidence of disturbance of peat deposit, i.e. broken surface, scarring or disrupted hydrology. The majority of the Proposed Development has been and is actively managed as commercial forestry, therefore a Factor of '2' (Unlikely) will be used in this assessment.	Frequent Many Continuous	Likely Probable Almost certain	3 4 5

Note: Denotes where risk factor applied to GIS model only*

Environmental Impact Zones based on proximity buffer zones applied to the main watercourses within the Proposed Development. Watercourses have been determined to be a primary sensitive receptor to a peat failure event. Table 4.4 denotes the potential impact scales to the environment. The Environmental Impact Zones map for the Proposed Development is found in Appendix A.5 (IFS Doc No. 1354461).

The distance to main watercourses has been used as the primary means of impact assessment within the risk assessment. Where watercourses are ephemeral/transient or minor artificial features they were not included as direct receptors. The impact distances are based on experience and guidance values provided within MacCulloch, F. (2006).

The approach advocated by MacCulloch is to divide the survey area into Environmental Impact Zones driven by site specific criteria and survey information. It is noted that defining a definitive distance for impact is extremely challenging due to the complex nature of terrain, peat depth, flow mechanics will all influence the flow path characteristics. At present there exists no defined method to accurately define the flow distances. Therefore Table 4.3 within report provides a framework estimate for the purposes of repeatable and representative semi quantitative risk mapping. Natural Power considers this approach alongside the multitude of site-specific factors which are considered during the risk assessment a valid approach for this development.

Table 4.3: Environmental Impact Zonation

Criteria	Potential Impact	Scale
Proposed access road/turbine within 50m of watercourse	High	4
Proposed access road/turbine within 50-100m of watercourse	Medium	3
Proposed access road/turbine within 100-150m of watercourse	Low	2
Proposed access road/turbine greater than 150m from watercourse	Negligible	1

Source: Natural Power

For each main infrastructure element, the Risk Ranking is assessed from the combined probability of occurrence for the main contributory factors which are greater than (1), multiplied by the highest impact scale. Table 4.5 identifies the risk ranking based on concepts of PLHRAG, (2017).

The risk to existing or proposed infrastructure has been scoped out and is not considered a determining factor to the severity of a peat slide over the proposed development. This is due to the spacing of the proposed layout and the large distance from existing settlements.

Access track sections have screened through the GIS based stability risk model and the elevated risk sections reviewed with further risk analysis and control measures. It is important to highlight that the full scope of the proposed infrastructure layout has been subject to field survey and review of stability risk factors.

Table 4.4: Risk Ranking and Actions

Risk Ranking Score	Actions
17 - >25	**High:** Avoid project development at these locations.
11 - 16	**Medium:** Project should not proceed unless risk can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce risk ranking to low or negligible.
5 - 10	**Low:** Project may proceed pending further investigation to refine risk assessment and mitigate hazard through relocation 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.

Source: Natural Power

5. Stability Analysis of Peat Slopes

5.1. Introduction

Assessing the desk study information, site layout and ground investigation data; a preliminary infinite slope analysis and subsequent peat slide risk assessment has been undertaken. Slope stability was assessed at turbine locations using slope angle measurements, peat depth, and undrained shear strength measured using an in-situ hand shear vane. This assessment should be viewed as semi – quantitative as it draws on both qualitative assumptions and numerical parameters.

For each proposed turbine location, the recorded peak undrained shear strength values have been input into the infinite slope model in order to calculate the potential factor of safety against peat slide. Where no shear vane test was undertaken a conservative strength of 10 kPa has been adopted.

5.2. Numerical Slope Analysis

A preliminary numerical slope analysis has been undertaken. Numerical slope stability was assessed across the development location using slope angle measurements (DTM derived), peat depth, and the minimum undrained shear strength measured using an in-situ hand shear vane. In addition, a 20 kPa surcharge has been modelled thus the sensitivity of slopes to failure is assessed under construction conditions. GIS modelling was used to produce a Factor of Safety (FoS) map for the Proposed Development (Doc no. 1355047, Appendix A.4).

The numerical stability analysis indicates no potential for translational peat slide at proposed turbine and infrastructure locations under current equilibrium and modelled surcharge loading conditions. The natural slope condition has been calculated to be stable and was observed to be so around the wind turbine locations during the field survey.

In the absence of more detailed subsurface data, the surface slope angle has been used as a reference to the likely slope surface angle at the base of the peat in the analysis. Further advanced in-situ test methods should be considered as part of a detailed site investigation phase usually carried out post-consent. The potential of disturbing sensitive peat deposits during pre-construction survey access should also be considered during future phases of intrusive investigation work.

The FoS accounts for a 20 kPa surcharge representing scenarios at infrastructure such as temporary storage stockpiles. The Peat Management Plan (Document No. 1355801) details mitigation measures for peat stockpiling. Slope stability assessments would be carried out during design phase for site tracks, hardstands and other relevant structures ensuring the proposed design results are safe, stable and environmentally compliant. It is Natural Power's view that, if during design phase structures are proposed (i.e. floating tracks) additional numerical stability assessment should be carried out by the appointed designer.

Table 5.1: Infinite Slope Analysis at Turbine Locations

	Peak Shear Strength	Unit Weight (γ)	Depth of peat(z)	Slope Geometry	Factor of Safety (FOS = Cu / γ z sinβ cosβ)	
Location	kPa	kN/m³	metres	(ß°)	No Applied Load	Surcharge 20 kPa
T1	10*	10	0.67	6	28.67	11.38
T2	10	10	0.52	2	18.68	5.49
T3	13	10	1.40	4	5.85	2.43
T4	10	10	0.41	10	11.52	4.30
T5	10	10	0.68	5	18.43	7.81
T6	16	10	0.36	5	20.67	7.13
T7	25	10	0.90	7	83.35	27.97
T8	58	10	0.98	4	22.12	8.92
T9	23	10	0.48	6	15.24	5.82
T10	21	10	0.62	8	9.62	3.82
T11	10	10	0.52	6	28.67	11.38

**Site wide value of 10 kPa used where no turbine specific values available.*

Source: Natural Power

The numerical stability analysis indicates no potential for translational peat slide at proposed turbine and infrastructure locations under current equilibrium or modelled surcharge loading conditions.

Wind Turbines: FoS values for the turbine locations, when allowing for a 20 kPa surcharge load have been derived. The lowest FoS with no applied load was calculated at 5.85 kPa for T03. The natural slope condition has been calculated to be stable and was observed to be so around the wind turbine locations during the field survey.

6. Peat Slide Risk Assessment

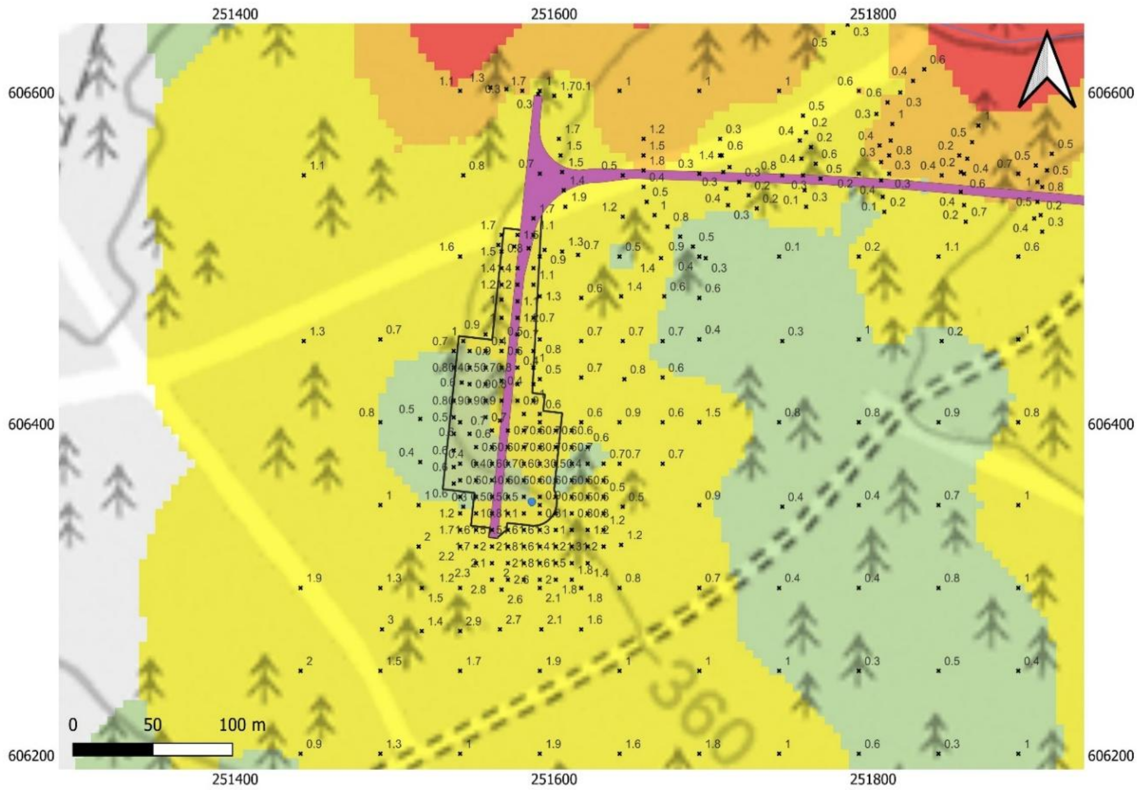
Risk rankings for the Proposed Development infrastructure positions are presented in Table 6.1. Across each turbine the qualitative risk scoring has been provided along with key inset map information.

The Peat Stability Risk Zonation map, Doc no. 1355033, Appendix A.6; provides a representation of the risk zonation across the Site and includes all infrastructure elements. The map is based on a Site wide GIS analysis and should not be viewed in isolation without the narrative of this report. The Risk Mapping does not show residual risk following implementation of targeted or routine control measures.

The indicative residual risk rating is provided assuming implementation of appropriate mitigation measures. Further detail of the risk assessment is highlighted within the preliminary geotechnical risk register presented in Table 6.3.

Table 6.1: Hazard Ranking for Proposed Turbine and Ancillary Infrastructure Locations

	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
T01	1	1	Peat Depth (Mean = 0.78m)	3	1*(3+3+2) =8 Low
			Slope Angle (6°)	3	
			FoS (Min = Cu_{min} > site mean)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

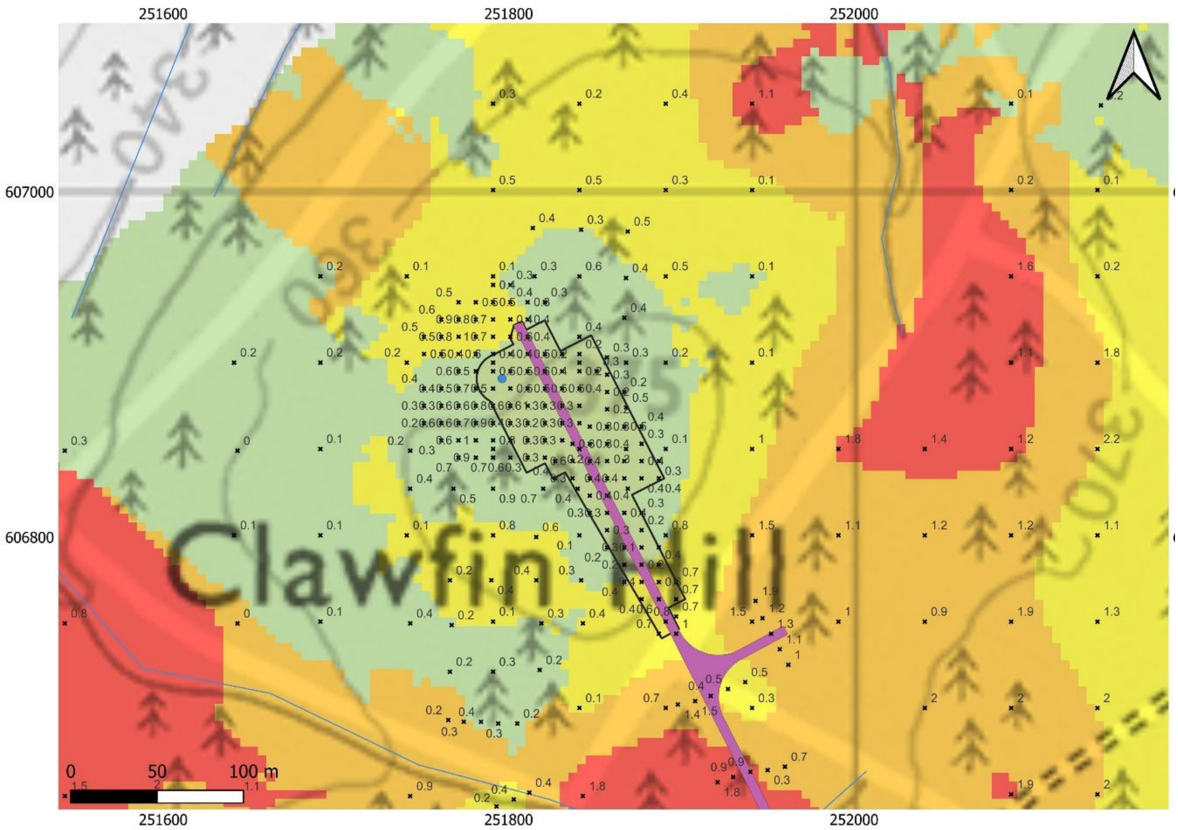


T01 Location – OS Mapping 1:25,000 – 1:1500 Scale

Location Specific Mitigation:

Land management factor of ‘2’ due to forestry operations. Drainage outfalls should be designed to avoid discharging to the northeast and southwest towards deeper peat deposits. The slope angle is conducive for peat sliding. Care should be taken when stockpiling peat around this turbine to avoid steeper gradients.

	Development Infrastructure	Environmental	Contributory Factors (Probability/Exposure)		Risk Ranking
T02	1	1	Peat Depth (Mean = 0.59m)	3	1 * (3) = 3 Negligible
			Slope Angle (2°)	1	
			FoS (Min = Cu_{min} > site mean)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

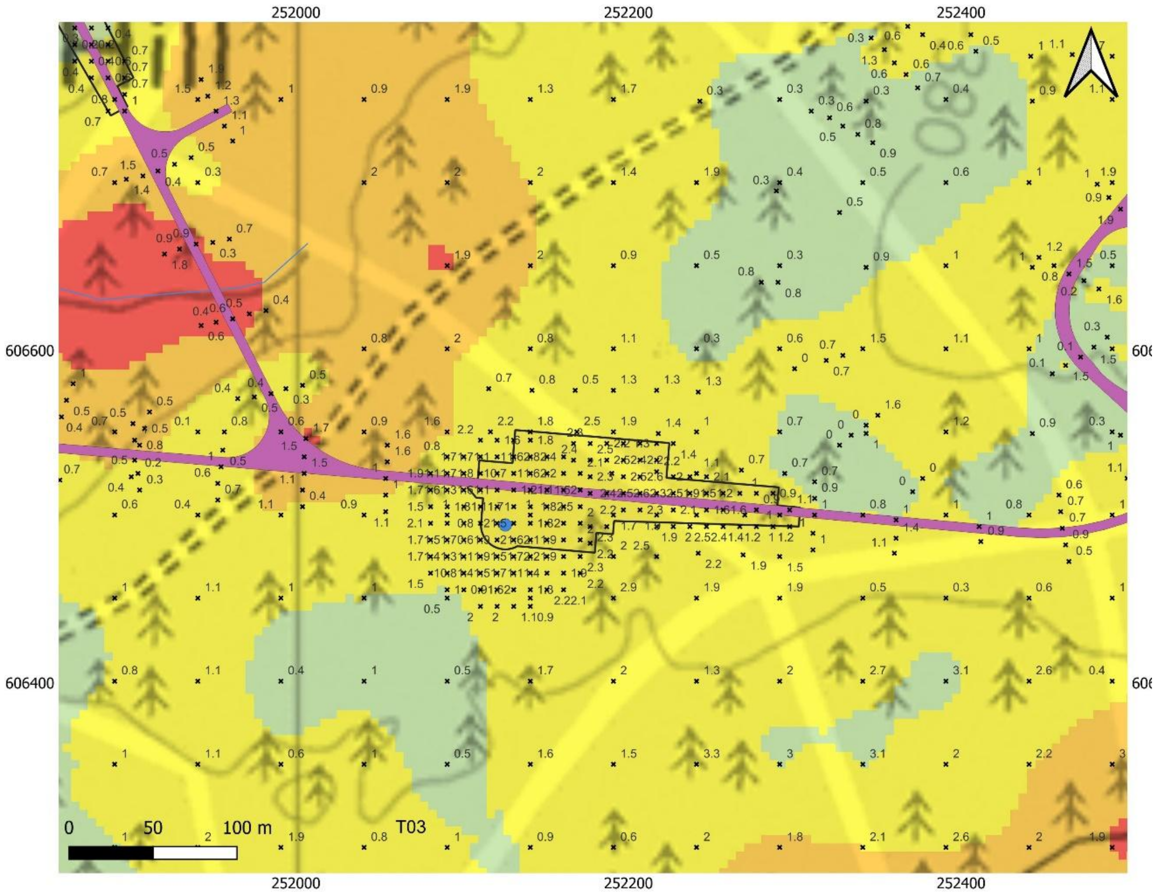


T02 Location – OS Mapping 1:25,000 – 1:1500 Scale

Location Specific Mitigation:

Land management factor of ‘2’ due to forestry operations. Drainage outfalls should be designed to avoid discharging to the east and southwest towards higher risk areas with deeper peat.

	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
T03	1	1	Peat Depth (Mean = 1.81m)	5	1 * (5+3+2) = 10 Low
			Slope Angle (4°)	3	
			FoS (Min = Cu_{min} > site mean)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

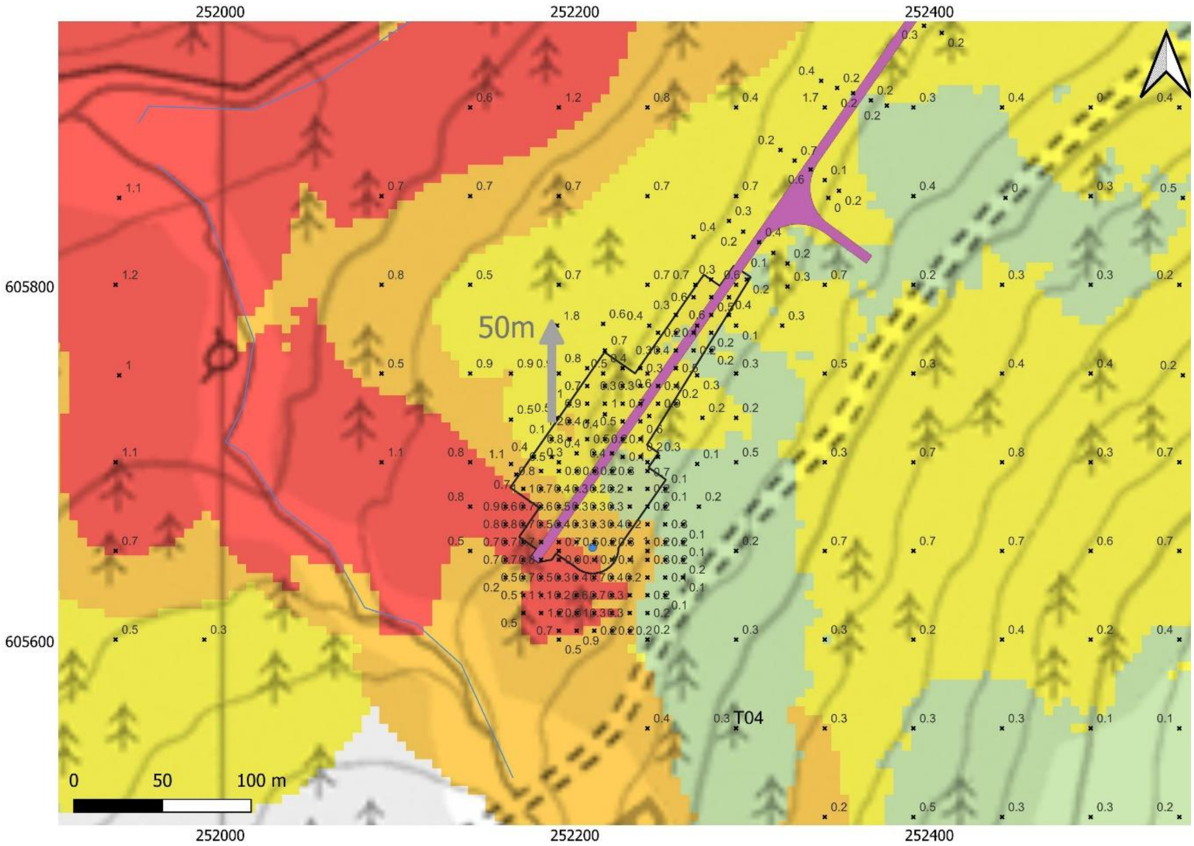


T03 Location – OS Mapping 1:25,000 – 1:1500 Scale

Location Specific Mitigation:

The slope angle is conducive for peat sliding and peat depths on average around the proposed turbine location are above 0.50m. Care should be taken when stockpiling peat during the construction process around this turbine due to the pockets of deep peat and steeper gradients. Land management factor of ‘2’ due to forestry operations. Drainage outfalls should be designed to avoid discharging towards pockets of deep peat found to the north and south of the hardstanding.

	Development Infrastructure	Environmental	Contributory Factors (Probability/Exposure)		Risk Ranking
T04	1	2	Peat Depth (Mean = 1.12m)	5	2* (5+5+2) =24 High
			Slope Angle (10°)	5	
			FoS (Min = Cu_{min} > site mean)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



T04 Location – OS Mapping 1:25,000 – 1:1500 Scale

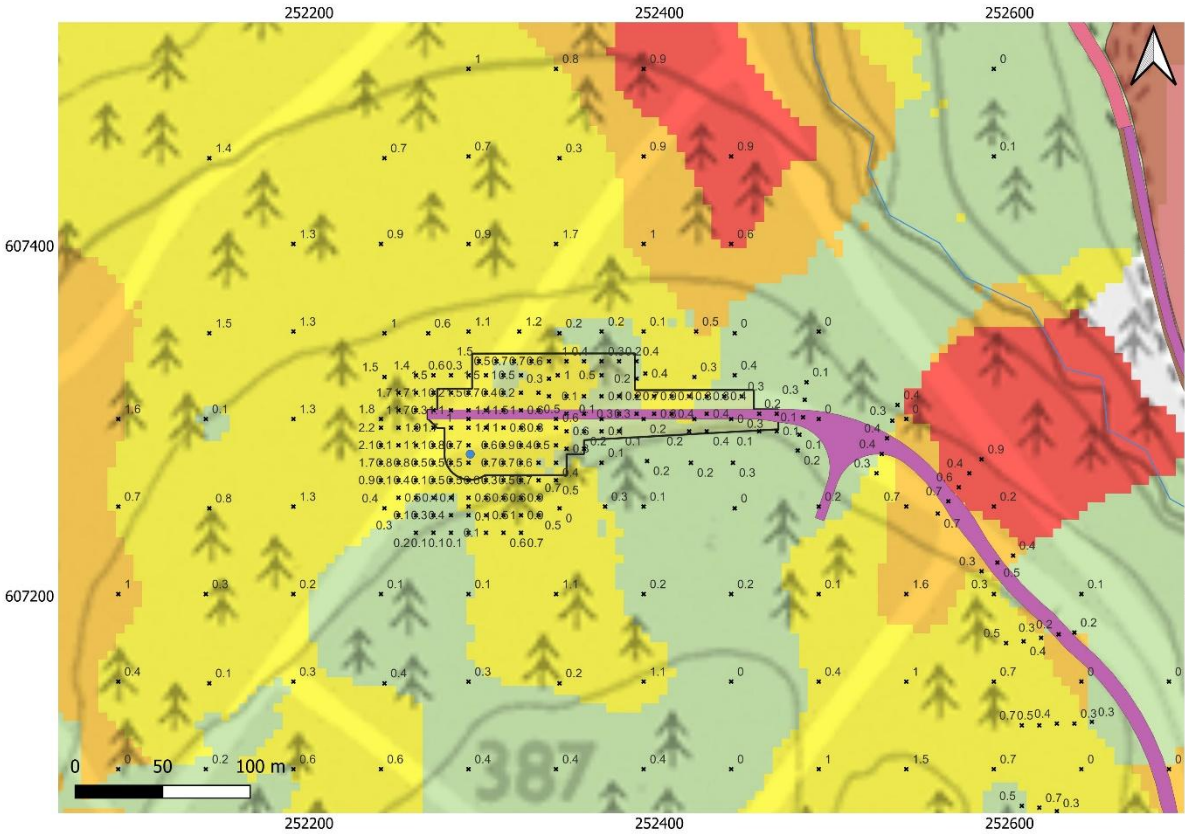
Location Specific Mitigation:

The environmental impact rating could be reduced from ‘2’ to ‘1’ by micrositing the turbine and associated infrastructure 50m to the north away from Benbrack Burn located to the southwest of the current proposed infrastructure position (illustrated by grey arrow on map above). This would also reduce the Slope Angle ranking from ‘5’ to ‘3’. This would reduce the overall risk ranking to Low.

Land management factor of ‘2’ due to forestry operations. Drainage outfalls should be designed to avoid discharging towards the Benrback Burn to the southwest.

The slope angle is conducive for peat sliding and peat depths on average around the proposed turbine location are between 1-2.0m. Care should be taken when stockpiling peat around this turbine to avoid steeper gradients. There are also localised deeper peat deposits to the west where special care will need to be taken during the construction process.

	Development Infrastructure	Environmental	Contributory Factors (Probability/Exposure)		Risk Ranking
T05	1	1	Peat Depth (Mean = 0.54m)	3	**1 * (3+3+2) = 8 Low**
			Slope Angle (5°)	3	
			FoS (Min = Cu_{min} > site mean)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



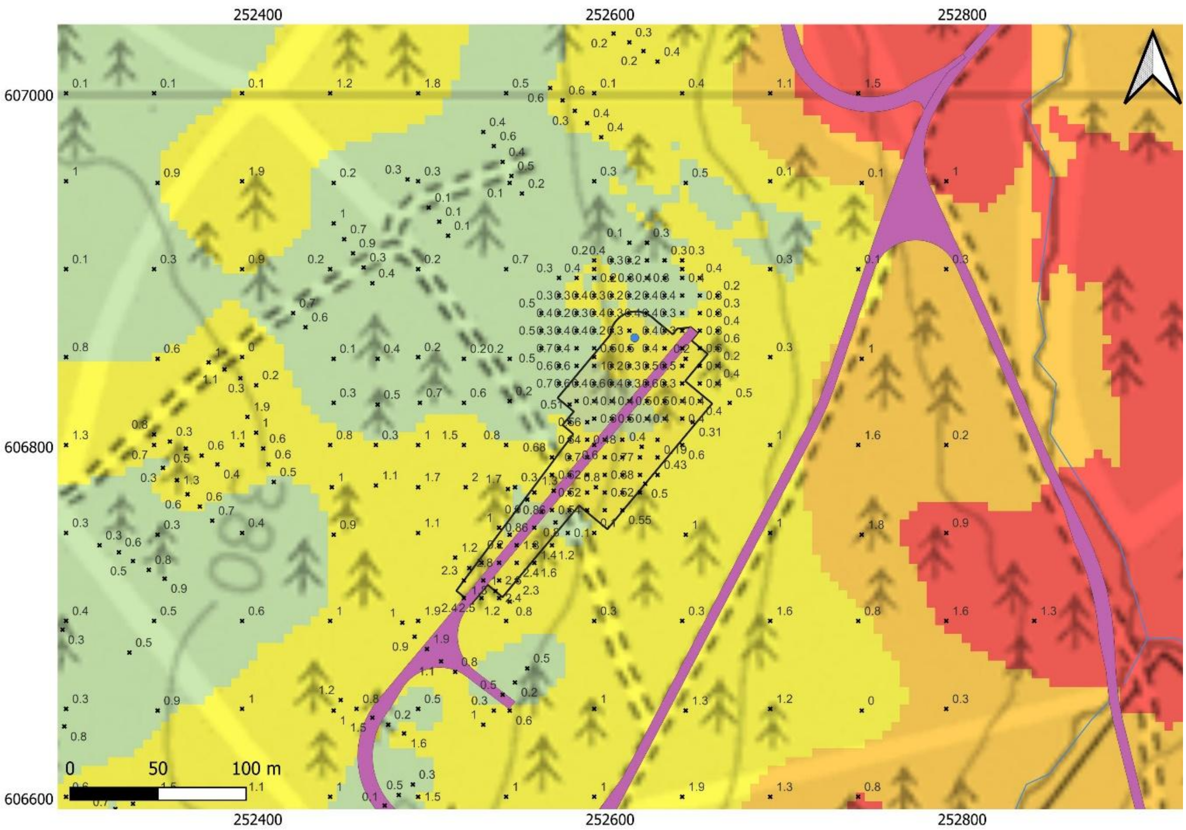
T05 Location – OS Mapping 1:25,000 – 1:1500 Scale

Location Specific Mitigation:

Land management factor of ‘2’ due to forestry operations. Drainage outfalls should be designed to avoid discharging towards the watercourse to the east and deeper pockets of peat to the west. The slope angle is conducive for peat sliding and peat depths on average around the proposed turbine location over 0.50m. Care should be taken when stockpiling peat around this turbine to avoid steeper gradients.

There are localised deeper peat deposits to the north and west where special care will need to be taken during the construction process.

	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
T06	1	1	Peat Depth (Mean = 0.71m)	3	1 * (3+3+2) = 8 Low
			Slope Angle (5°)	3	
			FoS (Min = Cu_{min} > site mean)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



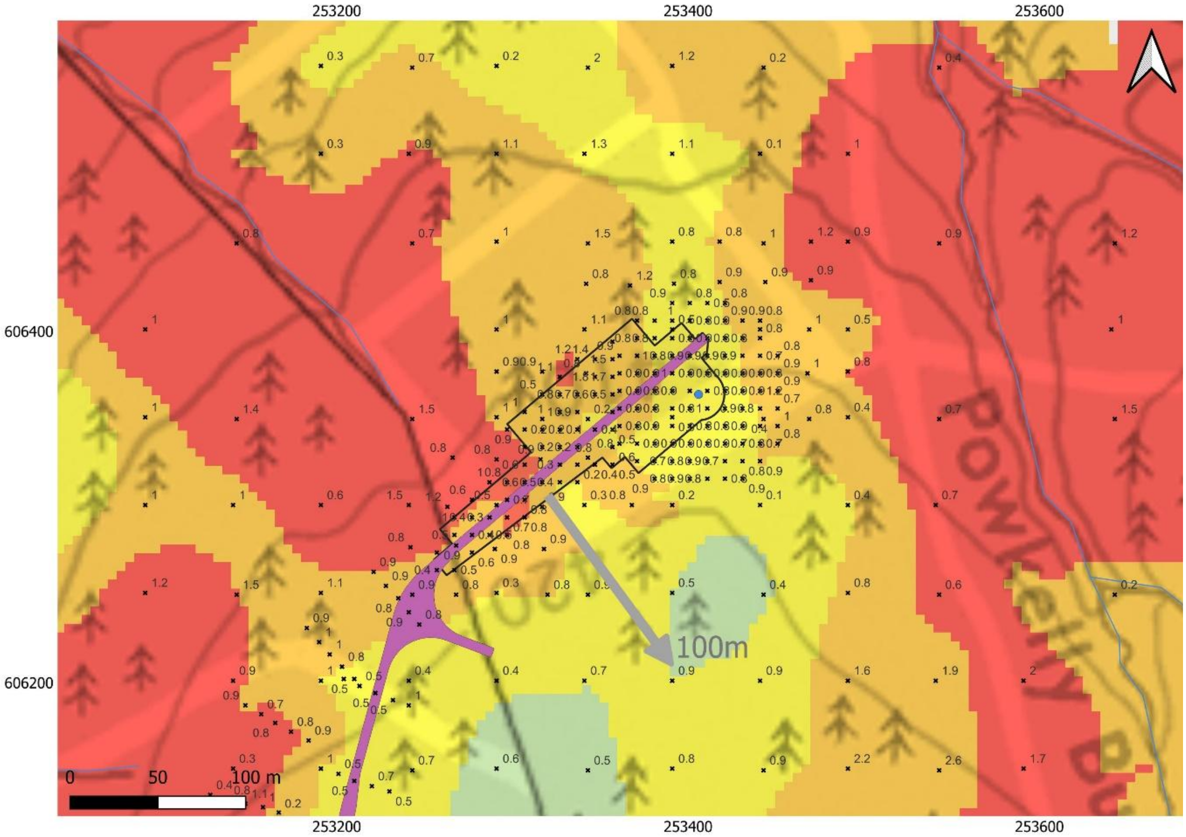
T06 Location – OS Mapping 1:25,000 – 1:1500 Scale

Location Specific Mitigation:

Land management factor of '2' due to forestry operations. Drainage outfalls should be designed to avoid discharging towards the watercourses to the east and deeper pockets of peat to the southwest. The slope angle is conducive for peat sliding and peat depths on average around the proposed turbine location over 0.50m. Care should be taken when stockpiling peat around this turbine to avoid steeper gradients.

There are localised deeper peat deposits in the southwestern areas of the hardstanding where special care will need to be taken during the construction process.

	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
T07	1	3	Peat Depth (Mean = 0.90m)	3	3 * (3+3+2) = 24 High
			Slope Angle (7°)	3	
			FoS (Min = Cu_{min} > site mean)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



T07 Location – OS Mapping 1:25,000 – 1:1500 Scale

Location Specific Mitigation:

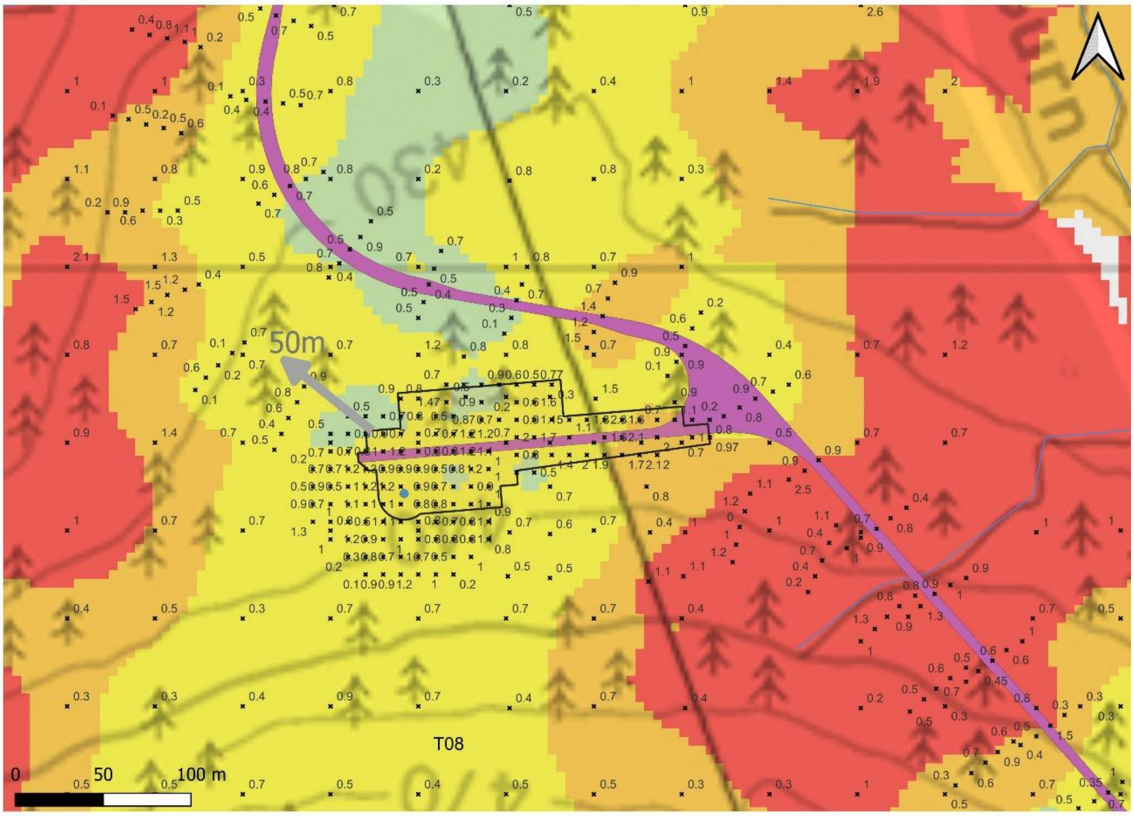
Micro-siting 100m to the southeast (illustrated by grey arrow on map above) would reduce the environmental impact ranking from ‘3’ to ‘1’, moving the infrastructure further from the tributary of the Penniquite Burn to the northwest. This would reduce the overall risk ranking to Low.

Environmental risk ranking given ‘3’ due to small portion of hardstanding within 50m of the tributary in the northwest, however most of the proposed layout is within the ‘2’ ranking value.

Land management factor of ‘2’ due to forestry operations. Drainage outfalls should be designed to avoid discharging towards the watercourses to the northwest and northeast.

Care should be taken when stockpiling peat around this turbine to avoid steeper gradients.

	Development Infrastructure	Environmental	Contributory Factors (Probability/Exposure)		Risk Ranking
T08	1	2	Peat Depth (Mean = 1.03m)	5	1 * (5+3+2) = 20 High
			Slope Angle (4°)	3	
			FoS (Min = Cu_{min} > site mean)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



T08 Location – OS Mapping 1:25,000 – 1:1500 Scale

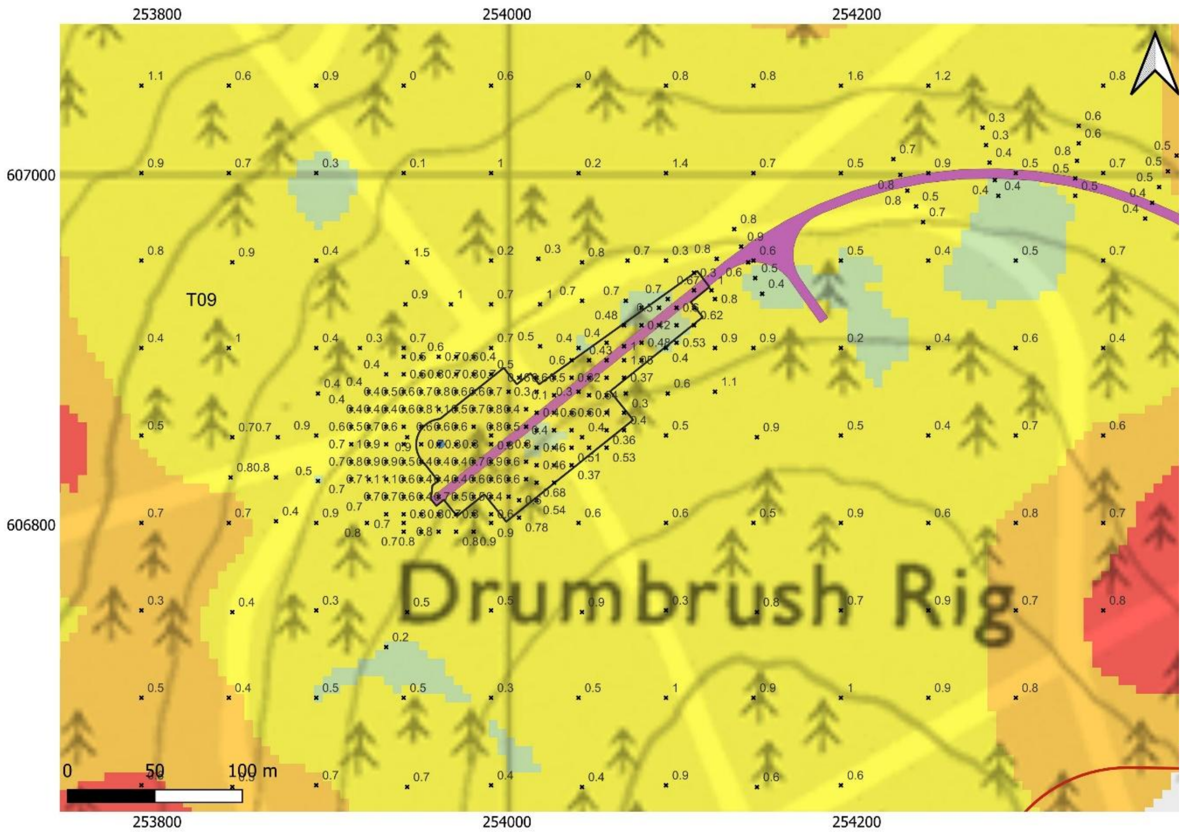
Location Specific Mitigation:

Environmental risk ranking of ‘2’ due to small portion of hardstanding within 150m of the watercourse in the eastern edges of the hardstanding. Micrositing 50m to the northwest (illustrated by grey arrow on map above) would reduce this environmental impact ranking for the small section of hardstanding from ‘2’ to ‘1’ and move the infrastructure towards shallower peat depths. This would reduce the overall ranking from High to Low.

Land management factor of ‘2’ due to forestry operations. Drainage outfalls should be designed to avoid discharging towards the tributary of the Powkelly Burn to the southeast.

Care should be taken when stockpiling peat around this turbine to avoid steeper gradients and deeper pockets of peat in the eastern side of the hardstanding area.

	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
T09	1	1	Peat Depth (Mean = 0.54m)	3	1 * (3+3+2) 8 Low
			Slope Angle (6°)	3	
			FoS (Min = Cu_{min} > site mean)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

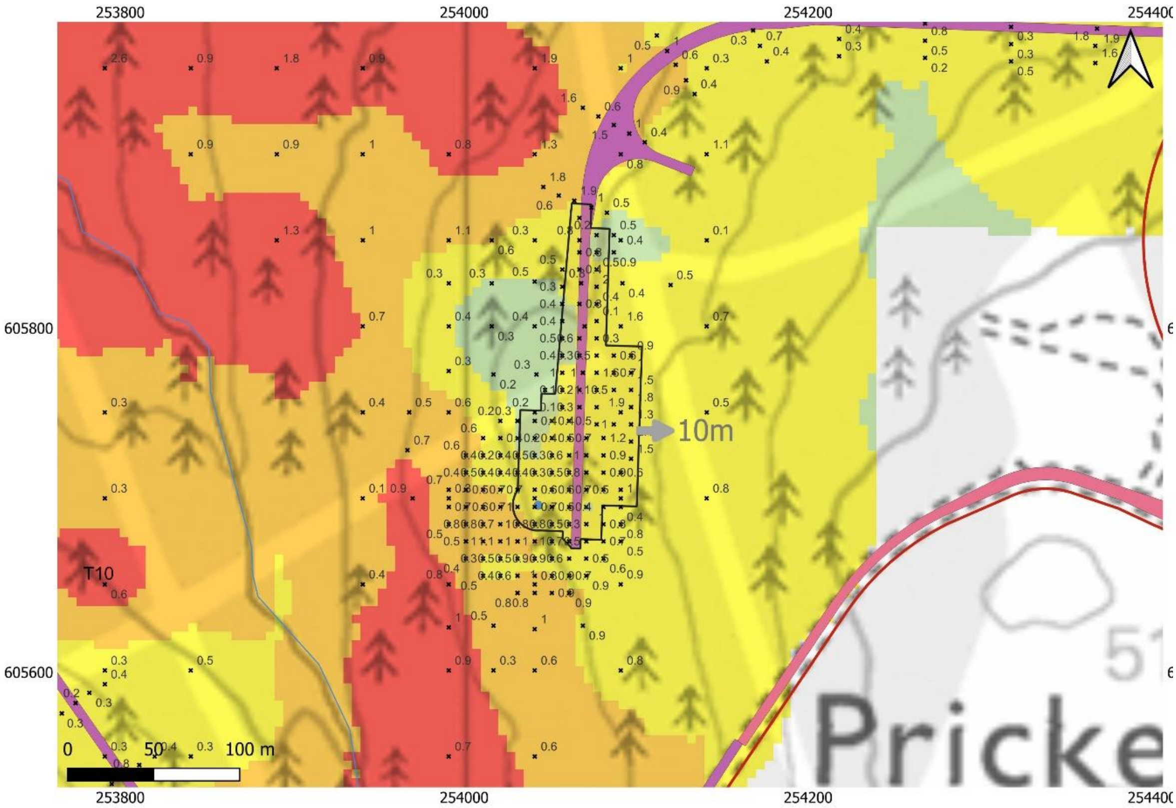


T09 Location – OS Mapping 1:25,000 – 1:1500 Scale

Location Specific Mitigation:

Land management factor of ‘2’ due to forestry operations. The slope angle is conducive for peat sliding and peat depths on average around the proposed turbine location are over 0.50m. Care should be taken when stockpiling peat around this turbine to avoid steeper gradients.

	Development Infrastructure	Environmental	Contributory Factors (Probability/Exposure)		Risk Ranking
T10	1	2	Peat Depth (Mean = 0.61m)	3	**2 * (3+3+2) = 16 Medium**
			Slope Angle (8°)	3	
			FoS (Min = Cu_{min} > site mean)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



T10 Location – OS Mapping 1:25,000 – 1:1500 Scale

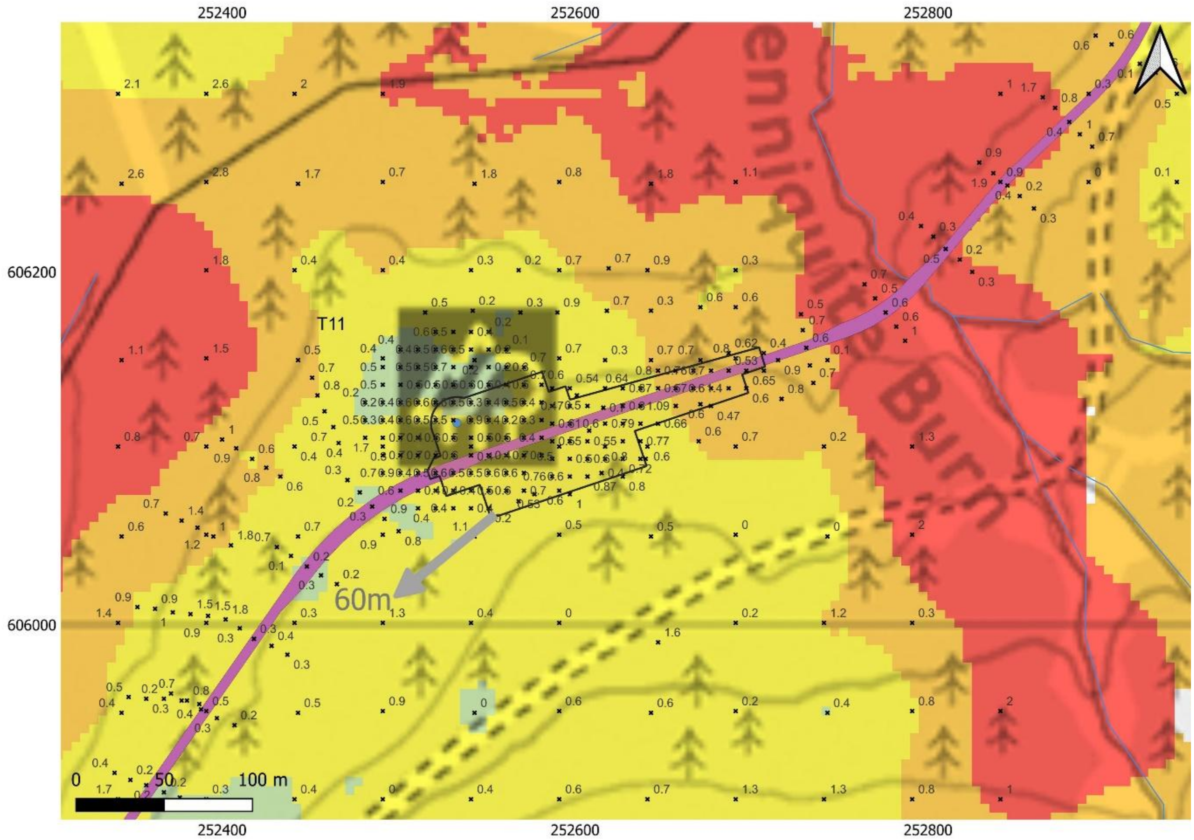
Location Specific Mitigation:

Environmental risk ranking given ‘2’ due to small portion of hardstanding within 150m of the watercourse in the southwest and north, however most of the proposed layout is within the ‘1’ ranking. Micro siting 10m to the east (illustrated by grey arrow in map above) would reduce this environmental impact ranking for the small section of turbine hardstanding from ‘2’ to ‘1’ and reduce the overall ranking to Low.

Land management factor of ‘2’ due to forestry operations. Drainage outfalls should be designed to avoid discharging towards the watercourses to the northwest and west. The slope angle is conducive for peat sliding and peat depths on average around the proposed turbine location are over 0.50m. Care should be taken when stockpiling peat around this turbine to avoid steeper gradients.

There are localised deeper peat deposits to the north and southwest where special care will need to be taken during the construction process.

	Development Infrastructure	Environmental	Contributory Factors (Probability/Exposure)		Risk Ranking
T11	1	2	Peat Depth (Mean = 0.58m)	3	2 * (3+3+2) = 16 Medium
			Slope Angle (6°)	3	
			FoS (Min = Cu_{min} > site mean)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



T11 Location – OS Mapping 1:25,000 – 1:1500 Scale

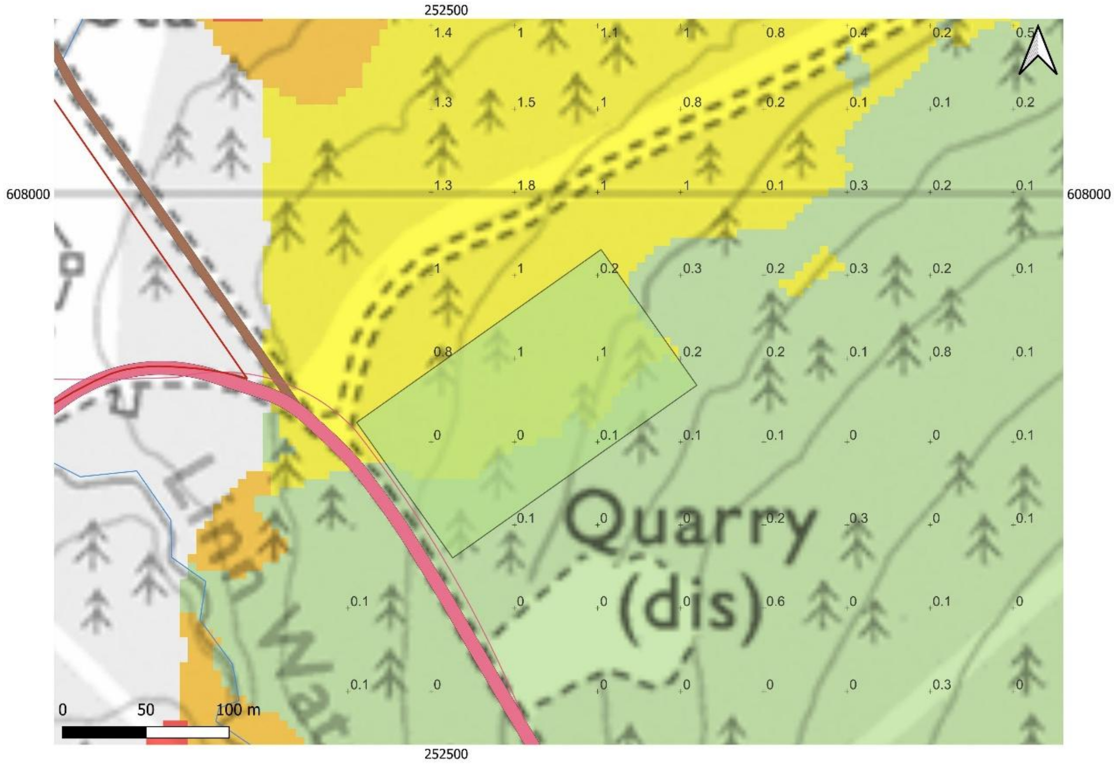
Location Specific Mitigation:

Micrositing 60m to the southwest (illustrated by grey arrow in map above) would reduce the environmental ranking from '2' to '1' and the overall risk rank would be reduced to Low.

Land management factor of '2' due to forestry operations. Drainage outfalls should be designed to avoid discharging towards the watercourse (Penniquite Burn) to the east and pockets of deeper peat. The slope angle is conducive for peat sliding and peat depths on average around the proposed turbine location are over 0.50m. Care should be taken when stockpiling peat around this turbine to avoid steeper gradients.

There are localised deeper peat deposits to the north and west where special care will need to be taken during the construction process.

	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
Substation Building / Battery Storage Facility	1	1	Peat Depth (Mean = 0.37m)	1	**1 * (3+2) = 5 Low**
			Slope Angle (7°)	3	
			FoS (Min = Cu_{min} > site mean)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

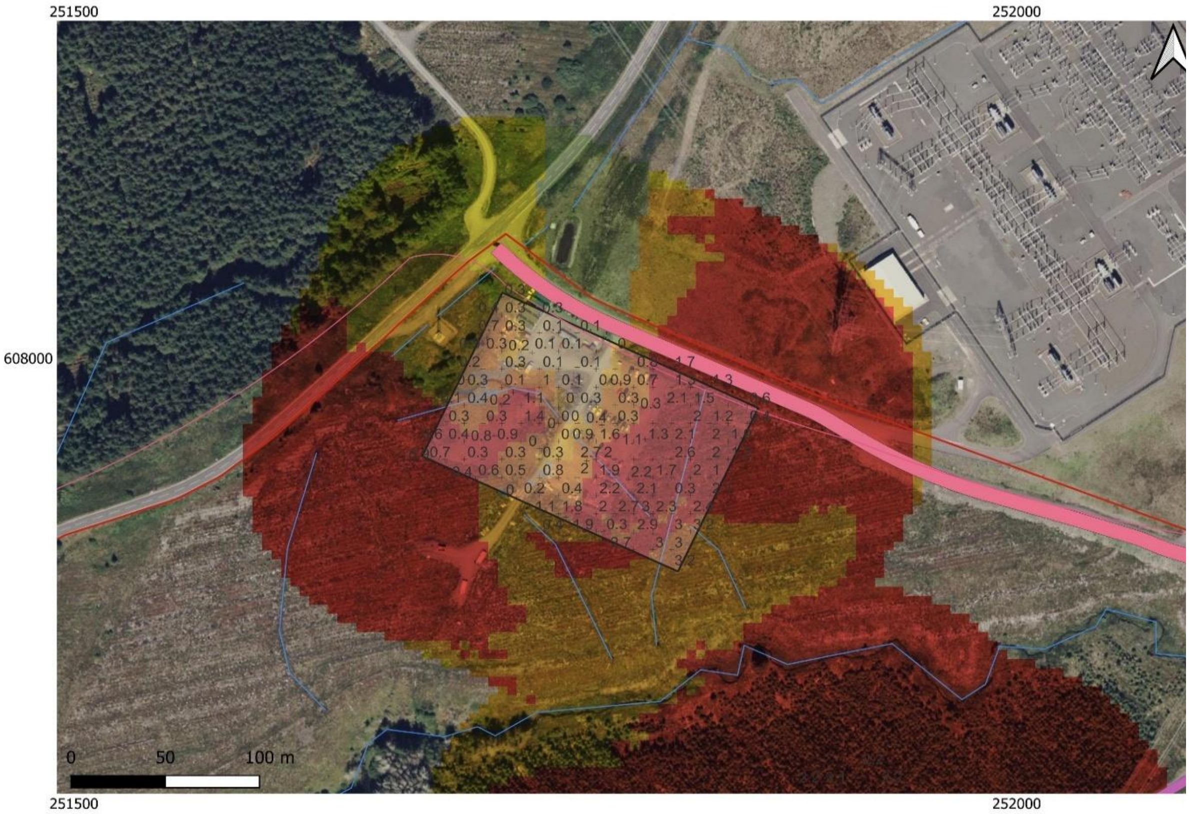


Substation/Battery Storage Location – OS Mapping 1:25,000 – 1:1500 Scale

Location Specific Mitigation:

Care should be taken during the construction process in the southwest where a small part of the proposed infrastructure is within the 100 – 150 m watercourse Special mitigation measures should be implemented to avoid contamination such as limiting stockpiles, drainage ditching and silt fencing. Special care should also be taken during construction to avoid stockpiling on areas of deeper peat as there are several probes with 1.0 m depth in the northeastern areas of the proposed infrastructure.

	Development Infrastructure	Environmental	Contributory Factors (Probability/Exposure)		Risk Ranking
Temporary Construction Compound	1	2/3*	Peat Depth (Mean = 1.00)	3	**2*(3+2) =10** **Low**
			Slope Angle (2.5°)	1	
			FoS (Min = Cu_{min} > site mean)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



Construction Compound Location – Bing Virtual Earth 1:25,000 – 1:1500 Scale

Location Specific Mitigation:

This location includes a pre existing hardstanding for South Kyle I Wind Farm and thus much of the soil and peat has been removed. It will be expanded within the boundary shown above for this development but will be fully reinstated once construction is complete.

Land management factor of '2' due to forestry operations and the pre-existing wind farm infrastructure. Drainage outfalls should be designed to avoid discharging towards the watercourses to the south (the Ashbeugh Glen). There are also localised pockets of peat deposits over 3.0m deep in the eastern sides of the proposed compound where special care will need to be taken during the construction process, for example when stockpiling peat these areas should be avoided.

*The watercourses shown in blue to intersect the Construction Compound in the above figure have been observed on site to be stagnant artificial channels on a very gentle gradient area, therefore are not anticipated to be sensitive receptors.

6.1. Turbine Bases and Ancillary Infrastructure

Table 6.2 below summarises the risk assessment outcome and hazard ranking assignments for each turbine and infrastructure location. The principal contributory factors and impact scales used to derive these assignments are also stated.

Table 6.2: Hazard Ranking Overview for Proposed Turbine and Ancillary Infrastructure Locations

Turbine/Infrastructure ID	Risk Ranking Baseline	Principal Contributory Factors in Risk Assessment	Risk Ranking and Targeted Mitigation and Best Practice Construction
T01	**Low**	Peat depth, slope angle	**Negligible**
T02	**Negligible**	Peat depth	**Negligible**
T03	**Low**	Peat depth, slope angle	**Negligible**
T04	**High**	Peat depth, slope angle proximity to watercourse	**Low**
T05	**Low**	Peat depth, slope angle	**Negligible**
T06	**Low**	Peat depth, slope angle	**Negligible**
T07	**High**	Peat depth, proximity to watercourse, slope angle	**Low**
T08	**High**	Peat depth, proximity to watercourse, slope angle	**Low**
T09	**Low**	Peat depth, slope angle	**Negligible**
T10	**Medium**	Peat depth, proximity to watercourse, slope angle	**Low**
T11	**Medium**	Peat depth, proximity to watercourse, slope angle	**Low**
Substation Building/Battery Storage Facility	**Low**	Proximity to watercourse	**Negligible**
Temporary Construction Compound	**Low**	Peat depth, proximity to watercourse, land management	**Low**

Source: Natural Power

The risk assessment reflects the probability of peat material entering the surface water course and being entrained to an offsite receptor without any mitigation. The wider geomorphological assessment and evidence from recorded peat depths would indicate that a large-scale translational mass movement of peat deposits is very unlikely.

6.2. Access Tracks

Sections of access track have also been reviewed across the site. The highest risk areas are where track alignments cross areas of deeper peat, watercourses and the steep slopes around the watercourse if peat is present. The areas of highest risk can be seen in Figure A.8. There are several areas of proposed new access track that contain pockets of peat over 0.50m deep (summarised within Table 3.4).

The following control measures are required in order to reduce the risk level to low at these discrete locations:

- Cross track drainage which prevents any ponding or build-up of groundwater pressure within the peat upslope or beneath the access infrastructure. Where possible existing drainage systems should be utilised and maintained (including artificial drains);
- No stockpiling or surcharging of the peatland along specific access track sections identified as high or medium risk on Figure A.6.
- A system of ongoing monitoring throughout the construction phase should be in effect to monitor any movement in the peat. A rapid reaction strategy should be developed to ensure measures can be deployed to protect the watercourse in the event of any movement. This may include installation of downslope retaining systems to prevent peat material entering the watercourse and robust watercourse protection measures at the crossing point.
- Floating access track construction could be implemented for the sections of track identified in Table 3.4 (Track Sections 1 – 9) to leave the peat deposits in-situ, this generally reduces disturbance to the peat and the groundwater flow within the peat land.

6.3. Peat Slide Pathways

The assessment considers environmental receptors (main watercourses) to be the primary focus of the risk assessment. Minor or ephemeral watercourses have been assessed to have the potential to transport material to offsite receptors. Where relevant onsite proposed infrastructure has been assessed.

Notwithstanding the point above, this report examines the terrain and the potential evolution of any triggered peat slide event. The determination has been that entrained peat flows would primarily be channelled along the main watercourse's downslope of proposed infrastructure; these locations are highlighted by the black arrows on the Peat Slide Pathways Map in Figure 6.1. The pathways shown indicate the directions where peat flows would travel into main watercourses or waterbodies, they do not indicate risk of instability. The main offsite receptors are the River Dee, Nith and Doon from which the main waterbodies within the Proposed Development merge into.

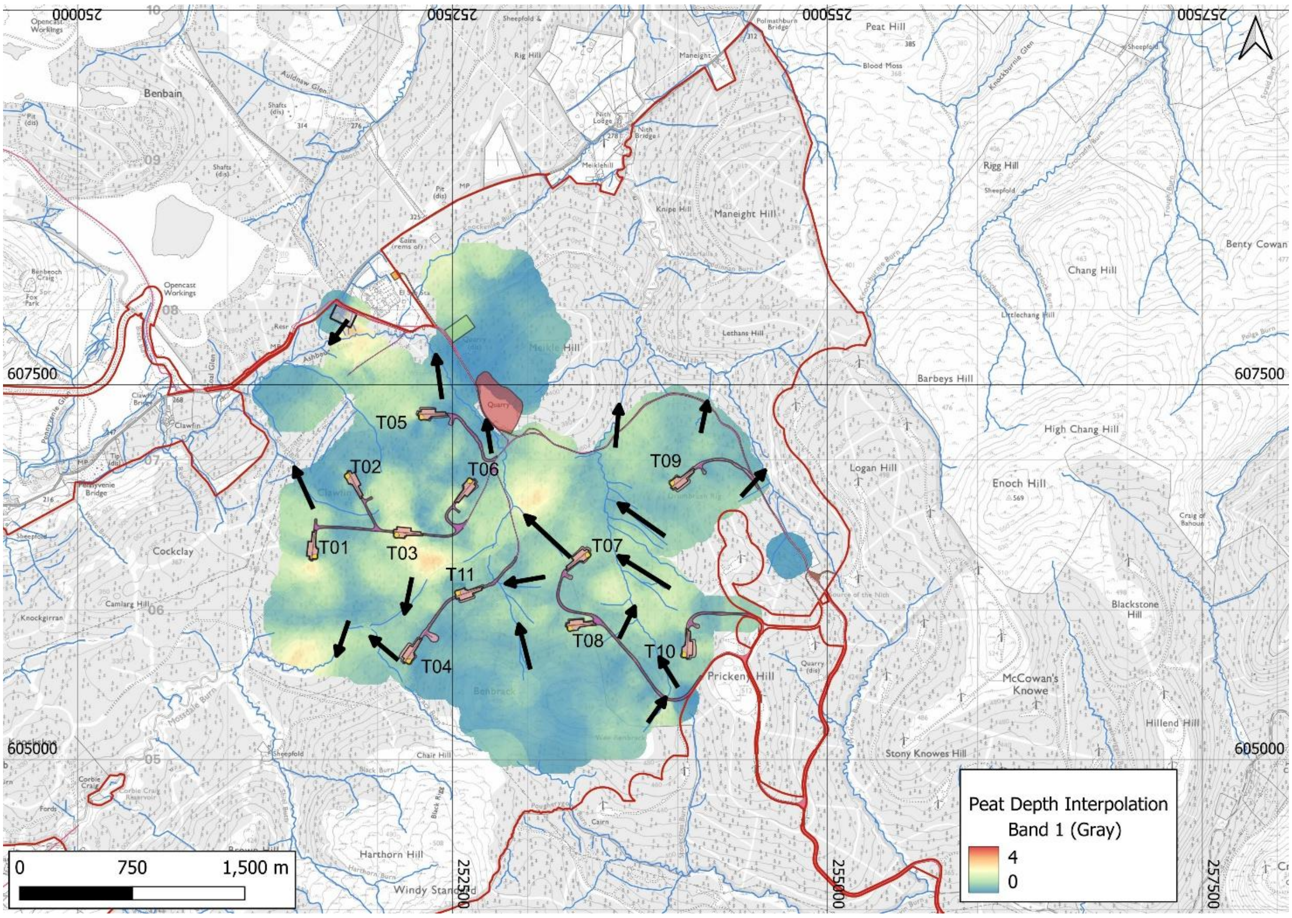


Figure 6.1: Preliminary peat slide pathways (black arrows) and indicative peat depth.

The risk of run out and significant damage to the wider hydrological environmental is deemed low, providing the relevant control measures outlined in his report are implemented at the site.

6.4. Preliminary Geotechnical Risk Register

The preliminary risk register for development wide hazards is listed in Table 6.3 below. Key. Control measures for the hazards have also been identified. A geotechnical risk register should be utilised on an individual turbine basis throughout the construction phase and amended accordingly as new information is received.

Table 6.3: Preliminary Geotechnical Risk Register

Hazard	Cause	Location	Consequence
Peat Landslide / Bog Burst / Peat Flow	High rainfall, and increased surface water infiltration leading to build up of pore water pressure	**T04, T07, T08, T10, T11, and Access Tracks**	Harm to personnel and damage to plant / equipment; Destruction of built infrastructure
Mitigation	Due consideration given to prevailing ground and weather condition when scheduling construction works. I.e. avoid opening new excavation during heavy precipitation and ensure sufficient drainage measures are in place to support construction activities. Ensure a contingency is in place to concentrate on more suitable construction activities during wet weather. The drainage design should be such that its construction is in sequence with providing necessary drainage to new areas of excavation and construction in advance of works. I.e. ensure cut-off ditches are in place prior to opening new excavation.		

Hazard	Cause	Location	Consequence
	The drainage design should as far as practicable preserve the natural hydrological regime and should not inundate areas with run-off which were previously not subjected to such affects. Monitoring weather forecast with site specific weather station; Monitoring (visual) regular site inspection to detect early indications of ground movement (tension cracks, groundwater issues).		
Peat Landslide / Bog Burst / Peat Flow	Concentrated loads placed at the top of slope system or on marginally stable peat deposits	**T01, T03, T04, T05, T06, T07, T08, T09, T10, T11 and Access Tracks**	Contamination of natural watercourses and damage to hydrological systems; Rapid ground movement and mobilisation of material downslope of construction operations; Harm to personnel, plant and equipment; Destruction of temporary or permanent construction works;
Mitigation	At these locations, robust and strict controls on the phasing and pace of construction must be in place. This would be most effectively managed through the CMS. Plant operatives should be briefed in detail regarding the side-casting and stockpiling of materials. Higher risk areas particularly at T06 and T08 should be demarked by high visibility ticker tape or similar as a warning not to stockpile any materials in the deeper peat areas. Ensure the peat depth contour mapping is available and has a high visibility during construction; A programme of frequent inspections should be implemented during excavation and access track construction works. This should be carried out by suitably experienced and qualified personnel. Where stockpiles are placed in suitable areas, these should be closely monitored through the use of high accuracy GPS level and visual survey		
Peat Landslide / Bog Burst / Peat Flow	Increased subsurface groundwater flow and 'piping' failure beneath natural peat deposits, temporary and permanent earthworks	**All turbine positions, and Construction Compound, Access Tracks**	Localised instability associated with temporary and permanent earthworks; Triggering of mass movement of peat material down slope causing harm to personnel, plant and equipment;
Mitigation	Ensure geotechnical design prevents blockages of groundwater flow. This may be achieved through the use of free draining fills and ensuring temporary and permanent earthworks do not cause the build-up of groundwater pressures. A programme of geotechnical inspections should be implemented throughout construction phase. Ensuring focus extends beyond immediate areas of construction, both up-slope and down-slope to detect any unforeseen effects on stability		
Bearing Capacity Failure (Peat Surface)	Increased loading of low shear strength deep peat deposits	**T03, T04, T08 and Construction Compound, Access Tracks**	Localised instability and settlement associated with temporary and permanent earthworks; Triggering of mass movement of peat material down slope causing harm to personnel, plant and equipment; Contamination of natural watercourses and damage to hydrological systems from peat material mobilised down slope;
Mitigation	Due consideration given to the prevailing ground and weather conditions when scheduling site works Ensure detailed peat depth contour plan to be used in construction planning and design; Use of appropriate plant machinery (low ground pressure and long reach to avoid over loading peat deposits) A programme of geotechnical inspections will be implemented during excavation works Geotechnical monitoring post-construction		
Peat Failure	Mass movement of temporary storage mounds and bunds	**All turbine positions, Construction**	Localised instability and settlement

Hazard	Cause	Location	Consequence
		Compound and Access Tracks	associated with temporary and permanent earthworks Triggering of mass movement of peat material down slope causing harm to personnel, plant and equipment;
Mitigation	Storage site selection and stockpile design by a suitably qualified and experienced geotechnical engineer; Routine maintenance and inspection of peat storage mounds		
Creep, long term settlement of structures	Tracks or hardstand founded on peat and/or poor or variable foundation soils	**All turbine positions and Construction Compound and Access Tracks**	Ongoing settlement and damage of infrastructure, e.g. damage to access track running surface.
Mitigation	Contingency of routine maintenance of infrastructure and drainage elements to ensure longer term issues do not cause a build-up of effects leading to higher level consequences e.g. larger scale instability		

7. Conclusions

The peat depths across the site are variable but generally high with a site-wide average of 0.78m. The proposed infrastructure layout primarily avoids the deepest areas of peat. All of the turbine positions are within peat deposits that have been assessed as having the potential for peat sliding.

The following construction related factors to peat slide are highlighted for consideration:

- Movement can occur following over-loading of peat slopes, e.g. by placement of fill, stockpiling and end-tipping directly onto peat slopes;
- Suitability of drainage measures and the prevailing groundwater conditions are also key factors to consider during construction. Increasing pore water pressures within peat deposits decreases the stability of a slope;
- In extreme events, peat can act as a viscous fluid and travel over very shallow slopes. The re-working or excessive handling of peat can reduce the shear strength to residual levels and hence lead to ‘liquid’ peat behaviour;
- The rate of construction can have a major influence on the stability of peat land environments. Rapid loading and limited time for excess pore pressure dissipation can also decrease the stability state of peat slopes;
- Excavation across a side slope, a convex slope / break in slope can induce peat failure;
- Therefore, the most significant but highly unlikely impact is death or injury to site personnel. More likely is damage of the environment and disruption to the proposed infrastructure leading to time and cost impacts.

It should be noted that where peat probes indicate shallow depths 0.1m to 0.5m that the deposits are likely to be composed of a topsoil and mineral subsoil, thus the risk of peat sliding is none.

The mean undrained shear strength determined across the Development is 21.5 kPa. This indicates peat of moderate shear strength. A conservative value of 10 kPa has been used in the slope stability modelling.

The risk ranking produced in this report is a combination of the overall likelihood with the potential environmental/impact effect of a peat instability event. With increased proximity to watercourses exposure of such an event is vastly increased as watercourses act as a sensitive off-site receptor and can carry peat debris to further offsite receptors. In addition, where relevant the position of proposed internal site infrastructure and assets has been considered.

The initial risk rankings are based on the risk of peat failure occurring without appropriate mitigation and control measures in place during construction. It should be highlighted that through geotechnical risk management, strict construction management and implementation of relevant control measures, this shall reduce the risk of peat failure across the development to residual low levels.

The risk assessment should be reviewed prior to construction and further refined following intrusive ground investigation and detailed infrastructure design.

8. Recommendations

The peat slide risk assessment cites key control measures which are required to ensure the risk of peat slide remains at residual (low) levels. However, there should be wider consideration of these measures across all areas of the proposed development which may be influenced by the proposed construction. This is critical where infrastructure may impact terrain and slope conditions beyond the proposed working areas.

- Location specific mitigation has been described within Table 6.1. This includes restrictions on peat storage and stockpiling during the construction process, floating access track and drainage outfall design. One recommendation is made for potential micro-siting post-consent that would reduce the environmental risk rating at several turbines, this is as follows:
  - Micrositing T04 50m to the north;
  - Micrositing T07 100m to the southeast;
  - Micrositing T08 50m to the northwest;
  - Micrositing T10 10m to the east;
  - Micrositing T11 60m to the southwest;
- A detailed intrusive ground investigation would be carried out (post-consent) and as part of the pre-construction phase of development. This investigation would seek to further characterise the peat deposits with emphasis on, in-situ shear strength testing and targeted undisturbed sampling and laboratory testing. All peat samples recovered should be classified in accordance with the Von Post system, (Hobbs, 1986) and current British and Eurocode standards for site investigation. Further investigation of the peat sub-soil interface would also be carried out.
- Groundwater level information would be collated as part of any future ground investigation;
- The results of a detailed ground investigation should be assessed with respect to refining the peat stability assessment at infrastructure locations where peat slide risk is elevated. All pertinent control measures and mitigation measures should be revised, and their implementation supervised following the results of the ground investigation and construction design phase of works;
- Continued assessment and monitoring throughout the construction phase of works and at suitable intervals post construction should be implemented to ensure the control measures are suitable and are providing adequate mitigation against peat instability;
- Construction practices should be managed through the Construction Method Statement (CMS) and within the wider context of the Construction Environmental Management Plan (CEMP). The CMS should be prepared by the appointed principal contractor and reviewed by a suitably experienced geotechnical engineer who has read and understood this report. The following general recommendations are provided in line with the, Good practice during wind farm construction, (2019) guidance:
  - Avoid peat arisings being placed as local concentrated loads on peat slopes without first establishing the stability condition of the ground and slope system. Stockpiling on areas of deep peat and in close proximity to steep slopes should be avoided.
  - Avoidance of uncontrolled and concentrated surface water discharge onto peat slopes as this may act as contributory factor to failure. All water discharged from excavations during construction phase should be directed away from all areas identified as susceptible to peat failure and should managed by a suitably designed site drainage management plan.
  - All excavations where required should be adequately supported to prevent collapse and the destabilising peat deposits adjacent to excavations.
  - A system of daily reporting should be established during construction and utilised to monitor the geotechnical performance of slopes including peat, sub-soil and bedrock. This should be

implemented and undertaken by a suitable experienced and qualified geotechnical engineer. Post construction this monitoring procedure should be curtailed to allow for annual or ad-hoc inspection as required.

8.1. Floating Track Construction

MacCulloch, (2006) advises that a 'floating' type road construction which leaves the peat deposits in situ may be advantageous with respect to preventing peat failure. This method of construction has a lower impact on the internal groundwater flow within the peat land. However, there are cases where groundwater flow within the peat can be detrimentally affected. The following control measures should be implemented as part of the design and construction of 'floating' access track:

- Prevent the rupture of vegetation surface of the peat by avoiding the use of large sharp rock fill;
- Prevent the overloading and subsequent shearing of the peat throughout construction and use of the 'floating' track;
- Monitoring of the long-term settlement of the 'floating' track is necessary to predict the effects of reducing permeability within the peat and hence increasing groundwater pressures beneath the track construction. Through ongoing monitoring additional drainage relief measures can be implemented when conditions for peat failure are predicted;
- Do not position 'floating' access track on or adjacent to convex side slopes.

An additional control on the construction and use of 'floating' track is through the strict management of construction traffic loading. This may involve the timing between heavy traffic to be staggered to prevent the effect of cyclic loading over short time periods reducing the shear strength of the peat. In order to assess the maximum loading rate or timing between heavy construction traffic it may be necessary to monitor the vertical deformation of the 'floating' track sections following loading and recording the time taken for recovery of vertical deformation. The use of simple settlement plates and survey pegs can be used to achieve this. The frequency of trafficking for heavy loads must then be timed to allow deformation of the 'floating' road to recover its deformation.

MacCulloch (2006) generally advises that in order to prevent injury or an environmental incident, it is important that there is a robust procedure in place should it become apparent that a peat failure is imminent.

8.2. Cut/Fill Track Construction

Across the main area of Development not affected by deep peat; the construction of proposed access tracks should be considered by excavation and replacement method, MacCulloch, (2006). Excavated peat is removed and targeted for suitable re-use. Aggregate would be used to form the subgrade and running surface of the track.

For 'Cut/Fill' track construction the risk of peat failure is therefore focussed on the peat deposits adjacent to the access track, and the placement of peat arisings. In these areas the following control measures are listed by MacCulloch, (2006):

- Careful excavation of peat deposits by appropriate machine excavator to limit localised peat failures which can occur on the edge of the track excavation. This is in order to prevent a minor failure triggering retrogressive peat failure affecting a larger area of peat adjacent to the track;
- Temporary drainage systems followed by establishment of a permanent drainage network. Silt traps and small retaining structures may be required especially in proximity to water crossings to prevent siltation and blockage of watercourses;

- Ongoing monitoring and on demand maintenance when silt traps require emptying and temporary drainage reinstated if blocking occurs. This will assist in maintaining hydrology baseline conditions;
- The permanent drainage system must direct surface water flow away from the 'cut' track to prevent peat failure within the track bunds;

8.3. General Earthworks

It has been identified that there is a requirement for the excavation of peat soils and superficial deposits during construction of the wind farm. Initially the vegetated peat layer and any topsoil should be stripped and temporarily stockpiled away from areas of deep peat and instability risk. The design of this stockpile must be agreed by a suitably qualified geotechnical engineer. When working in areas of deep peat (i.e. >0.5m) no peat or overburden should be stored on such deposits as this may lead to instability. The following options for peat storage may be considered:

- Dedicated peat storage areas designed under the advisement of a suitable qualified geotechnical engineer and conform to up-to-date regulations and waste directives.
- Re-use of peat in dressing-off of batters on access tracks, finishing of cable trenching works, the landscaping of turbine bases. Peat must be re-used to ensure stability and its long terms sustainability i.e. the prevention of drying of desiccation.
- Excavated glacial till and weathered rock may be used as backfill to turbine bases should material be deemed geotechnically suitable. All related works must be carried out in accordance with an agreed CEMP and conform to site restoration plans.
- For in-situ and undisturbed peat; site vehicle movements must be minimised across such areas, throughout construction and post construction. Observation and monitoring for settlement, deformation, or signs of failure along access tracks and critical working areas must be implemented. This may be achieved with a network of settlement plates and survey markers which can be periodically re-surveyed, and any differential movements identified. It is recommended that all earthworks are designed in accordance with current national standards. Such measures would be focused on zones of deep peat and areas at elevated peat slide risk.

The following risk mitigation is recommended with regards to peat storage:

- Storage site selection and stockpile design would be undertaken by a suitably qualified and experienced engineer;
- Temporary storage of peat in a single dedicated area shall be avoided;
- Peat storage on areas of low / negligible peat slide risk only
- Peat storage height shall not exceed 0.5m without dedicated stability assessment;
- Routine maintenance and inspection of peat storage areas would be undertaken.
- Additional mitigation measures are detailed in Natural Power's Peat Management Plan submitted along with the Peat Stability Assessment.

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10. Glossary

Table 10.10.1: Scientific Terms used within this Peat Slide Risk Assesement

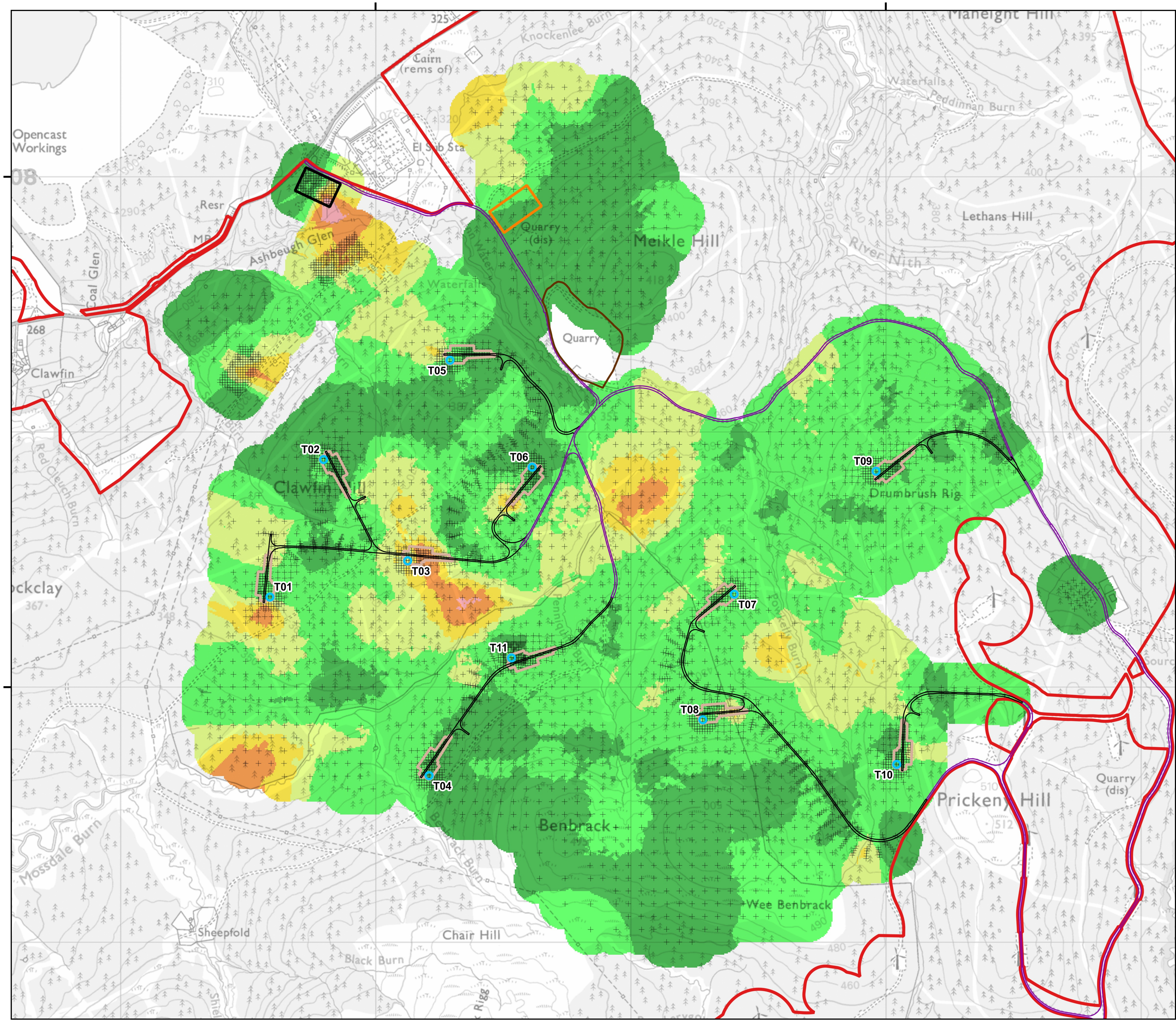
Term	Definition
Acrotelm	The thin aerobic zone at the surface of the mire usually fibrous and containing the majoring of groundwater flow through the peat mass, underlain by the thick anaerobic zone called the catotelm, usually a higher degree of humification and lower shear strength.
Bog Burst / Flow	Failure of a raised bog (i.e. bog peat) involving the break-out and evacuation of (semi-) liquid basal peat. A flow is formed of highly humified basal peat from a clearly defined source area.
Bulk Density	The normal in situ density of a soil, i.e. its mass divided by its volume.
Catotelm	see acrotelm.
Consolidation	The process by which a soil decreases in volume.
Construction Method Statement	(CMS), a detailed written description of how a particular construction activity will be carried out safely and in an environmentally compliant manner.
Diamicton	Glacially derived soil which is poorly sorted and contains soil particles ranging in size from clay to boulders.
Geographical Information System (GIS)	Form of technology capable of capturing, storing, retrieving, editing, analysing, comparing and displaying spatial environmental information.
Geo-hazard	Geological hazard, either natural or man-made, which threatens either humans or the environment in which they live.
Geo-membrane	Non-porous sheet that has a very low permeability (in engineering terms impermeable) usually formed of polyethylene.
Geo-textiles	Man-made fabrics, generally made from plastics but also may be made from natural materials, used in construction.
Groundwater	Water located beneath the ground surface in soil pore spaces and in the fractures of rock formations.
Ground Investigation	Specialist intrusive phase of site investigation with associated monitoring, testing and reporting to a national standard.
Hagg	Natural gully or weathering structure in surface of peat mass.
Hazard	Something with a potential for adverse consequences / harm.
Humification	The process of decomposition of a peat soil.
Hydrological regime	The statistical pattern of a river's constantly varying flow rate.
Mitigation	The limitation of undesirable effects / impact of a particular event.
Mitigation Measures	Actions in place to limit the undesirable effects / impact of a particular event.
Peat Slide	Failure of a blanket bog involving sliding of intact peat and the mineral substrate material or immediately above the contact with the underlying mineral soil substrate.
Peat debris slide	Shallow translational failure of a hillslope with a mantle of blanket peat in which failure occurs by shearing wholly within the mineral substrate and at a depth below the interface with the base of the peat such that the peat is only a secondary influence on the failure.

Term	Definition
Permeability	The rate at which water and air moves through a soil.
Pore water	The water filling the voids between grains of soil
Primary consolidation	The process by which a soil decreases in volume through the expulsion of internal pore water
Overland flow	Water passing rapidly over or through the surface layer of soil.
Peat	A largely organic substrate formed of partially decomposed plant material
Precipitation	Deposition of moisture including dew, hail, rain, sleet and snow.
Risk	The combination of the probability of an event and the magnitude of its consequences
Residual Risk	The risk remaining after mitigation measures have been undertaken.
Rockhead	The upper surface of rock mass beneath the superficial soil cover.
Runoff	Surface runoff is the flow of water over the surface that can result due to the surrounding soils lacking the capacity to infiltrate further water or due to the surface water flowing off infrastructure such as access tracks and hardstands.
Secondary Consolidation	The compression of a soil that takes place after primary consolidation due to creep, compression of organic matter etc.
Sedimentation	The tendency for particles in suspension to settle out of the fluid in which they are entrained.
Site Investigation	The overall process of discovery of information concerning a site, the appraisal of data, assessment and reporting. Can include desk, non-intrusive and intrusive investigation.
Shear strength	The maximum shear stress which a material can withstand without rupture/ failure
Shear vane	In situ test using a x4 blade steel vane pushed into the ground and rotated to provide an indication to the undrained shear strength of a soil.
Superficial Deposits	Young, sediments and soil deposits occurring at the surface.
Surcharge	An additional mass of material or load applied to an existing soil or structure
Topography	The physical features of a geographical area.
Undisturbed Sample	A sample of soil whose condition is sufficiently close to the actual condition of the soil in situ to be used to approximate the properties of the soil in the ground.
Water resources	The supply of groundwater and surface water in a given area.

Source: Natural Power

A. Maps

- Figure A.1 Interpolated Peat Depth
- Figure A.2 Geomorphological Features
- Figure A.3 Slope Angle Map
- Figure A.4 Factor of Safety
- Figure A.5 Environmental Impact Zonation
- Figure A.6 Peat Stability Risk Zonation
- Figure A.7 Superficial Geology
- Figure A.8 Solid Geology



Project:

South Kyle II Wind Farm, East Ayrshire

Title:

Figure A.1: Interpolated Peat Depth

Key

- Site boundary
- Proposed turbine
- Proposed crane hardstanding
- Existing track (to be upgraded)
- Proposed new track
- Proposed substation and battery storage
- Proposed temporary construction compound
- Proposed borrow pit
- Peat probe

Interpolated peat depth (m) *

- <= 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- > 3.0

* Interpolated using the ordinary kriging method with a spherical semi-variogram and a 100 m maximum search radius.

Scale @ A3: 1:15,000
Coordinate System: British National Grid

0 200 400 600 800 m

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The Natural Power Consultants Limited
The Green House
Forrest Estate, Dalry
Castle Douglas, DG7 3XS, UK
Tel: +44 (0)1644 430008
Fax: +44 (0)845 299 1236
Email: sayhello@naturalpower.com
www.naturalpower.com

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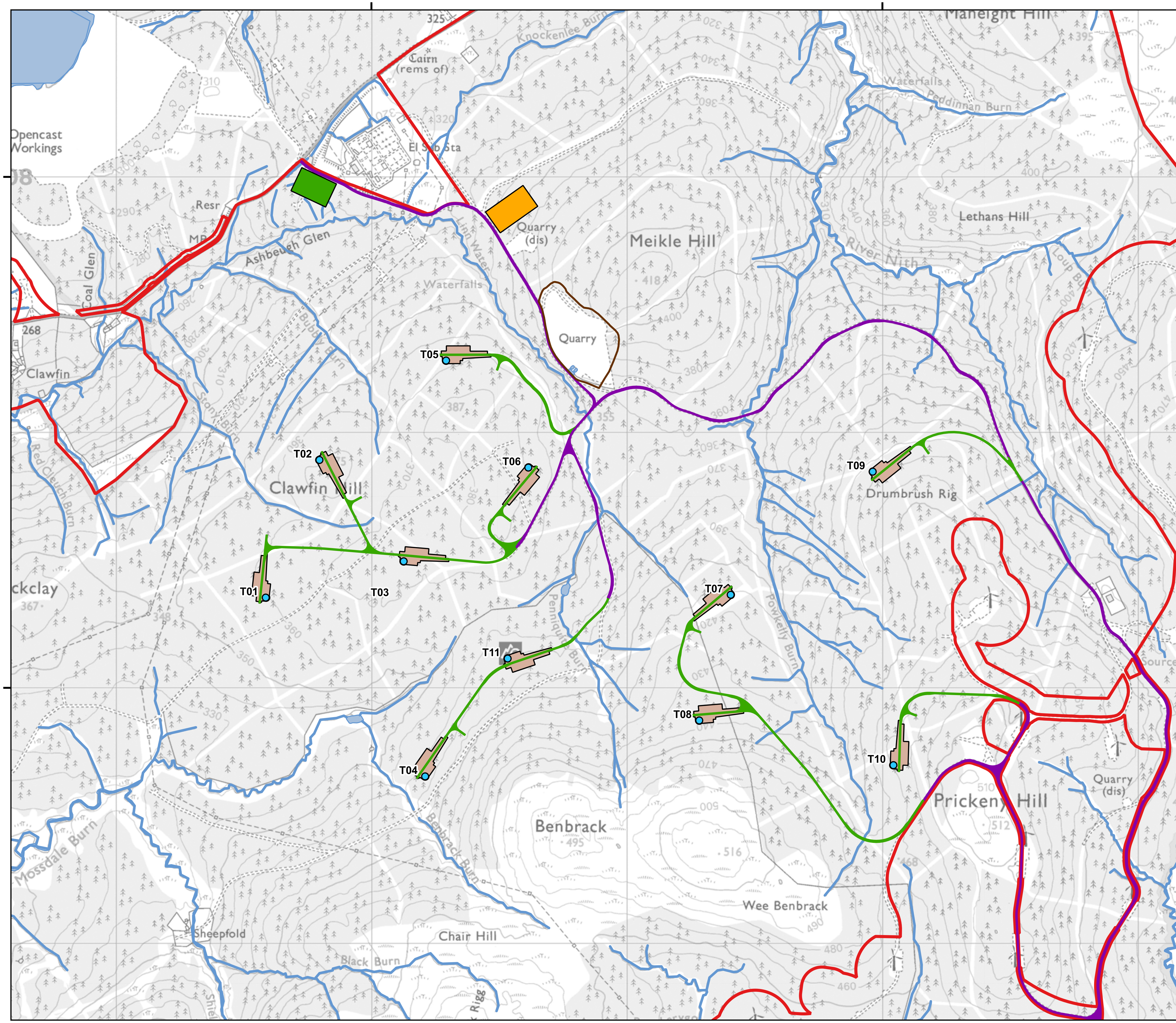

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Figure A.2: Geomorphological Features

Key

- Site boundary
- Proposed turbine
- Proposed crane hardstanding
- Existing track (to be upgraded)
- Proposed new track
- Proposed substation and battery storage
- Proposed temporary construction compound
- Proposed borrow pit
- Watercourses and waterbodies

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The Green House
Forrest Estate, Dalry
Castle Douglas, DG7 3XS, UK
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Email: sayhello@naturalpower.com
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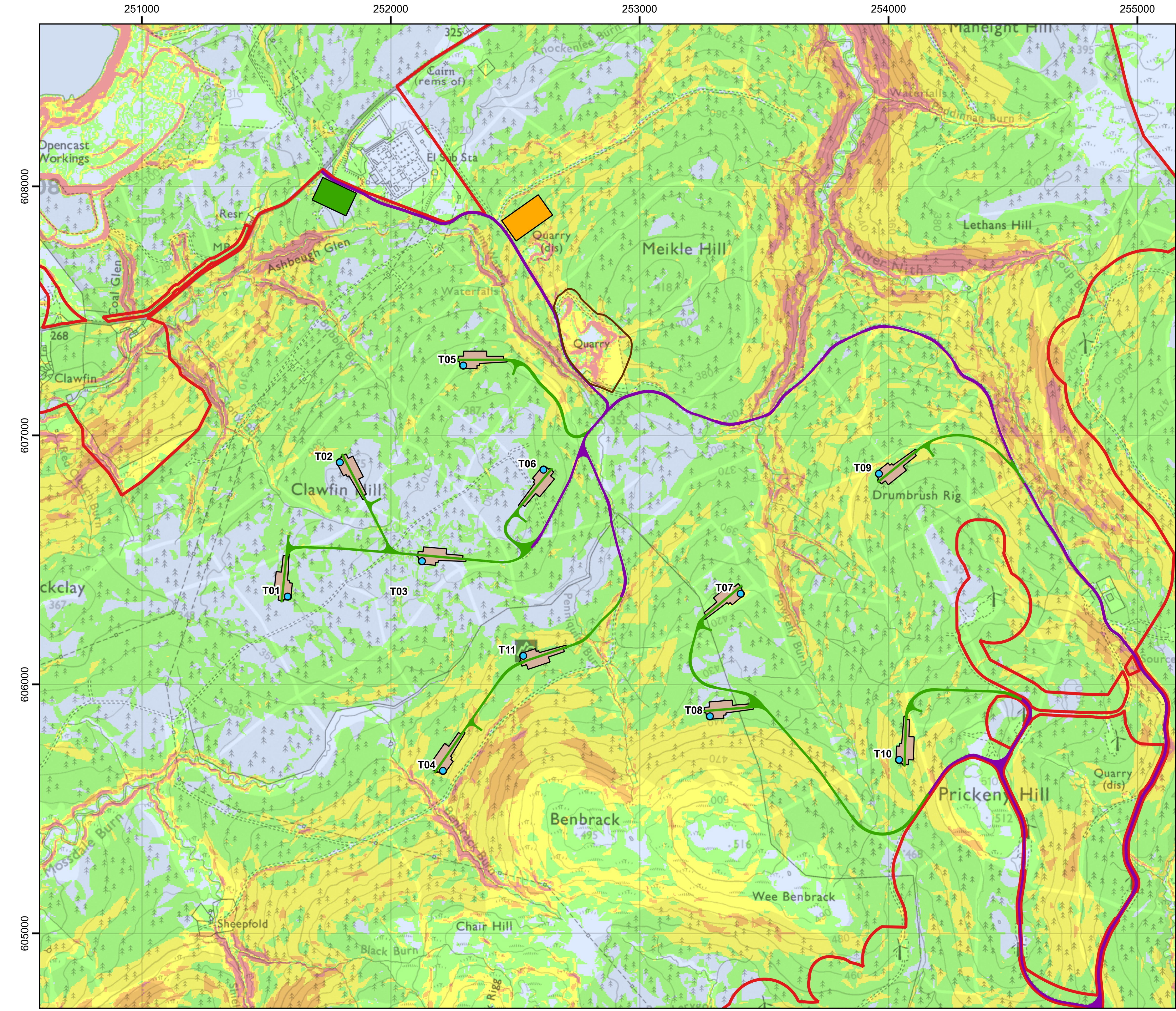

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Title:

Figure A.3: Slope Angle

Key

- Site boundary
- Proposed turbine
- Proposed crane hardstanding
- Existing track (to be upgraded)
- Proposed new track
- Proposed substation and battery storage
- Proposed temporary construction compound
- Proposed borrow pit

Slope angle hazard risk

- 5 (> 20°)
- 4 (16 - 20°)
- 3 (10 - 15°)
- 2 (4 - 9°)
- 1 (0 - 3°)

Scale @ A3: 1:15,000

Coordinate System: British National Grid

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The Natural Power Consultants Limited
The Green House
Forrest Estate, Dalry
Castle Douglas, DG7 3XS, UK
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Fax: +44 (0)845 299 1236
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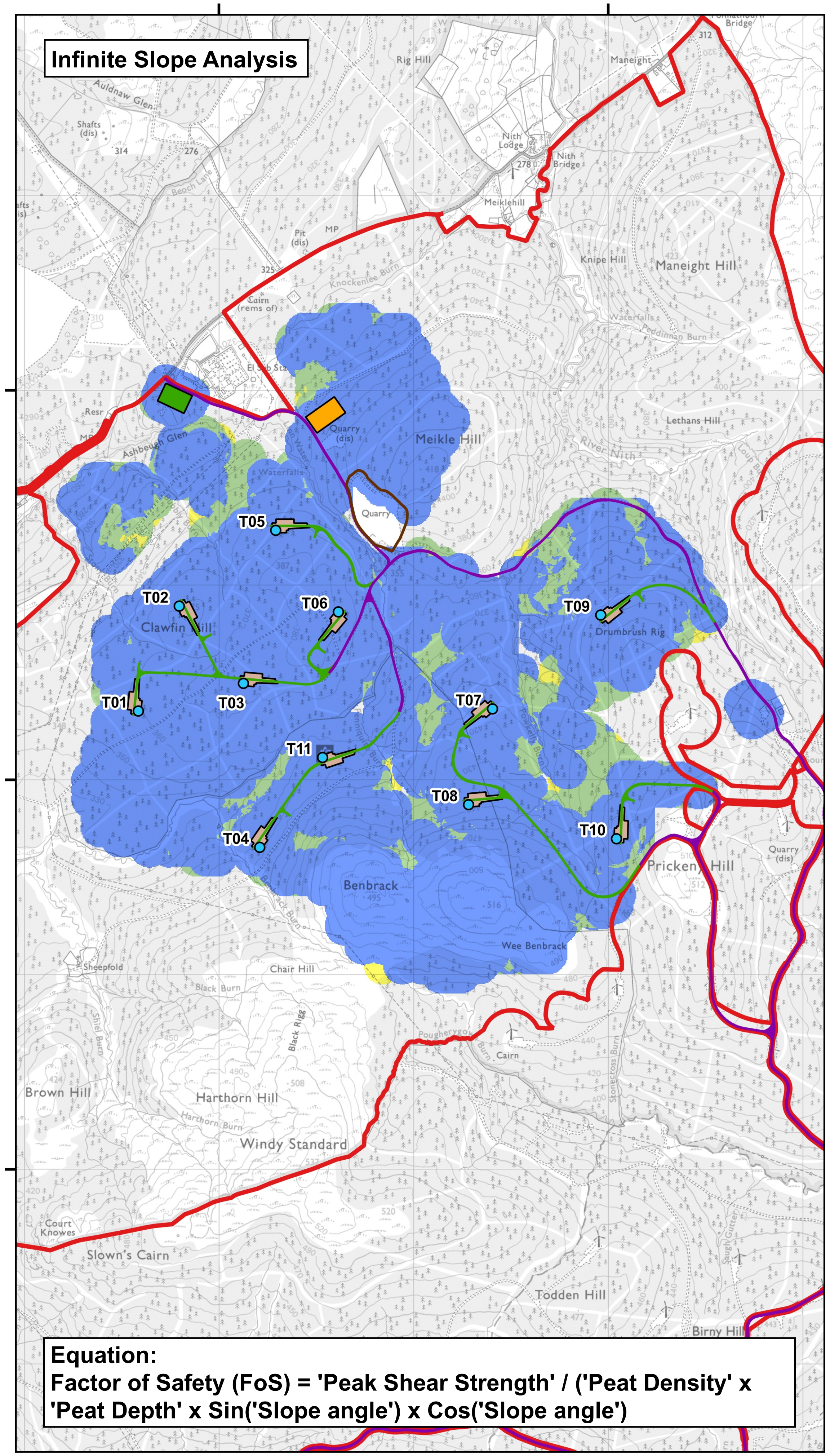

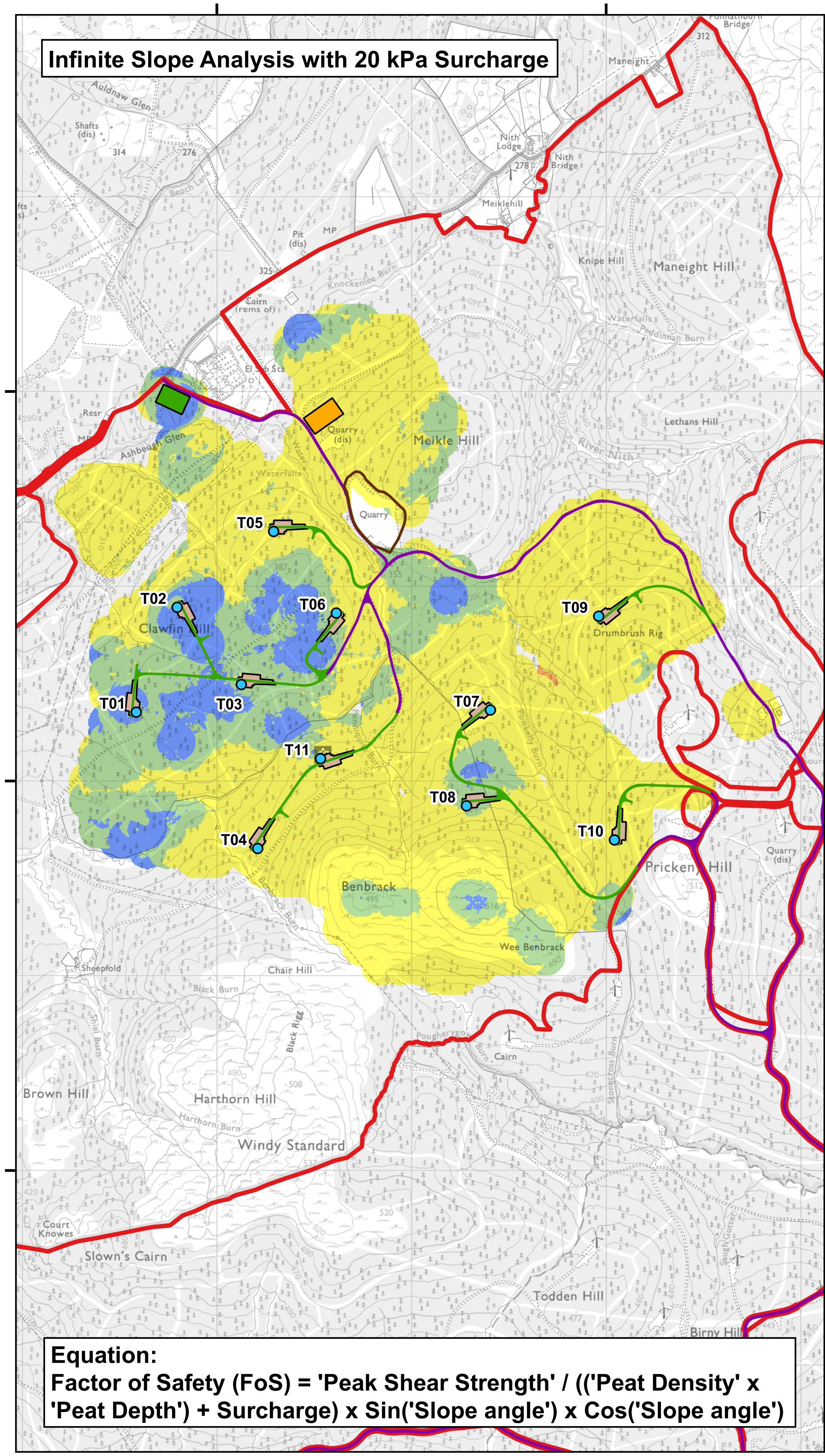

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Figure A.4: Factor of Safety

Key

- Site boundary
- Proposed turbine
- Proposed crane hardstanding
- Existing track (to be upgraded)
- Proposed new track
- Proposed substation and battery storage
- Proposed temporary construction compound
- Proposed borrow pit

Factor of Safety (FoS) *

- <1.0
- 1.0 - 1.3
- 1.3 - 5.0
- 5.0 - 10.0
- >10.0

*F = Cu / (y*z* sinβ * cosβ)
Where:
F = Factor of Safety (FoS)
Cu = Undrained shear strength of the peat (kPa) - assumed value 10 kPa
y = Bulk unit weight of saturated peat (kN/m³) -assumed value 10 kN/m³
z = Peat depth in direction of normal stress
β = Slope angle to the horizontal and hence assumed angle of sliding plane (degrees)

Scale @ A3: 1:28,000
Coordinate System: British National Grid
0 0.25 0.5 0.75 1 km
N

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Forrest Estate, Dalry
Castle Douglas, DG7 3XS, UK
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Fax: +44 (0)845 299 1236
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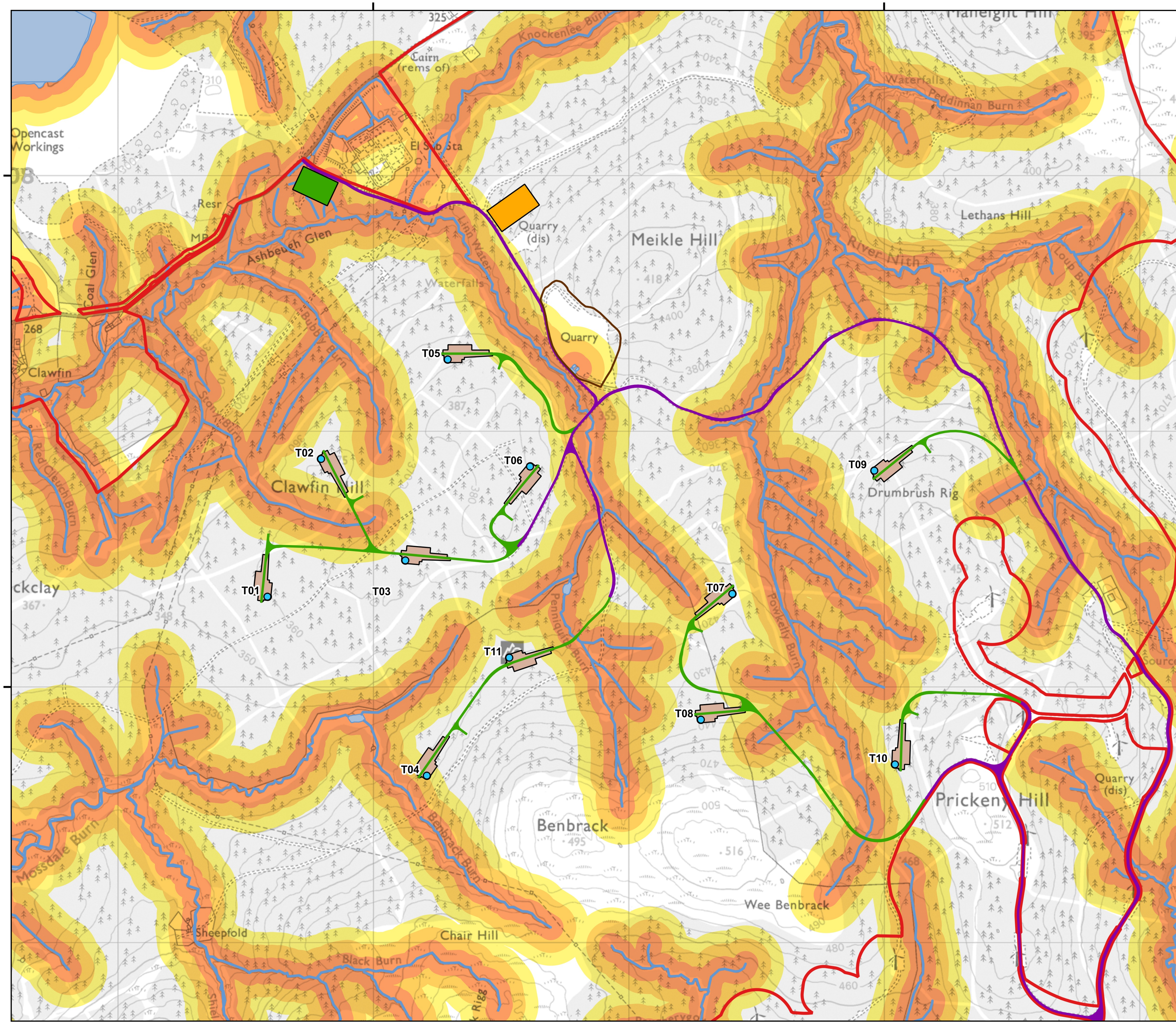

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Title:

Figure A.5: Environmental Impact Zonation

Key

- Site boundary
- Proposed turbine
- Proposed crane hardstanding
- Existing track (to be upgraded)
- Proposed new track
- Proposed substation and battery storage
- Proposed temporary construction compound
- Proposed borrow pit
- Watercourses and waterbodies

Environmental Impact Zone (proximity to watercourse)

- High risk (< 50 m from watercourse)
- Medium risk (50 - 100 m from watercourse)
- Low risk (100 - 150 m from watercurse)

Scale @ A3: 1:15,000

Coordinate System: British National Grid

0 200 400 600 800 m

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Castle Douglas, DG7 3XS, UK
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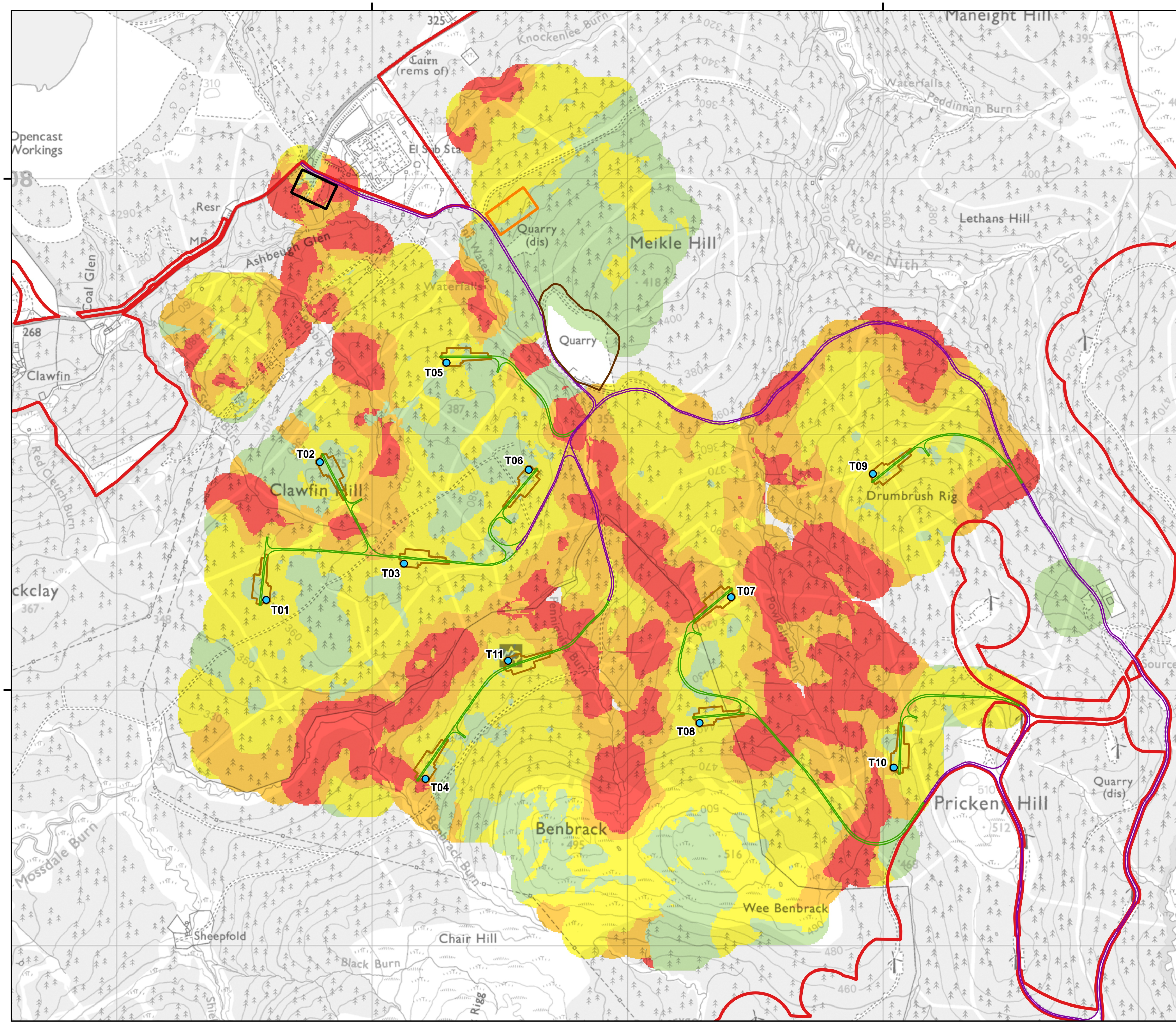

Project:

South Kyle II Wind Farm, East Ayrshire

Title:

Figure A.6: Peat Stability Risk Zonation

Key

- Site boundary
- Proposed turbine
- Proposed crane hardstanding
- Existing track (to be upgraded)
- Proposed new track
- Proposed substation and battery storage
- Proposed temporary construction compound
- Proposed borrow pit

Peat Stability Risk Ranking *

- 0 - 4 Negligible **
- 5 -10 Low
- 11 - 16 Medium
- > 16 High

* Peat stability risk zone based on terrain slope angle and peat depth factors with impact based on proximity to sensitive watercourse receptor. Please see accompanying reporting for further explanation.

** At sites where peat/soil depth is recorded or predicted to be 0.30m or below. The risk of a peat slide generating from these areas is deemed negligible for the purposes of the risk assessment.

Scale @ A3: 1:15,000

Coordinate System: British National Grid

0 200 400 600 800 m

N

Date: 27-03-25	Prepared by: DM	Checked by: LC
Ref: GB201396_M_150_C	Layout: 280923_11t_A	

Drawing by:
The Natural Power Consultants Limited
The Green House
Forrest Estate, Dalry
Castle Douglas, DG7 3XS, UK
Tel: +44 (0)1644 430008
Fax: +44 (0)845 299 1236
Email: sayhello@naturalpower.com
www.naturalpower.com

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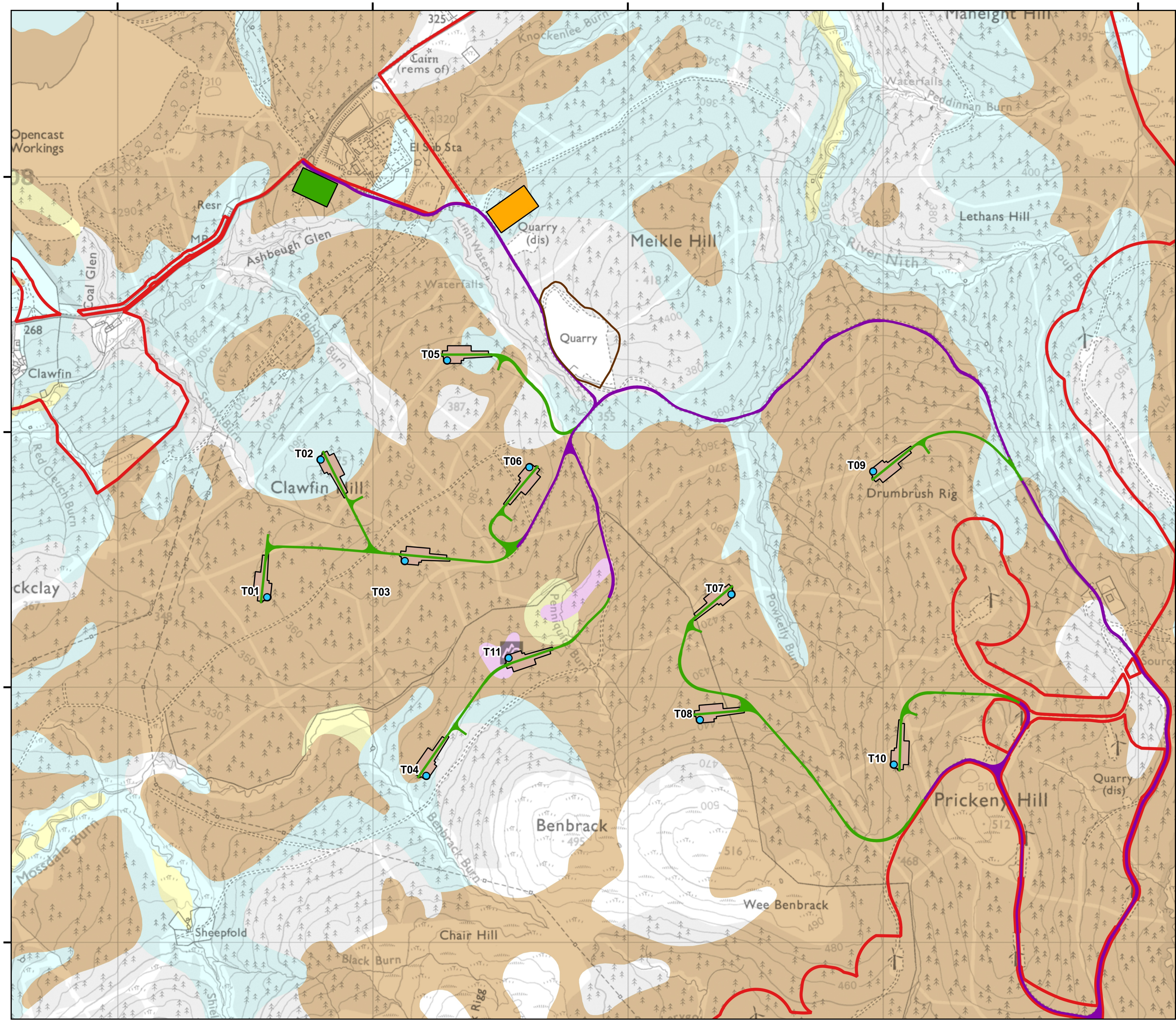
VATTENFALL



Project:

South Kyle II Wind Farm, East Ayrshire

Title:

Figure A.7: Superficial Geology

Key

- Site boundary
- Proposed turbine
- Proposed crane hardstanding
- Existing track (to be upgraded)
- Proposed new track
- Proposed substation and battery storage
- Proposed temporary construction compound
- Proposed borrow pit

Superficial deposits

- Alluvium - Silt, Sand and Gravel
- Glaciofluvial Deposits - Gravel, Sand and Silt
- Peat
- Till, Devensian - Diamicton

Scale @ A3: 1:15,000

Coordinate System: British National Grid

0 200 400 600 800 m

N

Date: 21-03-25	Prepared by: LG	Checked by: LC
Ref: GB201396_M_144_B	Layout: 280923_11t_A	

Drawing by:
The Natural Power Consultants Limited
The Green House
Forrest Estate, Dalry
Castle Douglas, DG7 3XS, UK
Tel: +44 (0)1644 430008
Fax: +44 (0)845 299 1236
Email: sayhello@naturalpower.com
www.naturalpower.com

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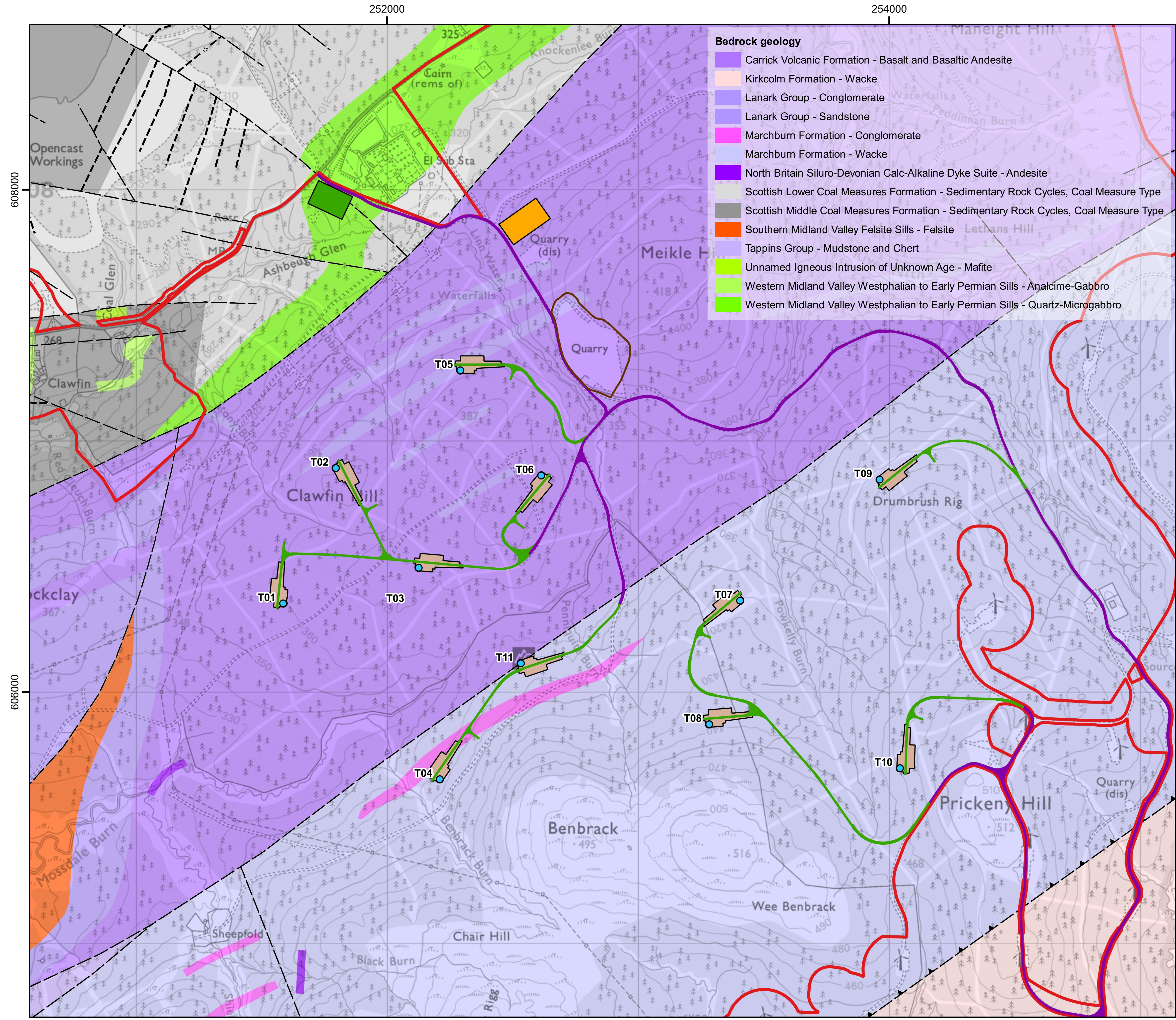

Project:

South Kyle II Wind Farm, East Ayrshire

Title:

Figure A.8: Solid Geology

Key

- Site boundary
- Proposed turbine
- Proposed crane hardstanding
- Existing track (to be upgraded)
- Proposed new track
- Proposed substation and battery storage
- Proposed temporary construction compound
- Proposed borrow pit

Linear features

- Coal seam, inferred
- Fault, inferred, displacement unknown
- Ironstone bed, inferred
- Reverse or thrust fault, inferred, barbs on hanging wall side, throw in metres

Scale @ A3: 1:15,000

Coordinate System: British National Grid

0 200 400 600 800 m

N

Date: 21-03-25	Prepared by: LG	Checked by: LC
Ref: GB201396_M_145_B	Layout: 280923_11t_A	

Drawing by:
The Natural Power Consultants Limited
The Green House
Forrest Estate, Dalry
Castle Douglas, DG7 3XS, UK
Tel: +44 (0)1644 430008
Fax: +44 (0)845 299 1236
Email: sayhello@naturalpower.com
www.naturalpower.com

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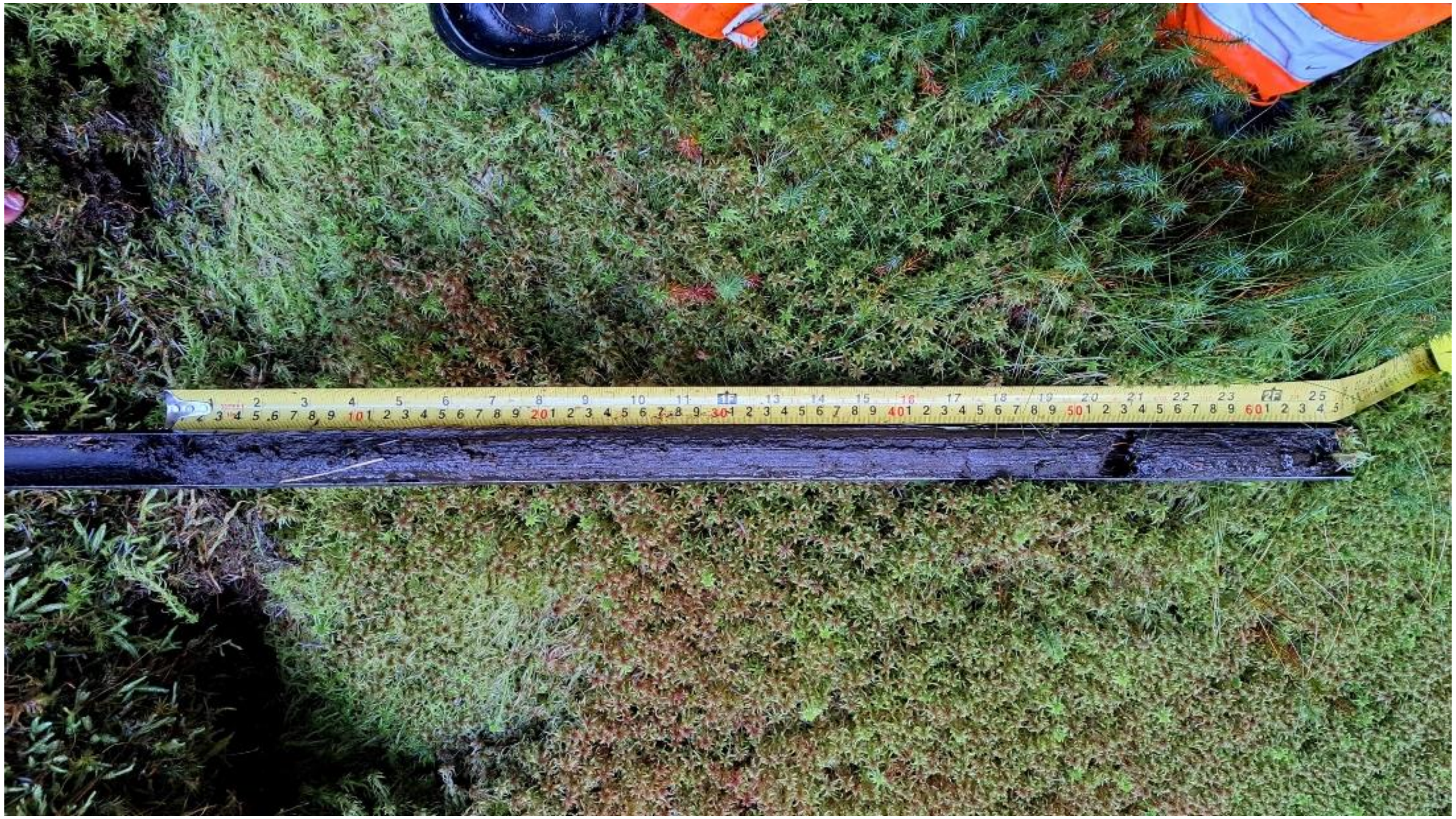
B. Site Photographs, In-situ testing, Lab testing, Peat Coring

- B.1 Peat Core Logs
- B.2 Peat Core Photos
- B.3 Hand Shear Vane Results
- B.4 Laboratory Testing Results

Peat Core Descriptions - South Kyle 2 Windfarm					
Location ID	**Top depth**	**Bottom depth**	**Log**	**Sample**	**Notes**
T3	0.00	0.30	Soft dark brown plastic fibrous PEAT (H6/B5)		
	0.30	0.50	Firm dark brown spongey fibrous PEAT (H6/B5)		
	0.50	0.90	Soft brown plastic pseudo-fibrous PEAT (H7/B6)	T3 (0.00m - 0.9m)	
T9	0.00	0.30	Soft dark brown spongey fibrous PEAT (H4/B3)		
	0.30	0.80	Firm brown plastic pseudo-fibrous PEAT (H7/B2)	PP-802 (0.00m - 0.8m)	
T1	0.00	0.40	Soft brown sponge fibrous PEAT (H6/B5)		
	0.40	0.65	Firm dark brown plastic pseudo-fibrous PEAT (H7/B4)	PP-72 (0.00m - 0.65m)	
T8	0.00	0.40	Soft dark brown plastic pseudo-fibrous PEAT (H6/B2)		
	0.40	1.10	Soft brown plastic pseudo-fibrous PEAT (H7/B6)	PP-692 (0.00m - 1.10m)	
T7	0.00	0.30	Soft brown plastic pseudo-fibrous PEAT (H5/B2)		
	0.30	0.80	Soft brown plastic pseudo-fibrous PEAT (H7/B6)		
	0.80	1.00	Very soft dark brown plastic amorphous PEAT (H9/B2)	PP-595 (0.00m - 1.00m)	
T6	0.00	0.20	Soft brown spongey fibrous PEAT (H3/B2)		
	0.20	0.50	Soft brown plastic pseudo-fibrous PEAT (H7/B3)		
T10	0.00	0.20	Soft brown spongey fibrous PEAT (H5/B5)		
	0.20	0.70	Firm brown plastic pseudo-fibrous PEAT (H7/B3)		
Track 1 (PP-1044)	0.00	0.10	Firm brown spongey fibrous PEAT (H2/B6)		
	0.10	0.80	Firm brown spongey fibrous PEAT (H5/B5)		
	0.80	1.20	Soft brown plastic pseudo-fibrous PEAT (H6/B4)		
	1.20	1.80	Soft black plastic pseudo-fibrous PEAT (H7/B3)		
Track 2 (PP-1064)	0.00	0.80	Soft brown spongey fibrous PEAT (H6/B5)		Highly disturbed
Track 3 (PP-1434)	0.00	0.80	Soft brown spongey fibrous PEAT (H4/B5)		

T01 (0-0.65mbgl)



T03 (0-0.90mbgl)

T06 (0-0.50mbgl)

T7 (0-1.00mbgl)

T8 (0-1.10mbgl)

T9 (0-0.80mbgl)

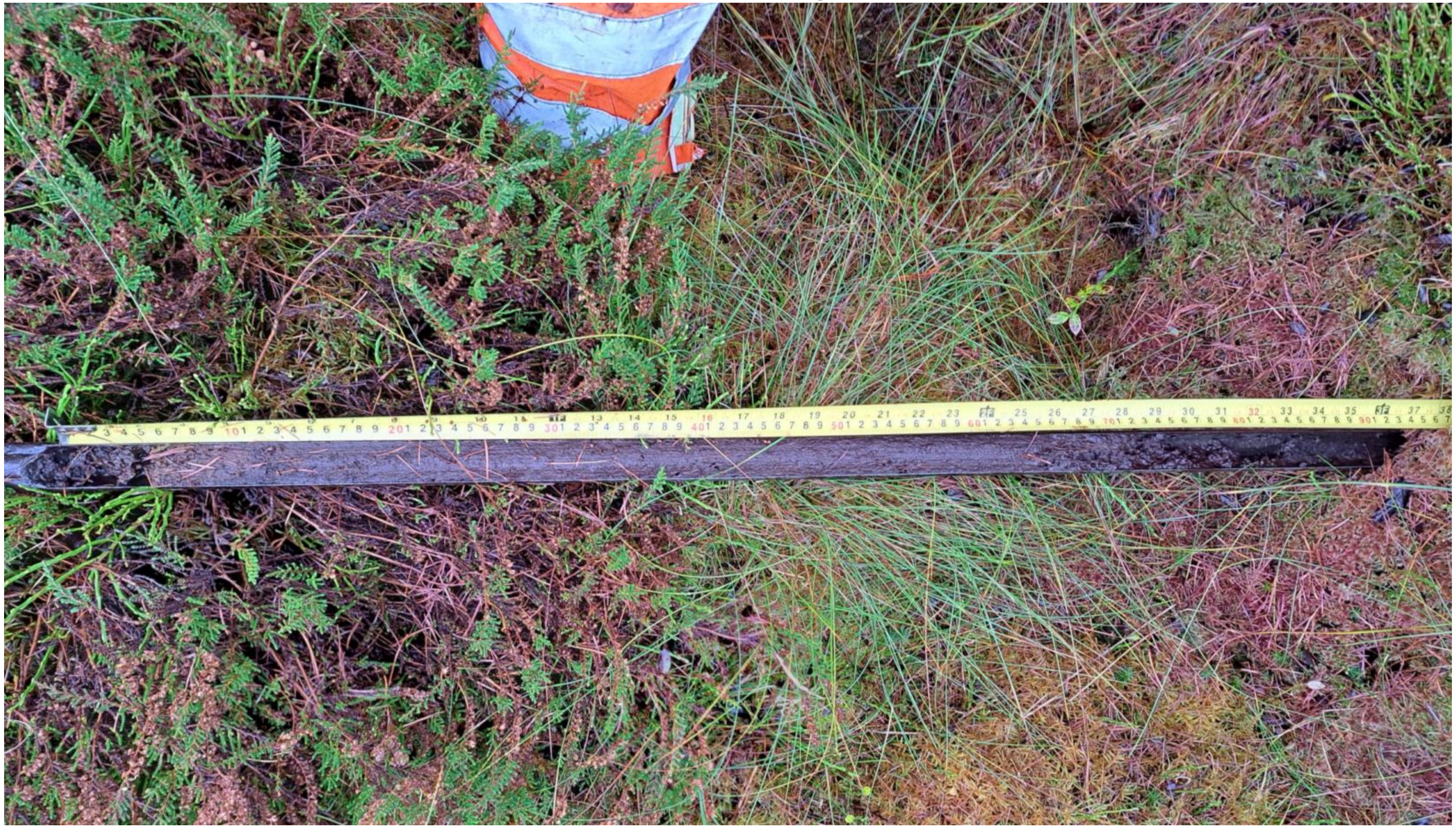
T10 (0-0.70mbgl)

Track 1 (0-1.00mbgl)

Track 1 (1.00 – 1.80mbgl)

Track 2 (0-0.80mbgl)

Track 3 (0-1.00mbgl)



Track 3 (1.00-1.80mbgl)

Track 4 (0-0.80mbgl)

Project Name: South Kyle 2 Windfarm
Project ID : 14805UKC

HSV Results	Corrected Hand Shear Vane Results		
Location	Depth	Peak	Residual
T3	0.5	14	9
T3	1	11	8
T3	1.5	10	7
T3	2	16	11
T9	0.5	23	9
T1	0.5	10	7
T8	0.5	52	42
T8	1	65	34
T7	0.5	24	12
T7	1	25	10
T10	0.5	21	11
T6	0.5	16	14
Track 1	0.5	14	8
Track 1	1	17	6
Track 1	1.5	19	7
Track 2	0.5	12	4
Track 3	0.5	25	9
Track 3	1	20	10
Track 3	1.5	23	14
Track 4	0.5	14	6

MATtest Limited
materials testing & consultancy

10 Queenslie Point
Queenslie Industrial Estate
120 Stepps Road
Glasgow
G33 3NQ

Tel: 0141 774 4032

email: info@mattest.org
Website: www.mattest.org

LABORATORY TEST CERTIFICATE

Certificate No :	**23/1293 - 01-1**
To :	**Alasdair Ellis**
Client :	**The Natural Power Consultants** The Green House Forrest Estate Dalry Castle Douglas **DG7 3XS**

LABORATORY TESTING OF SOIL

Introduction

We refer to samples taken from South Kyle 2 and delivered to our laboratory on 27th November 2023.

Material & Source

Sample Reference	:	See Report Plates
Sampled By	:	Client
Sampling Certificate	:	Not Supplied
Location	:	See Report Plates
Description	:	See Page 2
Date Sampled	:	Not Supplied
Date Tested	:	27th November 2023 Onwards
Source	:	14805UKC - South Kyle 2

Test Results

As Detailed On Page 2 to Page 4 inclusive

Comments

The results contained in this report relate to the sample(s) as received
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
All remaining samples for this project will be disposed of 28 days after issue of this test certificate

Remarks

Approved for Issue

T McLelland (Director)

Date 11/12/2023

UKAS TESTING 2643

BOREHOLE	SAMPLE	DEPTH (m)	SAMPLE DESCRIPTION
PP-72 (T01)	B	0.00-0.65	Black PEAT (Von Post Classification - H5)
PP-595 (T07)	B	0.00-1.00	Black PEAT (Von Post Classification - H6)
PP-692 (T08)	B	0.00-1.10	Brown PEAT (Von Post Classification - H7)
PP-802 (T09)	B	0.00-0.80	Brown PEAT (Von Post Classification - H7)
T03	B	0.00-0.90	Brown PEAT (Von Post Classification - H7)

SUMMARY OF SAMPLE DESCRIPTIONS

MATtest Limited
materials testing & consultancy

BOREHOLE	SAMPLE	DEPTH (m)	WATER CONTENT (%)
PP-72	B	0.00-0.65	537
PP-595	B	0.00-1.00	426
PP-692	B	0.00-1.10	906
PP-802	B	0.00-0.80	659
T03	B	0.00-0.90	726

Tested in accordance with BS 1377 - 2 : 2022 : Clause 4.1

SUMMARY OF WATER CONTENT TEST RESULTS

BOREHOLE	SAMPLE	DEPTH (m)	WATER CONTENT (%)	BULK DENSITY (Mg/m^3)	DRY DENSITY (Mg/m^3)
PP-72	B	0.00-0.65	537	0.99	0.16
PP-595	B	0.00-1.00	426	1.04	0.20
PP-692	B	0.00-1.10	906	0.97	0.10
PP-802	B	0.00-0.80	659	0.99	0.13
T03	B	0.00-0.90	726	0.98	0.12

Tested in accordance with BS 1377 - 2 : 2022 : Clause 8
Bulk Density : Linear Measurement

SUMMARY OF WATER CONTENT AND BULK DENSITY TEST RESULTS

Certificate of Analysis

Certificate Number	23-28658	*Issued:*	13-Dec-23
Client	MATTest Ltd. 10 Queenslie Point 120 Stepps Road Glasgow G33 3NQ		

Our Reference	23-28658
Client Reference	23/1293
Order No	MATSC5521
Contract Title	South Kyle 2
Description	5 Soil samples.
Date Received	06-Dec-23
Date Started	06-Dec-23
Date Completed	13-Dec-23
Test Procedures	Identified by prefix DETSn (details on request).
Notes	Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Kirk Bridgewood
General Manager

UKAS TESTING 2139

Summary of Chemical Analysis
Soil Samples

Our Ref 23-28658
Client Ref 23/1293
Contract Title South Kyle 2

			Lab No	2272524	2272525	2272526	2272527	2272528
			.Sample ID	T07	T01	T08	T09	T03
			Depth	0.00-1.00	0.00-0.65	0.00-1.10	0.00-0.80	0.00-0.90
			Other ID					
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	13/11/2023	08/11/2023	08/11/2023	08/11/2023	30/10/2023
			Sampling Time	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**					
Inorganics								
Carbon, Total	DETSC 2084*	0.5	%	38	33	35	43	37
Total Organic Carbon	DETSC 2084#	0.5	%	37	32	35	43	39

Information in Support of the Analytical Results

Our Ref 23-28658
Client Ref 23/1293
Contract South Kyle 2

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
2272524	PP-595 0.00-1.00 SOIL	13/11/23	PT 1L	Carbon, Total (14 days)	
2272525	PP-72 0.00-0.65 SOIL	08/11/23	PT 1L	Carbon, Total (14 days)	
2272526	PP-692 0.00-1.10 SOIL	08/11/23	PT 1L	Carbon, Total (14 days)	
2272527	PP-802 0.00-0.80 SOIL	08/11/23	PT 1L	Carbon, Total (14 days)	
2272528	T03 0.00-0.90 SOIL	30/10/23	PT 1L	Carbon, Total (14 days), Organic Matter (Auto) (28 days)	

Key: P-Plastic T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

End of Report

Creating a better environment

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sayhello@naturalpower.com

For full details on our ISO and other certifications, please visit our website.